



The 50-degree city: Designing urban life for extreme heat



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Executive summary

Extreme heat is a growing challenge for the future of cities, influencing public health, infrastructure performance, economic activity and quality of life. As urban populations grow and climate pressures intensify, cities will need to build resilience to cope with more frequent and prolonged periods of extreme heat. Cities that cannot maintain reliable infrastructure, comfortable public spaces and safe working environments during periods of extreme heat risk becoming less attractive places to live, work and invest.

The challenge is particularly acute across the Middle East, where temperatures are rising at almost twice the global average and several countries in the region already experience summer temperatures exceeding 50°C, placing increasing pressure on energy systems, water resources, public health and outdoor labour.¹

Around the world, cities are responding in different ways to extreme heat, by redesigning their urban environments to reduce heat exposure through active and passive measures, using technology and data to anticipate heat rather than react to it, and improving governance to coordinate activities and drive decision-making across multiple stakeholders.



This paper explores how extreme heat is reshaping urban development in the Middle East, highlights leading global practices of cities' responses to increasing heat, and presents a five-step heat resilience approach to help cities in the Middle East build long-term heat resilience while sustaining growth and quality of life.

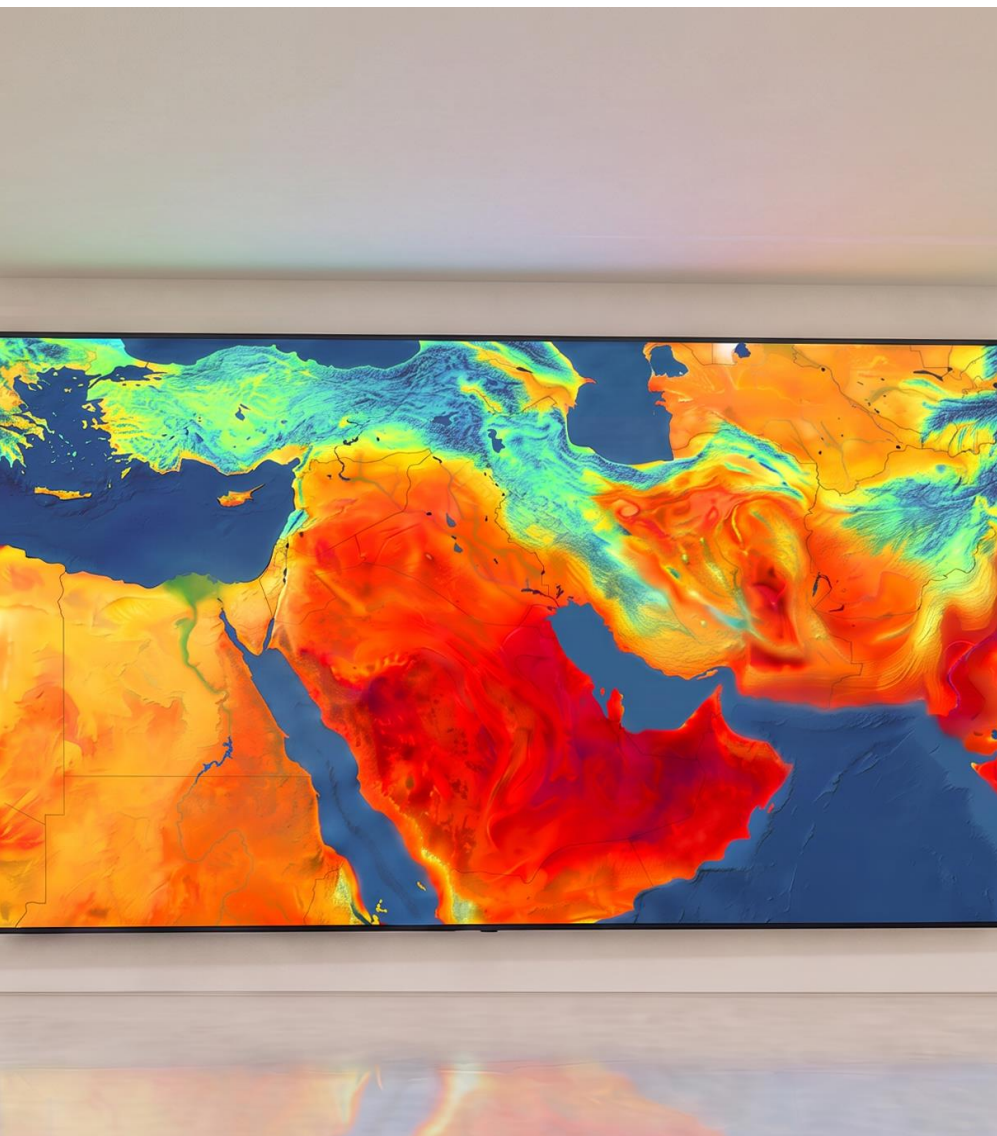


Understanding the urban heat effect on cities

For decades, urban development has prioritised density, connectivity and economic efficiency. These principles remain fundamental, but they are no longer sufficient, marking a fundamental shift in urban planning. Heat now influences almost every aspect of city performance and decisions, once driven primarily by efficiency and growth, must now also consider thermal comfort and climate resilience.

Highly urbanised areas have increased exposure to climate-related risks. Over the past seven decades, the world's urban population has grown from approximately 750 million people to more than four billion.² And with 55% of the global population living in urban areas, rising to 68% by 2050,³ the challenge of urban heat needs to be addressed with urgency.

So, how does heat accumulate? Buildings, roads and paved surfaces absorb and store solar radiation before releasing it after sunset, while limited vegetation reduces evaporative cooling and emissions from transport, industry and cooling systems generate additional waste heat. Together, these factors create the Urban Heat Island (UHI) effect, where densely developed areas can become warmer than surrounding rural landscapes.⁴ In Europe, for example, this can increase temperatures by 10 to 15°C.⁵



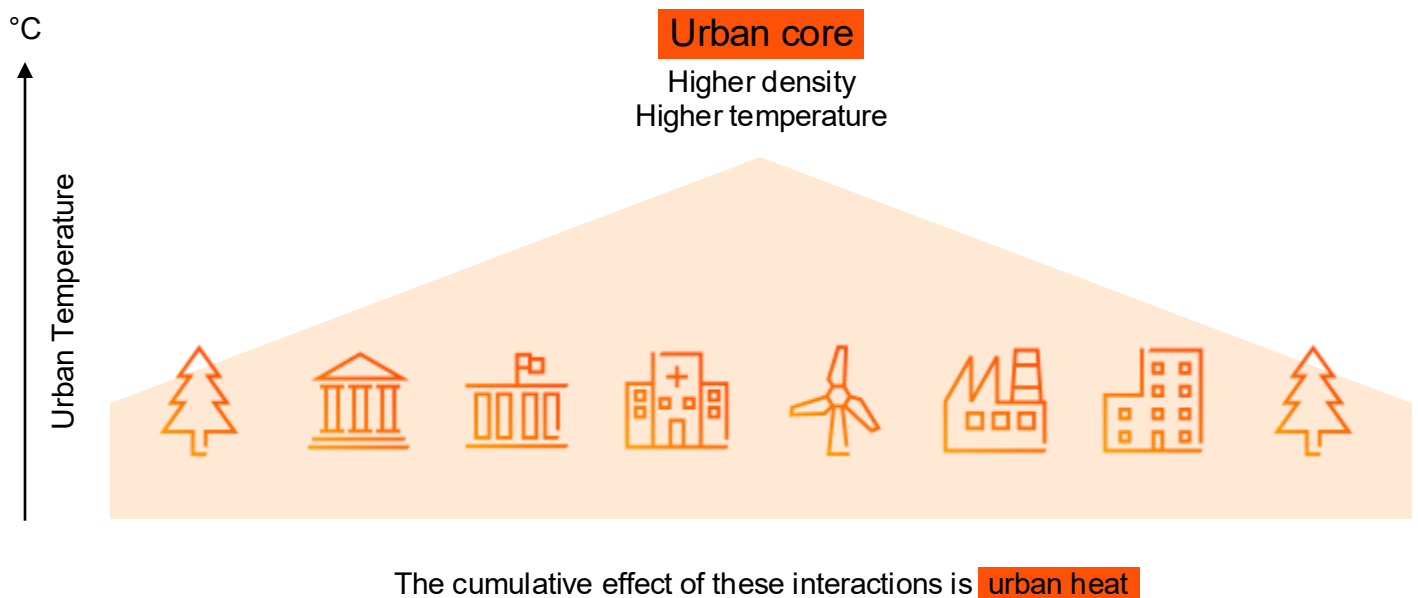
55%



of the global population
living in urban areas

rising to 68% by 2050

Figure 1: The effect of urban heat over cities



What drives urban heat?

Agglomeration
of buildings

Expansion of
roadways

Extensive concrete
surfaces

Green-house effect gases
from human activities

Climate change amplifies this effect. Rising temperatures can increase heat exposure in cities, while increasing frequency leaves less time for cities, infrastructure, and communities to recover.⁶

For many cities, this is redefining what resilience means. Unlike many urban risks, extreme heat cannot be prevented - only managed and adapted to. This places city leaders at the centre of building resilience by embedding heat mitigation and adaptation into urban planning, infrastructure investment, public health, and economic development.

The question facing city leaders is no longer whether to respond to rising temperatures, but how quickly they can embed heat resilience into the core of urban development.



Heat is amplifying existing inequalities

Extreme heat may affect entire cities, but exposure and vulnerability are uneven.

Low-income communities often experience higher temperatures because they have fewer trees and green spaces, more heat-absorbing surfaces, and older buildings with limited insulation or cooling.⁷ Older adults, children, people living with chronic illness and outdoor workers are also particularly vulnerable as exposure to extreme heat can increase the risk of heat exhaustion or heat stroke.⁸

Heat, therefore, compounds vulnerabilities associated with income, housing and health. Without targeted adaptation, cities risk widening social disparities and increasing long-term public health costs.

Extreme heat is a city-wide challenge, but an unequal one.





51°C+

Temperatures contributed to widespread electricity failures across southern Iraq

Infrastructure is under pressure

Much of today's transport, electricity, water and building infrastructure was designed for climatic conditions that are changing, leaving some systems increasingly exposed to temperatures beyond their original operating assumptions.⁹

Electricity networks are among the most visible pressure points as cooling demand rises sharply during extreme heat. In 2022, temperatures exceeding 51°C contributed to widespread electricity failures across southern Iraq, leaving millions without power.¹⁰ Transport systems face similar risks, with high temperatures capable of deforming roads, disrupting rail operations and reducing service reliability. For example, in Europe, recurring heatwaves have forced temporary rail closures and emergency responses after infrastructure exceeded safe operating temperatures.^{11, 12}

Water systems are also under growing pressure globally as higher temperatures increase evapotranspiration and water demand for irrigation, public use, and cooling. And warmer water can degrade water quality by increasing the rate of disinfectant degradation, while heat and drought place additional stress on distribution infrastructure, increasing the risk of pipe failures and associated maintenance requirements.^{13, 14}

In the GCC, where desalination supplies around 75% of urban water,¹⁵ extreme heat can place additional pressure on desalination systems by raising seawater temperatures. High-temperature and high-salinity feedwater can impair membrane performance, increase fouling and scaling risks, reduce water recovery and quality, and require more energy or additional treatment to maintain output.¹⁶

The resilience challenge is therefore shifting from protecting infrastructure against isolated events to ensuring essential systems can continue operating through more frequent and prolonged periods of extreme heat.



Economic impacts are mounting

Extreme heat is also becoming a structural economic challenge, affecting labour markets, productivity, public expenditure and investment.¹⁷ Outdoor and physically demanding sectors, including construction, logistics, manufacturing, and municipal services, are particularly exposed as heat reduces the number of safe working hours.



In 2020, 12 global cities collectively lost US\$44 billion in productivity due to extreme heat - a figure that could almost double to US\$84 billion by 2050 without targeted action.¹⁸ And for the world's largest cities, heat-related productivity losses could decrease real gross domestic product (GDP) by 1.4–1.7% by 2050, and up to 11% by the end of the century.¹⁹

The costs extend beyond productivity. Heat increases healthcare expenditure, energy consumption and infrastructure maintenance, placing additional pressure on households, businesses and public budgets. In the United States alone, summer heat is estimated to generate around US\$1 billion in additional healthcare costs each year.²⁰



These pressures are mutually reinforcing: infrastructure failures disrupt businesses, higher health and energy costs constrain budgets and lost working hours weaken productivity. Conversely, investment in heat resilience can reduce disruption, improve health outcomes and lower long-term energy demand, making adaptation an economic as well as a climate imperative.

These trends are turning heat resilience into a strategic urban capability. Rather than relying on isolated emergency measures, cities need to integrate heat considerations into the way they plan, invest and govern.



Three key shifts among global cities

Around the world, cities are responding to extreme heat in different ways, but leading approaches share a common characteristic: they embed heat resilience into long-term urban development rather than relying on isolated adaptation projects.

Three characteristics stand out.



01 They are redesigning urban environments to reduce heat exposure

Active cooling remains important, but leading cities are increasingly using passive measures such as green infrastructure, reflective materials and climate-responsive design to reduce heat retention and improve thermal comfort.^{21, 22}

4.5°C

Potential reduction in outdoor summer temperatures through Riyadh's cooling interventions

In Saudi Arabia, the Green Riyadh programme is aiming to plant 7.5 million trees and expand green spaces across the city by 2030.²³ Researchers modelling urban heat-mitigation scenarios in **Riyadh** found that combining cool materials with green infrastructure could reduce peak ambient temperatures by up to 4.5°C during summer and decrease cooling energy consumption by around 16%.²⁴

In Colombia, **Medellín** has adopted a similarly integrated approach through more than 30 interconnected green corridors linking transport routes, waterways and public spaces. The programme has reduced local temperatures by up to 2°C while improving biodiversity and the liveability of public spaces.²⁵

In France, **Paris** complements these approaches through more than 800 'cool islands', which are 2-4°C cooler than surrounding streets and connected by naturally cool pedestrian routes.²⁶ These examples show how urban design can reduce heat exposure while delivering wider environmental and public health benefits.





3D

Urban models help planners test heat impacts before development takes place

02 They are using technology and data to anticipate heat rather than react to it

Some cities are also using digital tools to improve planning before extreme heat occurs.

Singapore uses digital climate and environmental modelling as part of its urban-planning process. Tools including digital twins and high-resolution 3D city models allow planners to simulate wind flow, solar exposure and temperature, and to test how factors such as building height and configuration, street alignment, greenery and the placement of public amenities affect thermal comfort before construction or implementation.^{27, 28, 29}

In Australia, **Melbourne's** Integrated Climate Adaptation Model provides another example, allowing the city to model climate scenarios, identify vulnerabilities and assess different adaptation options.³⁰



03 They are governing heat across the whole city

The strongest lesson from leading cities is that heat resilience depends as much on governance as on physical interventions.

Urban heat cuts across multiple sectors, including: urban planning, transport, utilities, public health, emergency services and environmental management. Without coordination, interventions can become fragmented and less effective.

The strongest heat strategies connect people, policy and place.

In Sierra Leone, **Freetown** appointed Africa's first Chief Heat Officer to coordinate action across stakeholders, strengthen heat preparedness and protect communities most vulnerable to extreme heat.³¹

In Greece, **Athens** has adopted a similar model, appointing Europe's first Chief Heat Officer to coordinate with the city's cross-departmental team on climate adaptation, raise the profile of extreme heat as a key priority through media and broader communications, and establish a city-wide heat health task force.³²

Ahmedabad, in India, offers another governance model. Following a severe heatwave, the city developed South Asia's first comprehensive Heat Action Plan (HAP) through collaboration between local government, academic institutions, healthcare providers and telecommunications companies. The plan established clear responsibilities, early warning systems and public health protocols and has since informed approaches elsewhere.³³

These examples show that successful heat resilience does not depend on a single intervention. It requires physical adaptation, digital capability and effective governance to work together within a coherent long-term strategy.

The experience of leading cities shows that practical approaches already exist, but their value depends on bringing them together as part of a coherent, city-wide strategy. The question for governments in the Middle East is, therefore, how to create an integrated approach tailored to local climate conditions, institutional capacity and community needs.

The priority now is to embed heat resilience into the decisions that will shape infrastructure, buildings, public spaces and urban development for decades to come.

The decisions made today will determine whether future generations inherit cities that remain productive, healthy and liveable despite a changing climate.

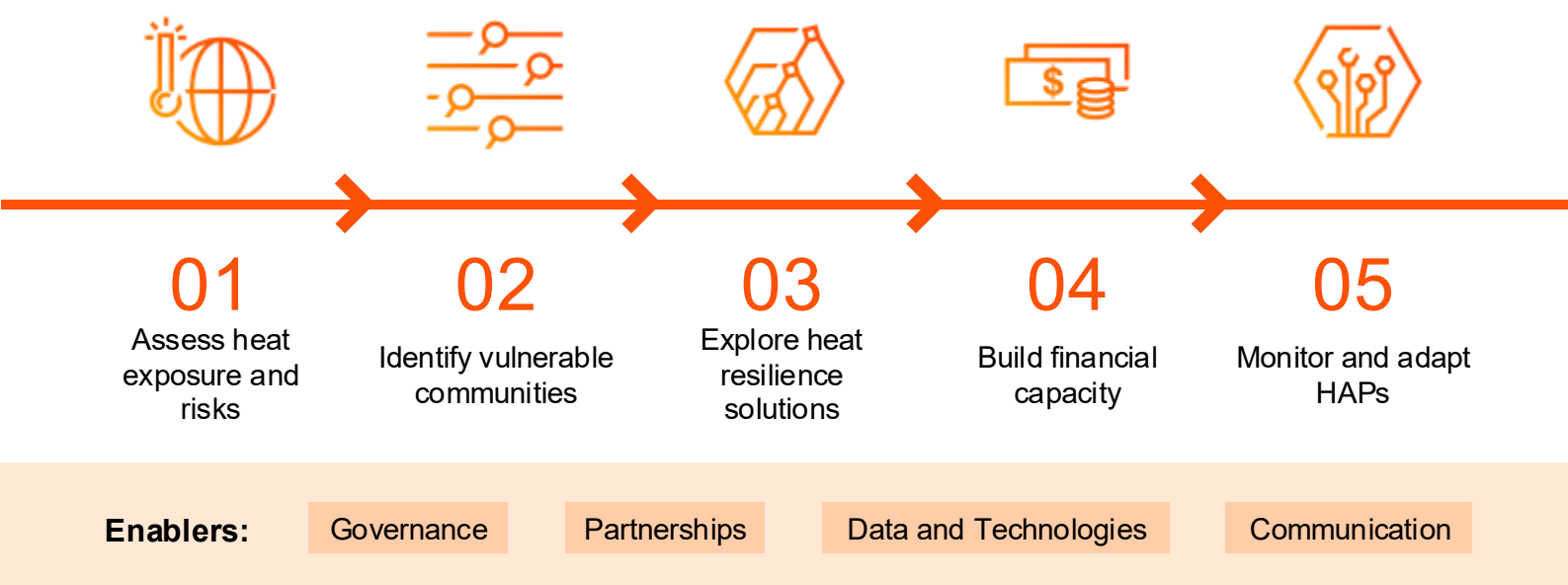


Future-proofing cities: The five-step heat resilience approach for cities in the Middle East

Within the next 25 years, 1.6 billion people across nearly 1,000 cities are projected to experience regular extreme heatwaves, equivalent to more than 40% of today's urban population.³⁴ The GCC is already one of the most highly urbanised subregions globally, with urbanisation rates ranging from 79% to 100%.³⁵ And as the wider region continues to urbanise at pace,³⁶ strengthening urban resilience to increasing extreme heat will become an essential strategic priority.

Cities in the Middle East will need integrated approaches that strengthen critical systems, including transport, energy, water, healthcare and emergency services, while addressing social vulnerability and long-term climate risk. Coordinating these priorities and translating evidence into action will require a comprehensive approach.

Figure 2: The five-step heat resilience approach



Drawing on international leading practice, this five-step approach offers practical guidance for developing heat resilience and Heat Action Plans, as implementation mechanisms that protect vulnerable communities, safeguard critical infrastructure and enable more resilient, sustainable and heat-ready cities.



01

Assess heat exposure and risks

Effective heat management begins with understanding where heat accumulates, who is exposed and which urban systems are most vulnerable.

This requires far more than measuring air temperature. Cities should develop a comprehensive understanding of how heat interacts with urban form, infrastructure and population characteristics. Temperature patterns should be analysed alongside humidity, land cover, albedo, demographic data and health outcomes to establish a detailed baseline of urban heat exposure.³⁷

Digital technologies are making this process increasingly sophisticated. Satellite imagery, geospatial analytics and digital climate models enable cities to map neighbourhood-scale temperature variation and identify localised heat islands that conventional weather stations may

overlook. These insights provide a stronger evidence base for prioritising future investment.

Artificial intelligence (AI) can extend these capabilities by analysing multiple datasets simultaneously to identify emerging risks and assess the likely impact of different adaptation measures.

Understanding the institutional factors at the outset helps identify implementation challenges before they emerge. Existing policies, planning frameworks, partnerships and technical capabilities all influence how effectively cities can respond to rising temperatures.

Ultimately, the objective is to establish a shared evidence base that supports coordinated decision-making across government and provides a foundation for future investment.

02

Identify vulnerable communities

Heat risk is shaped not only by temperature, but by age, health, income, housing, access to cooling and neighbourhood conditions.³⁸

Cities should therefore move beyond city-wide averages to identify where multiple vulnerabilities overlap.

Spatial analysis can combine demographic information with environmental data to identify neighbourhoods experiencing both high temperatures and limited adaptive capacity.

These insights allow cities to target interventions where they can deliver the greatest social and economic benefits, whether through tree planting, cooling centres, housing improvements, or enhanced public health services.

By integrating these layered vulnerabilities into planning processes, cities can design targeted interventions that protect the most affected communities, guaranteeing that resources are allocated to areas with the most critical needs.³⁹

03

Explore heat resilience solutions

Adaptation strategies should respond to local climate conditions, urban form and institutional capacity rather than replicate solutions developed elsewhere.

Successful cities typically combine passive and active cooling measures. Passive approaches include expanding urban forests, increasing vegetation, introducing reflective materials, improving building design and creating shaded public spaces. These measures reduce heat accumulation while delivering additional benefits for biodiversity, air quality and public wellbeing.⁴⁰

Active cooling interventions - including cooling centres, district cooling systems and mechanical air conditioning - remain essential during extreme heat events, particularly for protecting vulnerable populations and maintaining critical services. However, because these measures often increase energy demand, they should complement rather than replace passive adaptation wherever possible.

The priority is to combine these interventions in ways that strengthen resilience without unnecessarily increasing long-term energy demand.

04

Build financial capacity

As cities in the Middle East face increasing climate pressure, financial mechanisms play a vital role in driving transformative urban development. Building financial capacity requires cities to quantify both the costs of inaction and the wider benefits of adaptation. Cooler public spaces improve health outcomes, encourage walking and cycling, strengthen local economies and increase the attractiveness of urban environments. Better building design reduces energy demand and operating costs, while resilient infrastructure lowers maintenance costs and improves service reliability. Estimating the full range of benefits is a part of communicating the importance of addressing urban heat and mobilising stakeholder engagement.⁴¹

In addition, cities can move from identifying benefits to financing implementation. Energy-efficiency upgrades can be funded upfront and repaid through verified utility savings, reducing the initial capital burden on asset owners. In Abu Dhabi, the Energy Saving Performance Contracting model uses private Energy Services Companies (ESCOs) to deliver such improvements. Under the Building Retrofit Programme, the first Super ESCO is intended to act as a market catalyst, supporting upgrades across 3,000 buildings and recovering implementation costs through the resulting utility savings.⁴²

05

Monitor and adapt HAPs

Heat action plans (HAPs) should evolve as risks, evidence and local conditions change. Their value lies in coordinating action across departments, aligning investment and establishing accountability for delivery.

HAPs are particularly important in the Middle East, where temperatures are rising faster than the global average and more people are expected to live in urban areas,^{43,44} increasing potential exposure and risks to public health, outdoor work, mobility and energy systems.

Across the region, governments have already introduced measures to manage some of these risks. Qatar has strengthened protections for outdoor workers, including restrictions on work during the hottest months and temperature-based thresholds for stopping work.⁴⁵ Abu Dhabi's Safety in Heat programme provides a

framework for managing occupational heat risks,⁴⁶ while Saudi Arabia has developed extensive measures for Hajj that combine health surveillance, public warnings, medical preparedness and interventions to reduce heat exposure.⁴⁷

These provide the building blocks for integrated HAPs that coordinate action across public health, infrastructure, transport, housing, labour and environmental management, with clear triggers, responsibilities and milestones. Regular monitoring can track heat exposure, access to shade, heat-related illness and progress on climate-resilient infrastructure. For cities across the Middle East, this can shift heat management beyond seasonal, reactive measures towards a coordinated approach embedded in how cities plan, invest and operate.



Cross-cutting enablers for success

The experience of leading cities highlights key enablers that are critical to the deployment of Heat Action Plans.



Governance

Successful programmes are driven by visible leadership supported by clear institutional accountability. Dedicated leadership, whether through a Chief Heat Officer or an equivalent coordinating function at the national, regional and local levels, helps to align inter-agency coordination around shared objectives.⁴⁸



Partnerships

Managing urban heat extends beyond the responsibilities of local government. Universities, utilities, healthcare providers, private sector organisations and community groups all contribute expertise, resources and local knowledge. Partnerships also improve implementation by ensuring that adaptation measures reflect the needs of residents while drawing on specialist technical capability.



Data and technologies

Digital technologies are rapidly changing how cities understand and manage heat. Geographic information systems, digital twins, satellite imagery, sensor networks and AI-enabled analytics support more accurate risk assessments, improve infrastructure planning and strengthen emergency preparedness. Their greatest value lies not in technology itself, but in enabling better, faster and more evidence-based decisions.



Communication and community engagement

Public awareness remains one of the most effective forms of adaptation. Early warning systems, targeted communication campaigns and community outreach programmes help residents understand heat risks, access available services and adopt protective behaviours during extreme heat events. Sustained engagement also builds public support for long-term adaptation measures and encourages shared responsibility for urban resilience.

From heat risk to heat resilience

With extreme heat putting mounting pressure on cities' infrastructure, health, productivity and liveability, managing heat effectively will increasingly shape the region's ability to sustain urban growth and quality of life.

Cities across the Middle East need to embed heat resilience into planning, investment and governance, moving beyond short-term measures to strengthen long-term resilience.

For cities in the Middle East, this means they must:

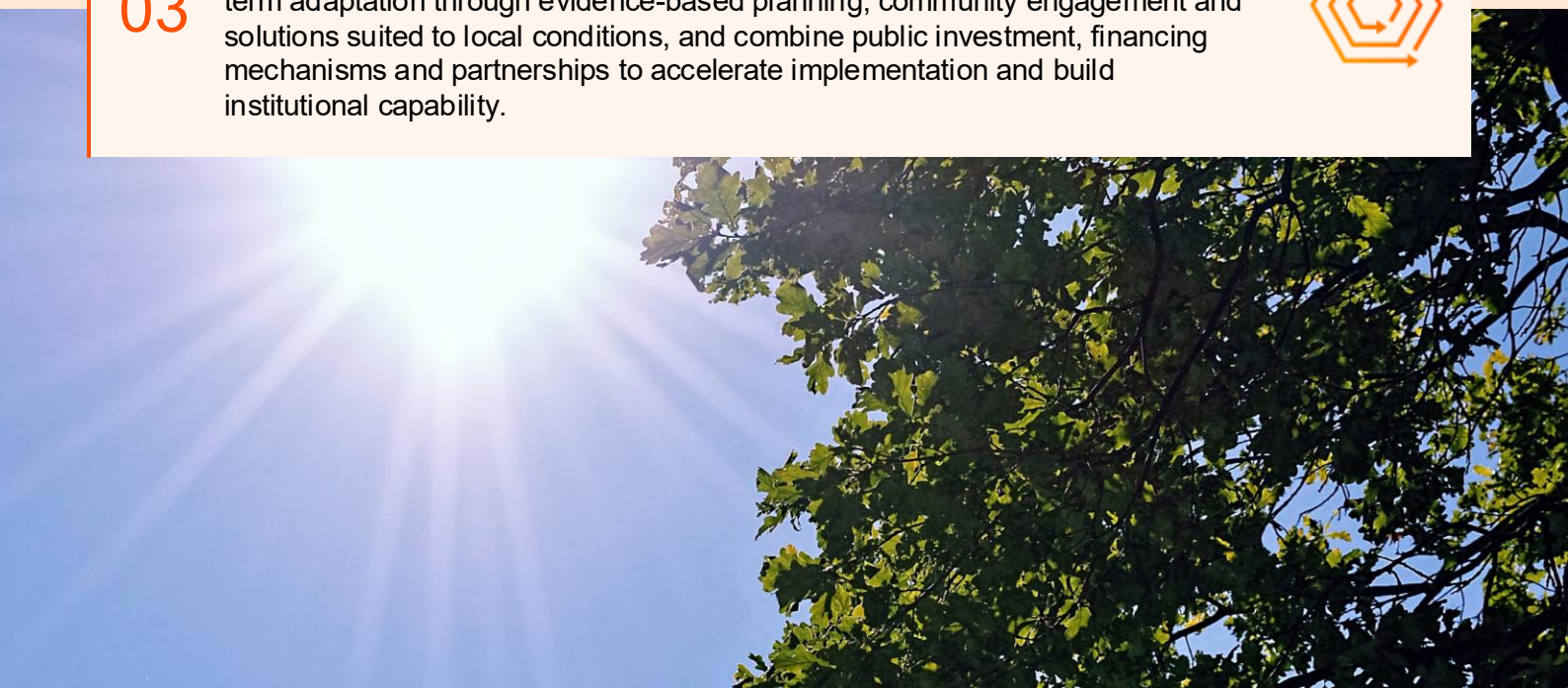
- 01 Treat heat as a strategic urban priority**
Recognise heat as a cross-cutting issue requiring coordinated action across government, infrastructure and communities.



- 02 Embed heat resilience in how cities operate, invest and govern**
Strengthen governance and institutional capacity, establish clear leadership, accountability and coordination to implement and continuously improve heat resilience measures and harness data, technology and artificial intelligence (AI) to support better-informed decisions.



- 03 Act now**
Develop locally tailored HAPs to connect emergency preparedness with long-term adaptation through evidence-based planning, community engagement and solutions suited to local conditions, and combine public investment, financing mechanisms and partnerships to accelerate implementation and build institutional capability.



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