AI-Based Risk Mapping of Urban Heat Vulnerability

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Abstract

As the sun rises over Dhaka in 2026, it brings more than light; it brings a quantifiable and escalating threat. The city, now grappling with a "feels like" temperature up to 4.5°C higher than the national average, has become a thermal battlefield. While residents in leafy, air-conditioned neighborhoods like Baridhara may find respite, countless others—rickshaw pullers in Korail slum or laborers in informal settlements—endure what amounts to a "stifling oven," where tin-roofed homes can reach internal temperatures exceeding 40°C.

Urban heat is no longer merely a seasonal inconvenience; it has evolved into a systemic health and socio-economic crisis. As research in Climate Data Science advances, the integration of AI-driven risk mapping and spatial clustering allows us to move beyond generalized weather reports to precise, computationally measurable analyses of urban heat vulnerability, revealing the stark inequities in exposure and resilience.

The quantitative reality underscores the urgency. In 2024 alone, heat-related conditions resulted in the loss of approximately 250 million workdays, imposing an economic burden estimated at $1.78 billion, nearly 0.4% of Bangladesh's GDP. The Urban Heat Island (UHI) effect amplifies these impacts: Dhaka's densely built core routinely experiences temperatures 2.5°C to 7.5°C hotter than rural peripheries, with concrete, asphalt, and industrial surfaces trapping heat well into the night. Health impacts are equally alarming. Summer months see a doubling of diarrhea and respiratory illnesses compared to winter, while heatwaves correlate with a 20% rise in mortality nationwide. Vulnerable populations, particularly low-income groups, outdoor laborers, and women in informal work, face compounded risks due to both physical exposure and limited adaptive capacity.

AI-based risk mapping offers a transformative approach to understanding and addressing these vulnerabilities. By constructing Heat Vulnerability Indices (HVI), researchers are able to layer environmental, infrastructural, and socio-economic data, creating granular, actionable insights. Using satellite data, such as Sentinel-1 synthetic aperture radar (SAR) and MODIS-derived Land Surface

Temperature (LST) imagery, models now analyze Dhaka at a 30-meter resolution, enabling neighborhood-level risk assessment. Radar Vegetation Indices (RVI) quantify green space and soil moisture, with studies demonstrating a strong inverse correlation ($R^2 = 0.88$) between vegetation cover and local heat exposure. Spatial autocorrelation analyses, such as Moran's I, identify heat hotspots—densely populated zones like Sadarghat, Kotwali, and Double Mooring—where high building density, lack of water bodies, and minimal ventilation create lethal thermal traps.

Critically, modern models integrate socio-economic and structural determinants, ensuring that vulnerability assessment accounts for more than temperature alone. Adaptive capacity metrics reveal that a low-income family residing in a katcha house faces five times higher heat risk than a family in a pucca structure, as tin and bamboo constructions can amplify indoor temperatures to 38–42°C. Gendered exposure is also pronounced: 80% of working women in Dhaka are engaged in informal, outdoor, or poorly ventilated roles, from garment factory labor to street vending, making them disproportionately susceptible to heat exhaustion, dehydration, and menstrual health disruptions. These insights highlight how urban heat intersects with poverty, occupation, gender, and housing, producing a complex vulnerability landscape that demands precise, data-driven interventions.

From insight to action, AI-generated risk maps are informing a new policy dashboard designed to enable proactive decision-making. Unlike blanket city-wide advisories, these dashboards allow policymakers to target interventions, deploying community cooling centers, drinkable water points, and shaded rest zones in the 0.8% of Dhaka identified as "very high risk." Engineering solutions are similarly data-informed: reflective roofing, urban greening, and strategic tree planting can reduce localized temperatures by up to 4°C, mitigating risk for residents in the densest neighborhoods. Coupling HVI maps with 5-day lead-time forecasts from the Bangladesh Meteorological Department enables anticipatory action, allowing factory managers, construction supervisors, and informal workers to adjust schedules, enforce mandatory hydration breaks, and avoid peak heat exposure.

Urban heat is a "silent killer," unlike floods or cyclones, it cannot be seen surging through the streets, yet its effects are measurable and deadly. AI transforms the invisible into actionable intelligence, converting satellite imagery, census data, and social indicators into a dynamic, predictive tool for urban resilience. In 2026, Dhaka's heat risk dashboard is no longer a theoretical model—it is a practical instrument for saving lives and reducing economic losses. By identifying thermal inequities, these tools also illuminate broader social inequalities, ensuring that interventions prioritize the most vulnerable rather than the most visible or affluent residents.

The path forward in urban climate resilience requires integrating AI insights with systemic planning. Mandatory urban greening initiatives can use HVI maps to enforce "green corridors" along major streets, promote rooftop gardens, and restore public parks in high-density neighborhoods. Heat-sensitive labor

policies must also evolve, providing regulated breaks, hydration access, and shaded rest areas for outdoor workers whenever AI forecasts predict temperatures exceeding 35°C. Sustainable cooling strategies, including permeable materials, mutual shading, and reflective surfaces, must complement these interventions, reducing reliance on energy-intensive air conditioning and ensuring equitable adaptation in low-income communities. In addition, public education campaigns guided by AI-generated risk profiles can inform residents of heat safety, enabling community-level resilience and informed decision-making.

The integration of AI-based urban heat mapping with policy and social planning positions Bangladesh as a leader in climate-responsive urban management. By targeting interventions at the most vulnerable households, monitoring environmental conditions in real time, and coupling predictive analytics with adaptive infrastructure, the nation can transform the lived experience of heat from a daily threat into a manageable public health challenge. Importantly, these measures demonstrate that climate resilience is not solely an environmental goal but a social justice imperative: the capacity to survive and work safely under extreme heat should not depend on wealth, occupation, or neighborhood.

In conclusion, urban heat vulnerability represents the intersection of climate science, data analytics, and social equity. In Dhaka and other fast-growing Bangladeshi cities, rising temperatures are more than a meteorological phenomenon—they are a lens through which the inequalities of urban life are revealed. By leveraging AI to map exposure, integrate socio-economic data, and predict high-risk zones, we are making invisible threats visible, enabling targeted, evidence-based interventions that protect the most vulnerable. In the era of “Smart Bangladesh,” technology is no longer a passive observer but an active participant in urban resilience. While algorithms identify the burn and measure risk, practical interventions—green infrastructure, heat-sensitive labor policies, and community cooling strategies—ensure that the city remains livable for all residents, not just those who can afford to escape the heat. AI-based risk mapping is the first step in this journey, translating complex climate and social data into actionable solutions, while the second step is ensuring that these insights translate into shade, hydration, and opportunity for everyone under Dhaka’s relentless sun.