ISSUE BRIEF

Heatwave Resilience:
Mitigating extreme heat impacts and fostering community and infrastructural resilience

Heat resilience: An imperative and a global priority

The frequency, duration and intensity of extreme heat and heatwave incidents is growing worldwide. Amplified by climate change, heat poses severe health, socio-economic and environmental risks.

Nearly 350 cities home to over 250 million people are vulnerable to extreme heat. While 14% of urban population is already facing extreme heat, it is likely to become 45% by 2050 *[UIRP Strategy, CDRI]* – including facing life-threatening effects due to heat and humidity. In fact, two-thirds of global exposure to extreme heat occurs in cities in the global south (primarily in Asia and Africa) where rapid urbanization and climate change impacts are more pronounced. *[Tuholske et al., 2021]*

Vulnerable segments such as the elderly, women, children, outdoor workers and labourers, key socio-economic services, infrastructure, and individuals with pre-existing health conditions face disproportionate impacts. Typical urban spaces compound these challenges, leaving millions at risk of heat-related illnesses, disrupted livelihoods, and compromised ecosystems. Urban areas are particularly susceptible to these effects because of the Urban Heat Island (UHI) phenomenon, wherein dense infrastructure and nonpermeable materials such as concrete, asphalt, metal etc. absorb and retain heat, leading to significantly higher temperatures. *[US EPA, 2008]*

Heat Action: an existing risk and an emerging priority

- *By 2100, heatwaves could increase in frequency by up to 41 times compared to pre-industrial levels (IPCC, 2022).*
- *By 2050, over 2bn children are likely to face frequent extreme heat/heatwave exposure (UNICEF)*
- *Heat-related deaths among vulnerable populations are projected to increase, with over 250,000 deaths annually by 2050 without adaptation measures (WHO, 2018).*
- *Heatwaves have already caused $145 billion in economic losses globally from 2000 to 2020, with rising trends expected (World Bank, 2021).*
- *More than 3.5 billion people could be living in regions experiencing dangerous levels of heat for over 20 days annually by 2070 (Nature Communications, 2020).*
- *By 2050, 70% of global population will be in urban areas, amplifying exposure to heat-related risks (UN, 2018)*
- *Vulnerable populations, outdoor workers and low-income communities face disproportionately higher health and economic burdens due to heat exposure (ILO, 2019).*
- *Higher mortality than from hurricanes, tornadoes and lightening combined – 500k excess deaths per yr [Riley 2018)*

Urban contexts amplifying the challenge: the 'What'?

Urban areas face intensified heatwave challenges due to the typical built environment. Some of the key interconnected factors contributing to heightened vulnerability to extreme heat/heatwaves include:

i. **Dense infrastructure and heat-absorbing materials** such as concrete, asphalt and metal dominate urban construction, create hotspots and make buildings and roads act as heat reservoirs trapping/radiating heat.

ii. **Poor urban planning** marked by compact structures, population density, inadequate ventilation between buildings, narrow streets etc. reduce ability to dissipate heat, minimize air circulation and create heat pockets.

iii. **Exploitation of urban ecosystems, disregard of environmental carrying capacity and limited green spaces.** Insufficient trees, parks, vegetation, biodiversity, encroachment on water bodies and wetlands in cities leads to higher surface/ambient temperatures and water scarcity -- while lack of evapotranspiration reduces the natural ability to cool the environment.

iv. **Higher temperatures cause increased energy demand** leading to higher reliance on air conditioning and cooling systems which in turn result in higher energy use and additional heat emissions from cooling units.

v. **Higher proportion of vulnerable populations** such as the elderly, women, children, outdoor workers, and marginal communities in informal settlements face high exposure and disproportionate impacts.

vi. **Urban socio-economic inequality** is further intensified by rural-to-urban migration, making disadvantaged communities more vulnerable due to limited access to cooling solutions and climate-resilient infrastructure.

vii. **Pressure on public health care system** as rising exposure to extreme heat causes heatstroke, stress, exhaustion, dehydration while worsening respiratory and cardiovascular conditions increase hospitalization rates -- placing additional burden on already stretched health systems.

In an urban context, these challenges call for immediate and proactive interventions, including sustainable urban planning, enhanced green infrastructure, cooling solutions, community engagement, multi-sectoral and multi-stakeholder approach to safeguard public health, mitigate environmental impacts, and build urban resilience.

Extreme heat: socio-economic impacts:

Apart from social impacts, economic losses from heat are four times higher in low-income countries. Within cities, low-income neighborhoods experience greater heat exposure. The wide-ranging impacts include --

- Higher mortality - combination of rapid urbanization and rising temperatures make extreme heat a "silent killer" with significantly higher mortality among elderly.
- Loss of productivity - loss of mandays and working hours is estimated to be the tune of USD2.4 tn by 2030.
- Economic losses - damage to infrastructure, increased healthcare costs, reduced labor capacity, and losses in agriculture, tourism and manufacturing sectors.
- Sectoral impacts - in key development sectors such as water, energy, transport and others disrupting supply and adversely affecting functionality and availability.
- Impacts on air quality, disease transmission, workplace injuries and mental health especially among vulnerable segments of society (women, girls, elderly, ailing etc.)

Extreme heat: key gaps and needs:

Key gaps and needs that must be addressed to support city authorities, sectors, stakeholders, and communities in reducing, mitigating, and adapting to heat risks include the following:

- Extreme heat/heatwave is not identified as a natural hazard in national and local risk management strategies
- Lack of contextual and actionable data and risk information on heat risks at city level
- Insufficient investments in developing synthesized analysis of socio-economic and health impacts
- Lack of understanding of heat impacts on key sectors such as water, energy, transport etc.
- Non-integration of heat risks into national, urban, local and sectoral development plans and programs
- Absence of dedicated heat action plans
- Limited involvement of non-governmental actors, sectors, stakeholders and communities in heat prevention, mitigation and adaptation action.

In addition, it is noted that there is inadequate availability of climate finance as only 7-8% of global urban climate financing needs are being met, with even far less going to cities in the global south. [C40, 2023]

UNDP's *Resilient Urban Futures initiative* aims to strengthen county/city-level systems and capacities for risk-informed urban development and resilience building and, while adopting a multi-risk approach, it specifically seeks to address the increasing incidence, frequency and magnitude of extreme heat and heatwaves in the cities of Damietta (Egypt), Hawassa (Ethiopia), Kisumu (Kenya) and Busia (Uganda).
With a focus on risk data, risk analytics and resilience diagnostics, it will help develop heat risk profile, map city hotspots, develop systems and capacities, integrate risks into urban/sectoral, deploy digital tech solutions to disseminate heat alerts and advisories, and implement Nature-based solutions to foster heatwave resilience.

Extreme heat and heatwaves: programmatic framework

The overall objective of the programmatic action is to enhance the resilience of city agencies, stakeholders, sectors and communities to extreme heat, heatwaves and urban heat island effect through a holistic and mutually complementary approach addressing all dimensions.

Taking a 360^0 perspective on issues connected with heat and the factors exacerbating the impacts in a city context, UNDP's Urban Resilience Strategy and 'Resilient Urban Futures' initiative addresses heat risks as part of its comprehensive risk prevention, preparedness, mitigation and adaptation interventions. This includes enabling the city agencies, infrastructure and development sectors, communities and stakeholders to –

- assess and analyze heat risks in a more contextual way, connecting it to overall urban resilience building efforts,
- augment city governance systems and capacities,
- integrate heat risk into the city and sectoral plans,
- engage diverse stakeholders and sectors for a more joined-up and shared approach,
- address the needs of vulnerable segments of society such as the elderly, women, girls, children, disabled, in-migrants, informal economy workers etc.,
- harness the potential offered by digital technologies to improve heat risk mapping, advisories and alerts dissemination,
- implement nature-based solutions to offset heat,
- engage communities and households to take local-level action, and
- strengthen city early warning systems, preparedness and risk management capacities to reduce the impact of extreme heat/heatwaves.

The programmatic approach is aligned with *SDG-11*, *Pillar-3 of the New Urban Agenda* and *UNDP Strategic Plan* aimed at building resilience to existing, emerging and systemic risks and crises to foster risk-informed urban development.

It contributes to *UNSG's Call for Action on Extreme Heat* emphasizing concerted efforts to enhance international cooperation on (i) caring for the vulnerable; (ii) protecting workers; (iii) boosting resilience of economies and societies; and (iv) limiting temperature rise to 1.5^0 C.

UNDP's Crowdfunding Campaign to advance heatwave resilience – in the city of Dhangadhi, Nepal, which experiences temperatures exceeding 40°C almost every year. These extreme conditions severely impact vulnerable groups, disrupt lives and livelihoods, hinder socio-economic activities, and lead to chronic health issues and increased hospitalizations.
The ***#BeatTheHeat*** Crowdfunding Campaign seeks to mobilize $50,000 as part of *Our City-Our Action* plan to implement nature-based solutions with particular focus on schools, markets, bus shelters and other public places by involving philanthropies, charities, corporate entities/consortiums, market associations, community groups and individuals to mitigate extreme heat and its adverse effects on people.

UNDP's Heatwave Resilience Action:

UNDP's heatwave resilience action tackles extreme heat with a comprehensive, multi-pronged approach designed to protect vulnerable communities, cool urban spaces, enhance preparedness, heat mitigation and emergency response to secure resilient urban futures.

Focus Area 1: Mapping Heat Risks

a. **Map Heat/Urban Heat Island Hotspots:**
Using satellite data, temperature sensors, and GIS tools, cities can pinpoint heat hotspots to prioritize cooling measures — areas where dense infrastructure, asphalt roads, and minimal green cover trap and intensify heat.

b. **Heat Risk Profiles and Assessment:**
By layering population data with environmental and heat maps, conduct data-driven vulnerability analysis to identify socio-economic and health vulnerabilities among the elderly, children, outdoor workers, and low-income communities — groups facing high exposure with least access to cooling resources – and develop targeted resilience/heat action plans.

c. **Assess Heat/Heatwave Impact on Infrastructure:**
Integrate meteorological data and forecasting, urban design insights, and environmental conditions to assess, analyze and anticipate heatwave intensity, duration, and location and its potential impacts on socio-economic sectors such as water, energy, transport etc.

Focus Area 2: Heat-Resilient Urban Plans & Infrastructure

a. **Sustainable Infrastructure:**
Urban greening, rainwater harvesting, green buildings etc. help mitigate urban heat by reducing temperatures, conserving water, and promoting energy efficiency in residential and public spaces.

b. **Heat Absorbing/Reflecting and Cool Materials:**
Promote heat-resistant, reflective construction materials— especially for rooftops, pavements, and public spaces – and use of reflective paint or tiles, light-coloured surfaces, and heat-resistant coatings to deflect solar radiation and lower building temperatures.

c. **Risk-Informed Urban Planning:**
Integrate heat risk into urban development plans and design while factoring access to hydration kiosks, urban wind corridors, shaded public spaces around high-density public spots – including use of tech applications, like Internet of Things (IoT), based monitoring systems.

Focus Area 3: Early Warning & Emergency Response

a. **Heat/Heatwave Alerts and Advisories:**
Support advanced models to analyze weather patterns, urban temperature fluctuations, and environmental data to issue heat stroke and heatwave alerts (onset, severity, duration etc.) and advisories to mitigate impacts.

b. **Digital Tech Applications:**
Foster use of digital tech solutions such as mobile-based apps and other innovative tools to improve heat forecast, analysis and to ensure timely alerts and advisories including suggesting shaded routes/areas.

c. **Emergency Response and Heatwave Drills:**
Establishing a nodal emergency management center and conducting regular simulation drills with health services, emergency responders, and urban planning teams will help test and refine emergency protocols. By simulating real heatwave scenarios, cities ensure that hospitals, fire departments, public health teams, and cooling stations are ready to act fast when temperatures soar.

Focus Area 4: Nature-Based Cooling Solutions

a. **Hydro stations, Regreening and Eco-Friendly Cooling:**
Expanding urban forests and creating pocket parks in densely populated areas ensures long-term natural cooling. Promoting community-friendly solutions like clay water pots (which keep water naturally cool), shaded water stations, and well-ventilated public spaces offers immediate relief — especially for vulnerable groups who may not have access to technology-driven cooling solutions.

b. **Restoration and Smart Management of Urban Water Ecosystems:**
Protecting and restoring urban wetlands and water bodies and promoting IoT-based smart irrigation systems with moisture sensors and automated drip irrigation ensure trees, gardens, and green roofs stay healthy with minimal water use — making urban greening efforts sustainable year-round.

c. **Tech Applications for Water Governance and Management:**
Harness the potential of digital and other tech applications to improve urban water governance and management by monitoring urban water supply and sanitation infrastructure, service delivery and to monitor usage and wastage.

Focus Area 5: Public Awareness:

a. **Communication and Educational Materials:**
Develop easy-to-understand educational materials with tips to promote hydration, heatstroke prevention, and cooling tips. Distribute them through schools, community centers, public transport hubs, and social media to ensure maximum outreach.

b. **Mass Media Campaigns:**
Leverage the power of TV, radio, and digital platforms to run large-scale awareness campaigns. Involving local influencers, community leaders, and health experts helps amplify the message — encouraging widespread action and engagement.

c. **Local Action and Community-Led Initiatives:**
Empower local stakeholders, communities and volunteers to lead hydration drives, distribute cooling kits, and assist vulnerable residents during heatwaves including first aid for heatstroke, spot early signs of heat exhaustion, home-cooling techniques etc., and 'how to' — ensuring community preparedness and action.

Focus Area 6: Partnerships & Collaboration:

a. **Civil Society Engagement:**
Foster an all-hands-on-deck approach by engaging UN and other international organizations, civil society, local business, industry and city-level actors and stakeholders, to customize heatwave strategies and tailored solutions for local contexts.

b. **Engage Academic and Technical Institutions:**
Foster pro-active engagement of academic and technical institutions to provide contextual knowledge and information to build capacity of communities, local actors and stakeholders to combat heat/heatwaves.

c. **Knowledge and Information Sharing:**
Foster access to national, regional and global knowledge networks and information sharing platforms for cross-learning and replication of good practices, success stories and innovative ideas for heat/heatwave mitigation and risk reduction action.

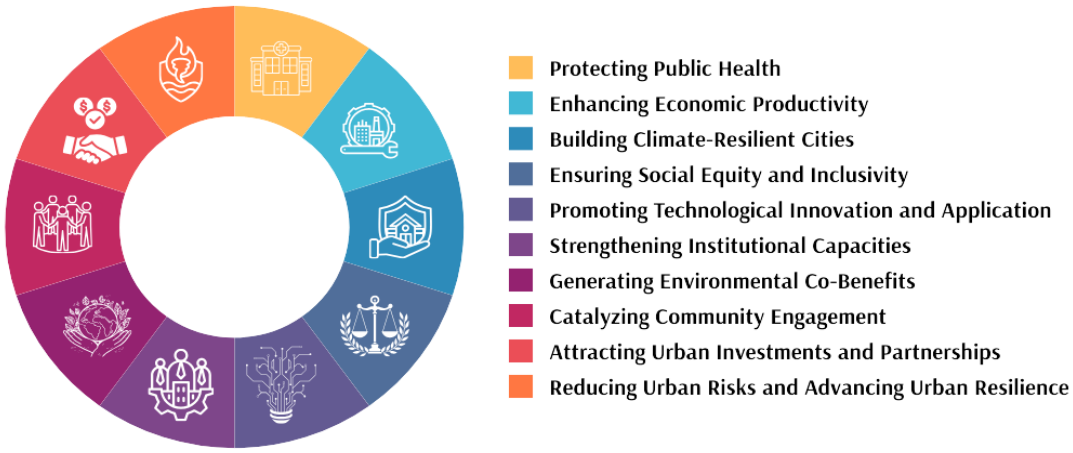
The time to Act is Now

Heatwaves are no longer rare events. They are becoming the new normal. Without immediate action, millions will face worsening health, economic, and environmental consequences. By scaling up investments, strengthening partnerships, and implementing innovative solutions, we can beat the heat and build thriving, resilient cities.

UNDP's heat/heatwave action framework is supporting cities to promote green infrastructure, advance sustainable urban development and protect vulnerable communities. Fostering a multi-stakeholder all-hands-on-deck collaborative action by local governments, communities, NGOs, businesses, and city stakeholders, it advances investments in climate resilient infrastructure, early warning systems & digital tech applications and nature-based solutions while empowering communities and stakeholders to strengthen local action.

Reaping the development dividends:

Investing in extreme heat/heatwave strategies and resilience action offers significant development dividends as it fosters healthier communities, boosts economic productivity, promotes social equity, and promotes sustainable urban environments. Addressing heat governance is not only essential for safeguarding lives but also creates opportunities for long-term social, economic, and environmental benefits – realizing sustainability aspirations of the SDGs.



For more information: **undp.org/expertise**

Ronald Jackson, Head of the Disaster Risk Reduction & Recovery for Building Resilience Team (DRT), Crisis Bureau, UNDP: **ronald.jackson@undp.org**
Rajeev Issar, Policy Specialist, Disaster and Climate Risk Governance and Urban Resilience, DRT, Crisis Bureau, UNDP: **rajeev.issar@undp.org**