Heat Wave Survival Guide and Best Practices

"A heat wave is an extended period of unusually high temperatures and often high humidity that causes temporary modifications in lifestyle and may have adverse health effects on the affected population."

Heat waves have been classified among the most dangerous weather phenomena globally are among the most dangerous natural hazards. Major heat waves are associated with negative effects on society and ecosystems, including excess mortality in the population and reduced vegetation product, and often they are linked to rapidly emerging flash droughts.

NDMA timely forecasted the areas impacted by the heatwave based on projected temperature and relative humidity profiles using the Coupled Model Intercomparison Project (CMIP-6) for the year 2024 (Fig. 1 & 2).

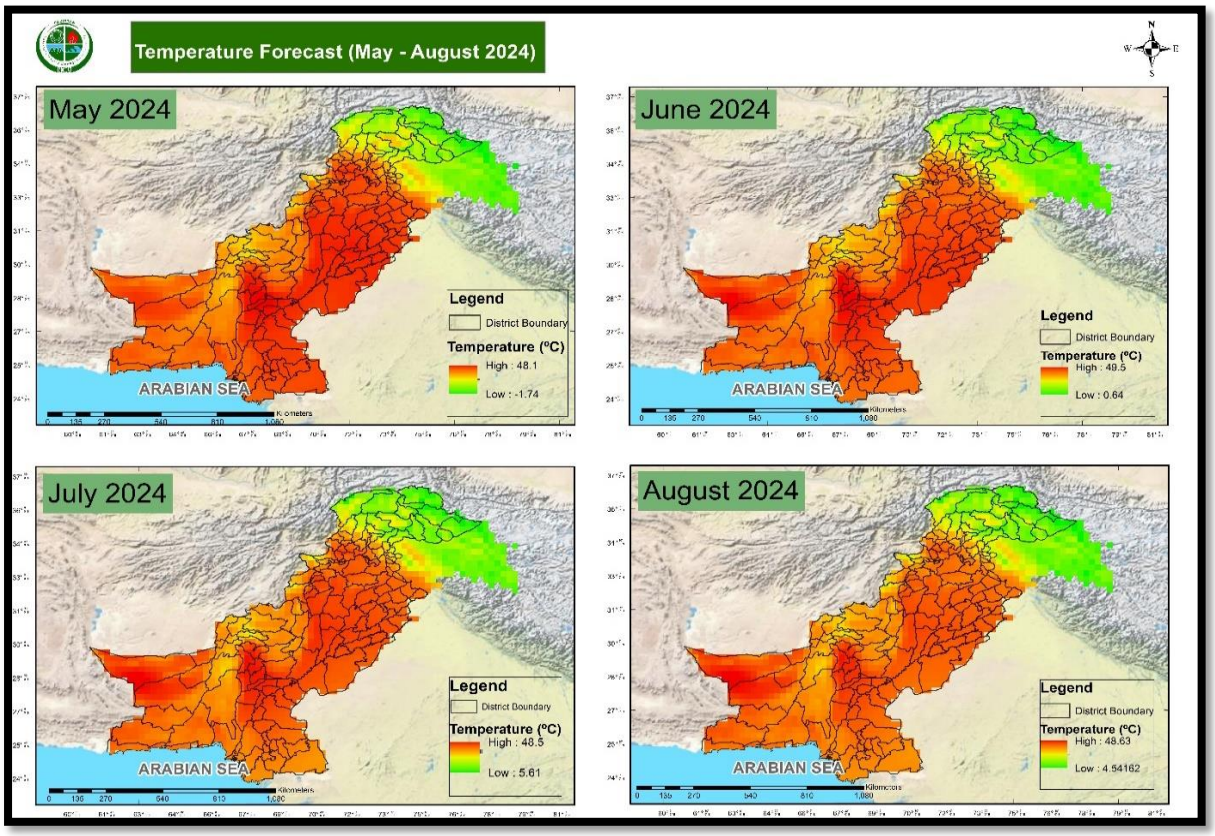


Figure 1 Temperature forecast (May – August 2024)

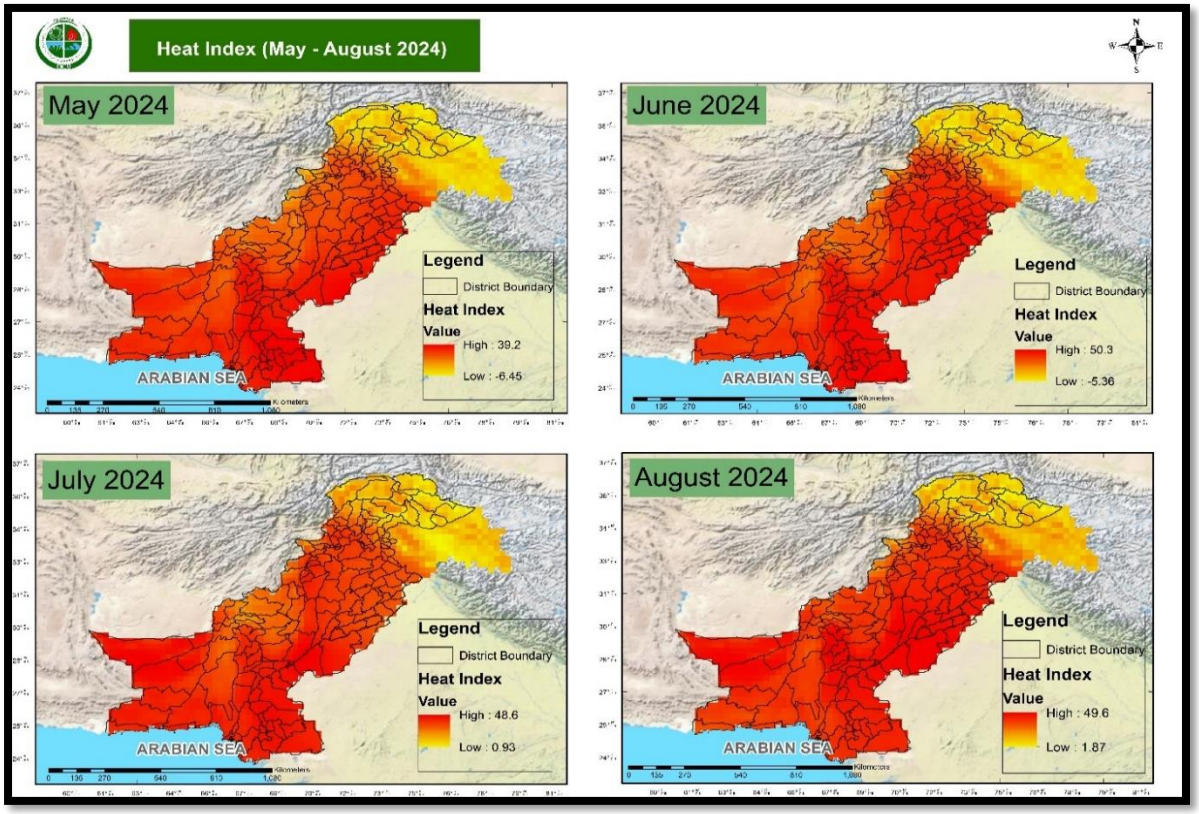


Figure 2 Heat Index (May - August 2024)

Impacts of heatwave

Heatwaves characterized by prolonged periods of extreme temperatures, have significant direct and indirect impacts on health, the environment, and socio-economic systems.

Direct impacts include immediate health effects such as heat-related illnesses, including heat cramps, heat exhaustion, heatstroke, and dehydration. These conditions often lead to exacerbation of chronic diseases like cardiovascular, respiratory, and renal disorders, particularly in vulnerable populations such as the elderly and individuals with pre-existing health conditions. Extreme heat also increases mortality rates and damages the environment by intensifying the risk of wildfires and worsening the urban heat island effect. In agriculture, heatwaves directly harm crops, leading to reduced yields and, in some cases, complete crop failure, while livestock suffer from heat stress and dehydration. Additionally, energy infrastructure is strained due to high demand for cooling systems, often resulting in power outages.

Indirect impacts extend beyond immediate consequences and include long-term effects such as the spread of vector-borne diseases like dengue and malaria, as warmer temperatures prolong the range and activity of disease vectors. Heatwaves also cause psychological stress, leading to mental health challenges like anxiety and

depression. Economically, they reduce productivity, particularly among outdoor workers, and escalate healthcare costs due to increased hospitalizations. Prolonged heat exacerbates water scarcity by triggering droughts, impacting agriculture, drinking water supplies, and sanitation. In extreme cases, regions become uninhabitable, forcing migration and displacement. Ecosystems also face severe disruption, with biodiversity loss as species unable to adapt succumb to heat stress. Social inequities are exacerbated, as marginalized communities with limited access to cooling systems, healthcare, and water resources are disproportionately affected. These wide-ranging impacts underscore the urgency of implementing adaptive measures to mitigate the effects of heatwaves on people, ecosystems, and economies.

Vulnerable Areas to Heatwaves

Certain regions are more vulnerable to heatwaves due to geographical, climatic, socio-economic, and infrastructural factors. In Pakistan, the following areas are particularly susceptible:

1. Sindh

Cities like Jacobabad, Larkana, and Dadu frequently record some of the highest temperatures globally, exceeding 50°C. Urban areas like Karachi are highly affected due to the urban heat island effect, dense population, limited green spaces, and inadequate cooling infrastructure.

2. Punjab

Southern Punjab cities such as Multan, Bahawalpur, and Rahim Yar Khan often experience prolonged and intense heatwaves. The combination of high temperatures and agricultural activities in rural areas increases the vulnerability of outdoor workers.

3. Balochistan

Areas like Turbat, Sibi, and Nokkundi are known for extreme heat conditions, with limited water resources and infrastructure to combat heat stress. Prolonged heatwaves in these areas significantly impact livelihoods, especially for marginalized communities.

4. Khyber Pakhtunkhwa

Low-lying areas, such as Dera Ismail Khan, experience heatwave conditions during peak summer months. The region's limited adaptive capacity and agricultural dependency increase vulnerability.

5. Northern Areas and Azad Jammu and Kashmir

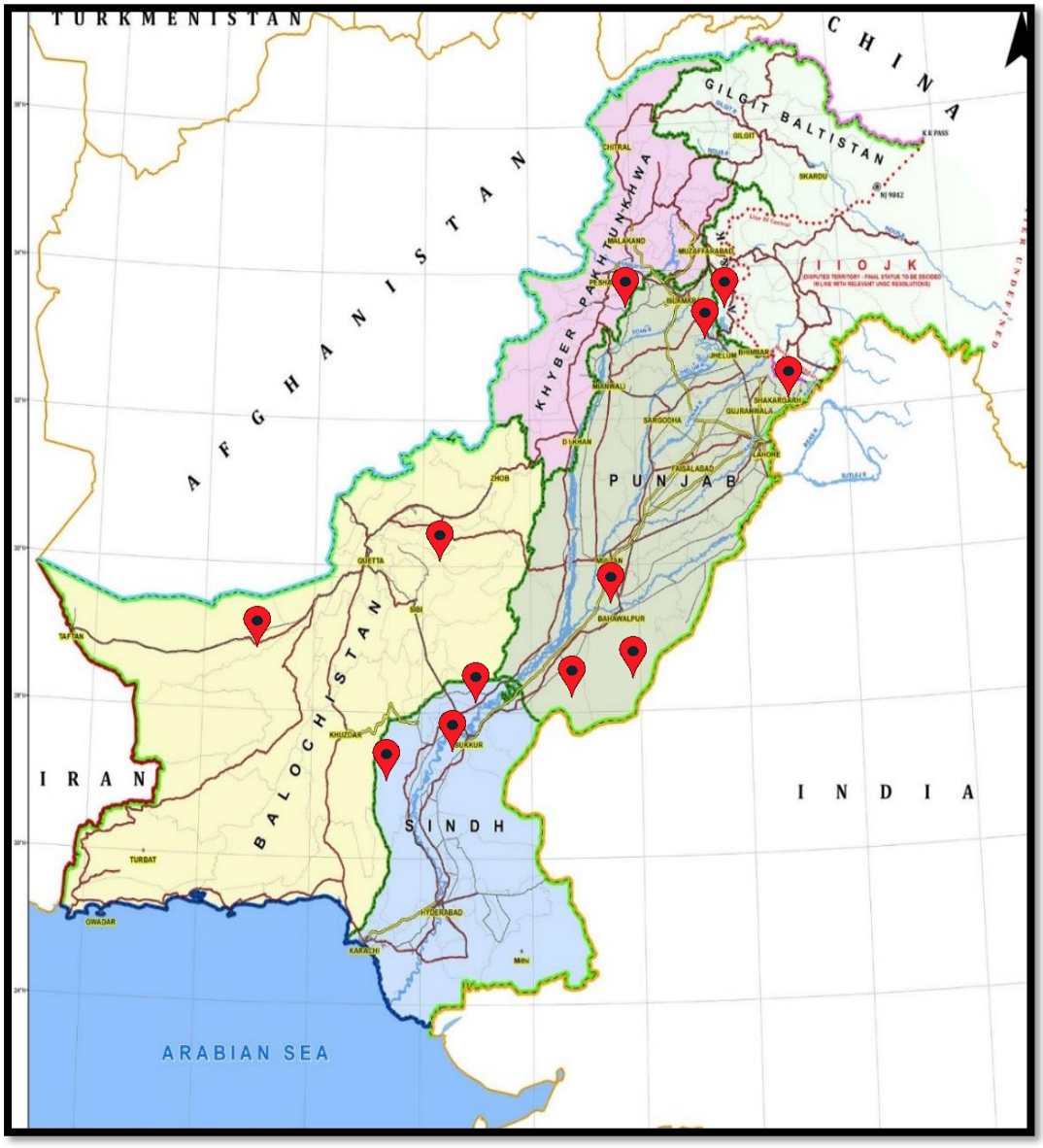
While generally cooler, these regions are increasingly experiencing heatwaves due to shifting climate patterns, which affect local ecosystems and glacial melt rates.

6. Urban Centers

Major cities like Lahore, Islamabad, and Rawalpindi face exacerbated heatwave impacts due to rapid urbanization, air pollution, and inadequate infrastructure to mitigate heat stress.

7. Desert Areas

Tharparkar in Sindh and Cholistan in Punjab are particularly vulnerable due to arid conditions, limited water availability, and poor access to healthcare.



Contributing Factors to Vulnerability

I. Limited access to cooling systems and healthcare increases risk.
II. Crowded urban areas exacerbate the urban heat island effect.
III. Inadequate housing, lack of green spaces, and limited access to water worsen conditions.
IV. Rural populations reliant on outdoor work face direct exposure.

Peak hours

In Pakistan, heatwaves typically occur during the pre-monsoon summer months, with the most intense periods often observed from May to June. During heatwaves in Pakistan, the **peak hours** when temperatures are at their highest are generally between **11:00 AM and 4:00 PM**. The Pakistan Meteorological Department advises the public to avoid outdoor activities during these peak sunlight hours to reduce the risk of heat-related illnesses.

Prevention Strategies

a) Community Awareness & Education

I. Launch public awareness campaigns to educate communities on the risks of heatwaves, including staying hydrated, avoiding the sun during peak hours, and using heat-resistant building materials.
II. Promote local government programs aimed at improving urban cooling, such as increasing green spaces and planting trees in cities to reduce heat islands.

b) Monitoring and Early Warning Systems

I. Use meteorological data, satellite-based observations, and Geographic Information Systems (GIS) to monitor and forecast heatwave conditions.
II. Establish early warning systems that deliver heatwave alerts to communities, especially vulnerable populations like the elderly and those with pre-existing health conditions.

c) Legislation & Policy

I. Enforce regulations that mandate the development of heat action plans in urban areas, ensuring measures to reduce indoor and outdoor temperatures.

II. Implement urban planning policies that prioritize energy-efficient buildings, cool roofs, and the integration of green spaces to combat urban heat islands.

d) *Sustainable Urban Design*

I. Encourage designs that integrate shading and cooling techniques, such as the use of reflective materials in public spaces and the creation of urban parks and water features to reduce heat.

II. Encourage the construction of heat-resistant infrastructures like cool roofs and walls.

Response Strategies

a) Rapid Response Teams

i. Form specialized teams equipped to manage heatwaves by setting up temporary cooling centers, distributing water, and providing medical aid to vulnerable populations.

ii. Equip teams with mobile units to monitor heat conditions and provide emergency relief.

b) Incident Command Systems

i. Use the Incident Command System (ICS) to coordinate heatwave response efforts across local, provincial, and national authorities.

ii. Ensure that coordination includes healthcare agencies, civil protection, and urban planning teams for an integrated approach.

c) Community Involvement

i. Train community volunteers, particularly in heat-vulnerable areas, to assist with heatwave response efforts, such as distributing water or assisting elderly residents.

ii. Establish local heat action networks that can mobilize resources quickly during a heat event.

Post-Heatwave Recovery Measures

a) *Infrastructure Adaptation*

i. Retrofit public spaces, hospitals, and schools with cooling systems such as air conditioning or ventilation improvements.

ii. Reassess urban planning regulations to ensure that new construction projects are designed with heat resilience in mind.

iii.

b) Health Monitoring & Rehabilitation

i. Set up health monitoring systems to track heat-related illnesses focusing on vulnerable populations.
ii. Implement rehabilitation programs for individuals who experienced heatstroke or dehydration, offering long-term medical support and education on how to cope with future heat events.

c) Environmental Restoration

i. Restore green spaces that were damaged by heat-related events, and plant more heat-resistant species to improve urban heat management.
ii. Rehabilitate water resources and restore natural cooling systems in cities and rural areas.

Adapting to Rising Temperatures: Local and Global Academic Insights

- Installation of green roofs provide shade and remove heat from the roof surface and surrounding air.
- Increasing tree plantings around buildings to shade parking lots and in outdoor areas.
- Combine recycled elements with locally sourced materials for aid items, capitalizing on their standardized nature.
- Use evaporative cooling techniques by wetting a surface like cloth or mat, allowing water to evaporate and naturally cool the surrounding air.
- In desert regions, the adoption of sustainable irrigation systems like drip irrigation or recycled water systems can contribute significantly to water conservation efforts.
- Encourage the use of heat resistant paints (containing boric acid and calcium chloride), chemical prophylaxis, and processed foods.
- Maximize shade by building narrow roads and alleys that offer natural relief from sunlight.
- Using materials with higher solar reflectance can help reduce heat absorption and lower surface temperatures, thereby mitigating the heat island effect.
- Instalment of solar powered appliances such as fans and air conditioners to stay cool and comfortable.
- Guide individuals to nearby response centres for assistance by collaborating with social welfare organizations.
- Provide essential health services, nutrition supplements, counselling, preschool activities, and awareness programs for children.

- Capacity building of local communities to better prepare for and respond to heatwaves. This includes training community members in first aid, heat stress management, and disaster preparedness.
- Conduct research to understand the impacts of extreme temperatures on ecosystems, agriculture, infrastructure, and human health.
- Develop innovative solutions to mitigate these impacts, such as heat-tolerant crops, energy-efficient cooling technologies, and urban planning strategies to reduce the urban heat island effect.
- Disseminating accurate information about impending heatwaves, educating the public about the dangers of extreme heat, and providing tips on how to stay safe and cool during heat waves.
- Educating citizens regarding the dangers of extreme heat and the steps they can take to protect themselves when extreme temperatures occur.
- Educate communities about the consequences of heat stress risks, preventive measures, and available resources.
- Use low-tech, high-efficiency methods like a double-roof system and walls constructed with plastic bags filled with compacted earth for effective cooling in refugee camps.
- The use of smart irrigation technologies is another option, which involves sensors and data analysis to adjust watering schedules based on plant requirements and weather patterns.
- Choose homes with limestone and natural materials to naturally control humidity, absorbing moisture in humid conditions and releasing it on sunny days. The sandy texture reflects solar radiation, providing effective cooling for a comfortable living environment.
- Encourage Construction of thick-walled houses using materials like adobe (soil, water, and organic additives) or stone for insulation against high temperatures.
- Smart building design considerations:
    - ✓ Minimize solar heating in hot seasons.
    - ✓ Maximize indoor cooling rate in summer.
    - ✓ Optimize orientation and window size for efficiency.
- Ambulances should initiate early cooling treatment upon picking up the patient.
- Regular monitoring of weather patterns and issuing early warnings about potential heatwaves, allowing authorities and communities to take proactive measures to mitigate their impact.
- Harness natural energy for passive summer cooling.
- Locating and rescuing individuals who may be at risk due to the heat, such as hikers, elderly individuals, or those experiencing heat-related illnesses.

- Companies must assess and reduce their carbon footprint, compensating for any remaining emissions.






Case Studies on Heatwave Management Around the Globe

1. Singapore – Urban Cooling Initiative

Overview

Singapore has adopted a unique approach by integrating "urban cooling" as part of its long-term climate action plans.

Best Practices

I. The city has implemented green roofs, vertical gardens, and rooftop parks to absorb heat and provide shade, helping to reduce ambient temperatures.
II. Streets and walkways are designed with shade structures and cooling plants, creating pathways of relief from the heat.
III. The use of water features like fountains and misting systems in public spaces helps lower temperatures and improve air quality.

Outcome

Singapore's efforts have created more comfortable living spaces and significantly reduced the urban heat island effect.

2. United Kingdom – Heatwave Action Plan (HAP)

Overview

The UK has developed a proactive Heatwave Action Plan that includes specific measures tailored to the country's cooler climate and the vulnerability of the elderly population.

Best Practices

I. The UK sends personalized heat warnings to vulnerable individuals, such as elderly people and those with pre-existing medical conditions, through health services.
II. Public buildings like libraries and community centers are designated as cooling centers and are open during extreme heat events.
III. Initiatives like green roofs, tree planting, and shaded walkways are encouraged to reduce urban heat exposure.

Outcome

This proactive approach has minimized heat-related health risks and prevented fatalities, especially among at-risk groups.

3. United States – Phoenix, Arizona: Cool Pavement Program

Overview

Phoenix, one of the hottest cities in the U.S., has implemented the Cool Pavement Program as part of its strategy to mitigate the effects of heatwaves.

Best Practices

I. The city has used reflective materials and coatings on roads and pavements to lower surface temperatures.
II. Streetlights and other city infrastructure have been modified to use less heat-absorbing materials, and buildings are retrofitted to improve cooling efficiency.
III. Phoenix has aggressively expanded its urban tree canopy to provide natural shade and cool urban spaces.

Outcome

The Cool Pavement Program has reduced temperatures by several degrees, offering relief to residents during peak heat events.

4. Spain – Valencia Heatwave Action and Early Warning System

Overview

Spain, which faces frequent and intense heatwaves, has developed a sophisticated Heatwave Early Warning System (HEWS) to reduce the impacts of extreme temperatures.

Best Practices

I. The HEWS provides early alerts, allowing local authorities to prepare and deploy resources, such as ambulances and cooling centers.
II. The government runs campaigns to raise awareness about heat risks, hydration, and prevention measures for vulnerable populations.
III. New buildings are required to have heat-resistant features such as reflective roofs, green walls, and better insulation.

Outcome

The HEWS has significantly improved response times during heatwaves and reduced the number of heat-related fatalities.

5. Mexico – Mexico City's Heat-Resilient Housing Program

Overview

Mexico City has faced severe heatwaves due to its geographical location and urban density. The city has initiated a unique heat-resilient housing program to address these challenges.

Best Practices

I. The city has partnered with local organizations to install reflective materials on residential rooftops to reduce indoor temperatures.
II. Mexico City has also implemented vertical gardens and green roofs to combat the urban heat island effect in densely populated neighborhoods.
III. The city has introduced solar-powered fans and air conditioning units in low-income areas to provide cooling without adding strain to the power grid.

Outcome

These measures have helped mitigate indoor heat and have made the city's most vulnerable populations more resilient to heatwaves.

6. Japan – Heatstroke Prevention in Tokyo

Overview

Japan, particularly Tokyo, faces intense summer heatwaves. The city has developed unique measures to protect citizens from heatstroke.

Best Practices

I. Tokyo has a real-time heatstroke risk alert system that sends notifications to residents on their mobile phones, advising them to stay cool or hydrate.
II. The city has established cooling centers that are equipped with fans, ice packs, and water for residents, particularly targeting the elderly and children.
III. Tokyo has installed sensors on public infrastructure, such as bus stops and train stations, to monitor heat levels and activate cooling measures like misters when temperatures rise.

Outcome

The heatstroke prevention measures have been successful in reducing hospital admissions and fatalities related to heat stress.

7. South Korea – Busan Heatwave Management and Cooling Trees

Overview

Busan, South Korea's second-largest city, implemented a unique strategy involving “cool trees” to combat heatwaves.

Best Practices

I. The city planted specific tree species known for their ability to reduce temperatures by providing dense shade and moisture through transpiration.
II. The city integrates green spaces, parks, and urban forests into new developments to cool the urban environment.
III. Special “cool parks” are established with water features, shaded rest areas, and other heat mitigation technologies to provide residents with cool spaces during heat events.

Outcome

This strategy has improved public health outcomes during heatwaves and helped make the urban environment more resilient to future heat impacts.

8. India – Ahmedabad Heat Action Plan (HAP)

Overview

In 2013, the city of Ahmedabad in India launched the Ahmedabad Heat Action Plan (HAP), one of the first of its kind in India. The plan was developed with the support of the Indian Institute of Public Health and the World Bank.

Best practice

I. The plan uses meteorological data to predict and issue heat warnings, which is communicated to the public via media outlets and mobile messages.
II. Cooling centers in public spaces like malls and schools are established for vulnerable populations during extreme heat.
III. Mass campaigns educate the public about heat-related risks and preventive measures.
IV. Hospitals and clinics are equipped and prepared for an increase in heat-related illnesses.

Outcome

The plan has been successful in reducing the number of heat-related deaths and improving public awareness and preparedness. Other cities in India, including New Delhi and Mumbai, have adopted similar plans based on Ahmedabad's success.

9. Australia – Melbourne's Cool Roofs Program

Overview

In Melbourne, the increasing urban heat island effect led the city to launch an initiative to reduce indoor temperatures during heatwaves through the use of "cool roofs" and other green infrastructure.

Best practice

I. The city incentivized businesses and homeowners to install reflective roofs that can significantly reduce building temperatures.
II. Parks, green roofs, and urban forests have been expanded to reduce the ambient temperature.
III. Public campaigns encourage people to minimize heat exposure by staying in cool environments and using reflective materials.

Outcome

The program has led to a reduction in indoor temperatures during extreme heat, providing relief for vulnerable populations.

10. Europe – The European Heat-Health Action Plans (HHAP)

Overview

The European Union has implemented Heat-Health Action Plans (HHAP) across several member states to address the increasing frequency of heatwaves due to climate change.

Best practice

I. These plans involve forecasting and issuing early warnings about heatwaves, targeting vulnerable populations, and setting up public information systems.
II. Hospitals are equipped to manage heat-related illnesses, with extra staff and cooling systems during heat events.
III. Cities like Paris, Rome, and Madrid have adopted heat-resilient urban planning strategies, such as creating more green spaces, using reflective pavement, and planting trees.

Outcome

These initiatives have reduced the mortality rate during heatwaves across the EU, particularly in countries like Spain, France, and Italy, where heatwaves are more frequent.

Survival guide

Extreme heat can be fatal for people of all ages, including those with chronic illnesses, pregnant women, and the elderly. However, there are numerous actions we can do to shield our loved ones and ourselves from the heat.

1. Adopt cool roof technologies, such as reflective coatings and green roofs, to lower building temperatures.
2. Avoid outdoor activities during peak heat hours.
3. Stay hydrated by drinking plenty of water and natural juices (e.g., sattu, mint).
4. Wear natural materials like cotton to stay cool.
5. Take baths with neem water to reduce body heat.
6. Wear light-coloured to stay cool.
7. Close curtains or blinds during the hottest part of the day to block out the sun's heat.
8. Use high-SPF sunscreen/sunblock to prevent sunburn on your skin.
9. Understand about the signs and symptoms of heat exhaustion and heatstroke, such as headache, nausea, fast heartbeat, and disorientation.
10. Encourage the use of energy-efficient appliances and lighting to reduce heat generation and lower energy costs.

11. Implement water-saving techniques and collaborate with local authorities for sustainable water management.
12. Employ evaporative cooling techniques, such as wetting a cloth or mat, to naturally cool down spaces.

Gap Analysis for Heatwaves in Pakistan

I. Most risk assessments are generalized and fail to account for Pakistan's diverse geography and climate. Specific regions such as Sindh's urban centers (Karachi, Hyderabad) and rural areas (Tharparkar, Umerkot) experience vastly different heatwave impacts, requiring tailored strategies.
II. Indigenous knowledge of coping with extreme heat, such as traditional housing designs (mud huts, ventilated structures) and cultural practices (use of lightweight clothing), is underutilized in urban planning and community-based interventions.
III. Coordination between provincial and municipal authorities is weak, resulting in delayed responses and inefficient resource allocation during heatwaves. For instance, the lack of synchronization between Karachi Metropolitan Corporation (KMC) and Sindh's provincial disaster management authorities was evident in past heatwave crises.
IV. While early warning systems exist for rural flood-prone areas, urban heatwaves lack robust alert mechanisms. For example, Karachi, with its history of deadly heatwaves, does not have a dedicated city-wide alert system tailored to the urban population's needs.
V. Urban areas often rely on concrete-heavy designs that exacerbate the urban heat island (UHI) effect. Unlike international cities employing cool pavements and shaded corridors, Pakistani cities largely neglect such measures. Rural areas face challenges with non-heat-resistant housing that traps heat during extreme temperatures.
VI. Pakistan's labor force, particularly outdoor workers (e.g., construction workers, farmers, and street vendors), is among the most vulnerable to heatwaves. Workplace safety regulations and heat-adaptive work practices (e.g., flexible work hours, cooling stations) are either absent or inadequately enforced.
VII. Women in rural areas often face additional burdens during heatwaves, such as increased water collection efforts and caregiving roles. Policies and interventions seldom address these gendered impacts, leaving women more exposed to heat-related risks.
VIII. Cooling technologies, such as affordable fans or air conditioners, remain inaccessible to a significant portion of the population, particularly in low-income households. Public cooling centers are sparse, and their coverage is limited.

IX. Major urban centers lack basic hydration facilities like water fountains or kiosks in public spaces, which are vital for preventing heat-related illnesses during peak heat hours.

X. Heatwave awareness campaigns are sporadic and fail to drive behavioral changes, such as the adoption of protective clothing, staying hydrated, and identifying early symptoms of heatstroke.

Recommendations

1. Develop region-specific heatwave vulnerability maps using GIS and satellite data to tailor interventions.
2. Integrate traditional cooling practices with modern design in rural and urban housing projects.
3. Establish heatwave-specific task forces at municipal levels to coordinate early warnings, public awareness, and emergency responses.
4. Invest in cool pavements, green roofs, and shaded pedestrian pathways to mitigate the UHI effect.
5. Introduce policies mandating heat-adaptive work hours, breaks, and shaded rest areas for outdoor workers.
6. Ensure heatwave interventions address the unique needs of women, such as access to water and childcare facilities.
7. Provide subsidies for affordable cooling technologies and establish public cooling centers in densely populated areas.
8. Install water kiosks in urban and rural areas, particularly along high-traffic roads and in markets.
9. Implement year-round campaigns targeting heatwave preparedness and early response, leveraging schools, mosques, and local media for outreach.