This paper was presented at the 23rd International Conference on Sustainable Development (ICSD 2026), held at the Imperial Hotel and Ba Ria – Vung Tau University in Vung Tau, Vietnam, June 3-4, 2026.

https://doi.org/10.64211/oidaijsd190810

Rapid Urban Micro-Mapping and Cooling Strategy for Coastal Tourism and Public Health: An Urban Planning Study

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OIDA International Journal of Sustainable Development, Ontario International Development Agency, Canada.
ISSN 1923-6654 (print) ISSN 1923-6662 (online) www.oidaijsd.com
Also available at https://www.ssrn.com/index.cfm/en/oida-intl-journal-sustainable-dev/

Abstract: Large Megacities in Southeast Asia face increasing thermal stress due to rapid urbanization, high impervious surface coverage, and climate-driven temperature rise. In 2025, Ho Chi Minh City expanded its boundaries to include two provinces, Binh Duong to the north and northeast and Ba Ria-Vung Tau to the southeast. The new consolidated Megacity went from 10 million to 14 million people and more than tripled its land area, incorporating sizable agricultural and coastal marine environments. This study establishes a model for urban planners to redesign cities using thermal mapping and heat stress analytics to reduce urban heat island intensity. It is structured as a case study of Vũng Tàu Ward, the highly dense coastal tourism core in the newly consolidated Ho Chi Minh Megacity, and is designed to demonstrate how targeted micro-scale thermal mapping and wet-bulb global temperature (WBGT) assessment studies can produce the data necessary to promote more cooling urban design and lead to better urban planning. In the context of Vung Tau, this can strengthen both tourism capacity and public health resilience in the context of rising temperatures associated with global warming. As a coastal destination dependent on walkability, outdoor recreation, and beach-oriented commerce, Vũng Tàu's economic vitality is linked to thermal comfort. Simultaneously, increasing heat exposure presents heightened vulnerability for elderly residents, outdoor workers, and visitors. By integrating thermal mapping with urban design planning, the study positions climate adaptation as both an economic development strategy and a public health response. This research contributes to the emerging discourse on scalable, low-cost climate resilience strategies for cities in Southeast Asia. It demonstrates that rapid micro-heat mapping can serve as a decision-support tool for integrating vegetation planning, stormwater management, tourism development, and public health preparedness into cohesive urban cooling strategies.

Keywords: UHI, Megacities, Climate Adaptation, Heat Stress, Public Health, Tourism

Introduction

Heat Stress and Urbanization in Southeast Asia

Major cities in Southeast Asia are getting hotter. A recent report from the ASEAN Centre for Energy (ACE) projects temperature increases in major ASEAN cities through 2050. Days exceeding 35°C are projected to increase by 167% to 240% by 2050, reaching between 85 and 120 extreme-heat days annually, with heat seasons beginning earlier and lasting longer (ACE, 2026). Table 1 shows projected heat conditions for six major Southeast Asian cities by 2050.

Table 1: Projected heat conditions for six major Southeast Asian cities by 2050

Southeast Asian Cities Heat Stress

City	Baseline 2000 (°C)	Current 2025 (°C)	Change 2000-2025	Projected 2030 (°C)	Projected 2040 (°C)	Projected 2050 (°C)	Total Change 2000-2050	Days >35°C (Current)	Days >35°C (2050)
Bangkok	33.3	34.2	**+0.9°C**	35.8	36.9	38.1	**+4.8°C**	45	120
Jakarta	31.9	32.8	**+0.9°C**	34.1	35.2	36.4	**+4.5°C**	28	95
Manila	32.6	33.5	**+0.9°C**	34.9	36.0	37.2	**+4.6°C**	38	110
Ho Chi Minh City	33.0	33.9	**+0.9°C**	35.2	36.4	37.7	**+4.7°C**	42	115
Kuala Lumpur	32.2	33.1	**+0.9°C**	34.4	35.6	36.9	**+4.7°C**	35	100
Singapore	31.7	32.6	**+0.9°C**	33.8	34.9	36.1	**+4.4°C**	25	85

Source: Adapted from ACE (2026).

Ho Chi Minh City is projected to have a temperature increase of 4.7°C from 2000 to 2050, with the number of days exceeding 35°C rising from 42 in 2025 to 115 by 2050. This projection parallels a Cornell Global Labor Institute (GLI) study using station-based observations, which found that annual days at or above 35°C in Ho Chi Minh City rose from an average of 28.8 days in 2005-2009 to 74.4 days in 2020-2024, an increase of 158.3% (ACE, 2026; Wakamo & Judd, 2025).

The impact of increasing temperature in cities is likely to produce heat stress, a condition that occurs with the increase of environmental and metabolic heat, and can produce heatstroke, heat exhaustion, and worsening chronic illnesses (World Health Organization, 2026). It significantly impacts vulnerable groups, such as older adults, pregnant women, outdoor workers, and low-income households with less access to air conditioning or heat-reducing cooling centers (ACE, 2026; World Health Organization, 2026).

This study focuses on Vung Tau Ward, a coastal beach tourism destination for residents of central Ho Chi Minh City. It consists of more than 117,400 people in an area of 16.86 sq. km., with a high density of approximately 6,963 people per sq. km. (Tuổi Trẻ Online, 2025). (Figure 1). In 2025, Ho Chi Minh City consolidated with the neighboring provinces of Binh Duong and Ba Ria-Vung Tau to become a megacity of 14,002,598 people with a land area of 6,772.59 sq. km., more than tripling the size of the old city and incorporating agricultural and coastal tourism areas such as Vung Tau (National Assembly of Vietnam, 2025). This consolidation poses great challenges to planners because rapid urban development, the loss of agricultural and green open space, and automobile-oriented urban sprawl could exacerbate rising metropolitan temperatures and accelerate regional heat stress. This study does not examine that metropolitan-scale challenge; rather, it focuses on how one urban ward can redesign its streets, increase its trees and vegetation, and use materials that produce a cooler environment.

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Figure 1: Ho Chi Minh City Consolidation

Source: Author-generated map based on National Assembly of Vietnam (2025).

Urban Heat Islands, Albedo and Emissivity

The three concepts that this paper discusses are Urban Heat Island intensity, the Albedo Effect and Surface Emissivity. Urban Heat Island Intensity (UHII) measures the temperature difference between an urban area and a baseline of a surrounding natural vegetative area. The formula is:

$$\Delta T_{u-r} = T_u - T_r$$

There are two ways to determine UHII. The first is Surface UHII, that is measured by the heat generated from specific surfaces and is measured through thermal mapping. The second is Canopy Layer UHI Intensity that measures ambient temperature using a Wet Bulb Global Temperature (WBGT) Index. The formula for WBGT is:

$$WBGT = 0.7T_w + 0.2T_g + 0.1T_d$$

Both metrics determine how a city's man-made surfaces trap heat compared to natural areas. The Albedo Effect is a metric that shows the reflective power of different surfaces and relates to Surface UHI Intensity. Shiny and light surfaces reflect radiant energy and can reduce heat stored by urban surfaces. However, in exposed pedestrian environments, reflected radiation can increase mean radiant temperature (MRT), making a person feel hotter even if the surface temperature is lower (Erell et al., 2014; Schrijvers et al., 2016). Emissivity measures the capacity of a surface to absorb solar energy and release it as thermal infrared radiation. Surfaces such as asphalt and concrete are key components of urban material infrastructure. The paradox of UHI mitigation is that high-albedo surfaces may help reduce overall urban heat load while also increasing daytime radiant exposure for pedestrians unless paired with shade and context-sensitive design.

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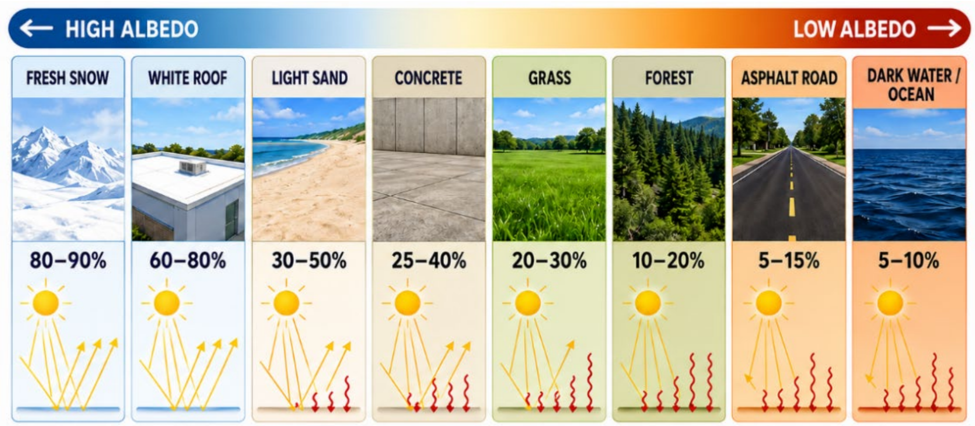
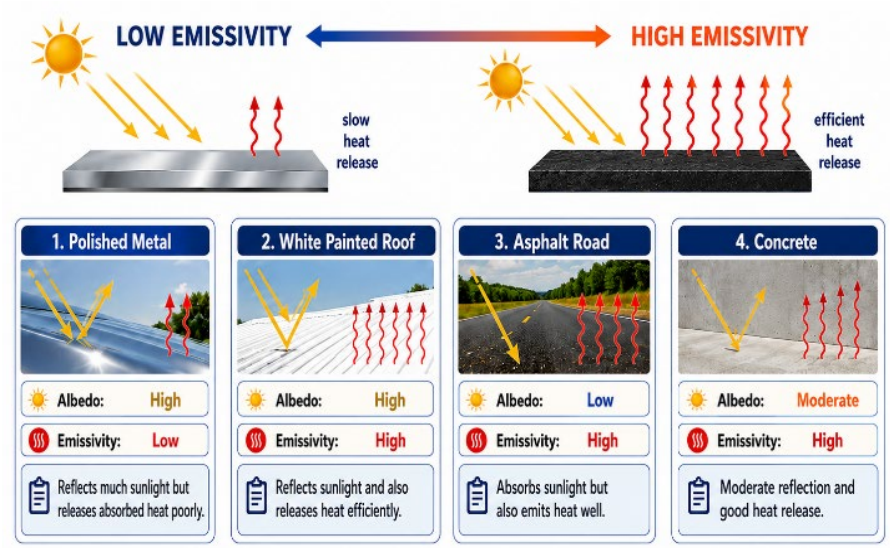
Figure 2: The Albedo Effect:



Source: Generated by Robert W. Taylor on May 23, 2026

Figure 3: Emissivity



Source: Generated by Robert W. Taylor May 23, 2026

Research Questions

The paper addresses the basic question of how can various urban nodes within metropolitan areas in Southeast Asia combat the serious impacts of UHII due to global warming? The expansion of older urban areas into surrounding rural areas and the continued migration from rural areas to major Megacities puts a stress on both surrounding agricultural land and increased temperature through the urban heat island effect. This paper presents a triage model of how urban planners can redesign specific urbanized nodes within larger regional Megacities to reduce UHII. It looks at one urban node, Vung Tau Ward, in Ho Chi Minh City, Vietnam, and shows how the use of thermal mapping and WBGT assessments are effective tools for urban planners to use to retrofit/redesign these environments to reduce hotspots and lessen heat stress. Through data generation and analysis, it presents three deliverables: first, four thermal illustrations of how surface materials effect temperature; second, a site analysis of twelve sites and their varying impacts on heat stress; and third, an implementation model by which urban planners can triage the most vulnerable sites and redesign/retrofit three streets to lower their UHII.

Methodology

The study was completed over a 30 day period in May, 2026. Instruments used were a hand-held thermal mapping instrument and a hand-held WBGT device. The thermal mapping device gathered data on emissivity, ambient temperature, thermal images, and distance from measured surfaces. Distances from surfaces were set between 1 meter and 3 meters for thermal temperature readings. The WBGT provided data on ambient temperature, relative humidity, wind speed, and heat stress. Sites were selected randomly based upon travel and observations in Vung Tau Ward. Data was collected for four surface thermal illustration sites, twelve street sites, and three street sites selected for redesign along heat cooling concepts. Data was categorized for analysis using computerized modeling procedures.

Figure 4: Instruments: Thermal Imaging Camera and WBGT Meter

Source: Generated by Robert W. Taylor on May 23, 2026

Results

Surface Design and Heat Resilience

Four surfaces were analyzed for their emissivity, cool spots, and hot spots at a three-meter range. Surface #1 was a Tree-Shaded Area that showed that vegetation provides strong passive cooling through shade and evapotranspiration. Tree canopy reduces surface heat and improves thermal comfort. Surface #2 was a Concrete Drainage System that was dry at the time but surrounded by vegetation. Without water, the dry concrete infrastructure can retain heat, but a shaded, vegetated, or moisture-supporting drainage design could reduce local heat stress. Surface #3 was an asphalt street with white paint. The dark asphalt shows the highest heat load, but is lowered by applying shade or reflective surfaces to it. Surface #4 is an outdoor space material configuration that demonstrates the relationship between material choice, spatial configuration and thermal comfort. Lighter paving, shape, and planted edges improves heat resilience. The difference between the cool spot and the hot spot in the thermal images reflect the importance of using shade, vegetation and higher albedo materials together in urban design (Berke & Palmer, 2018; Bruggers, 2026; Evola et al., 2017; Kouhirostami & Abukhalaf, 2021).

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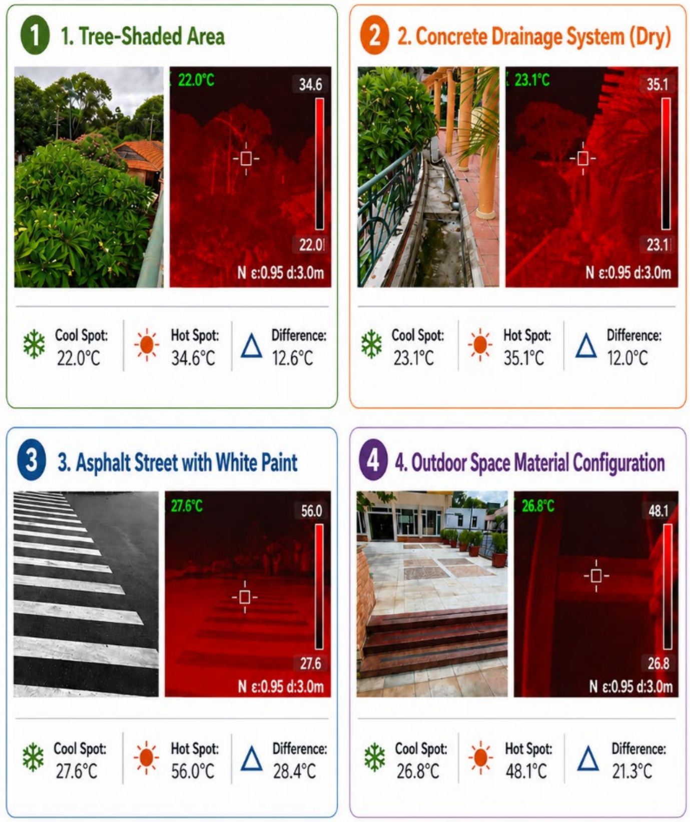
Figure 5 – Four Sites: Surface Design and Heat Resilience

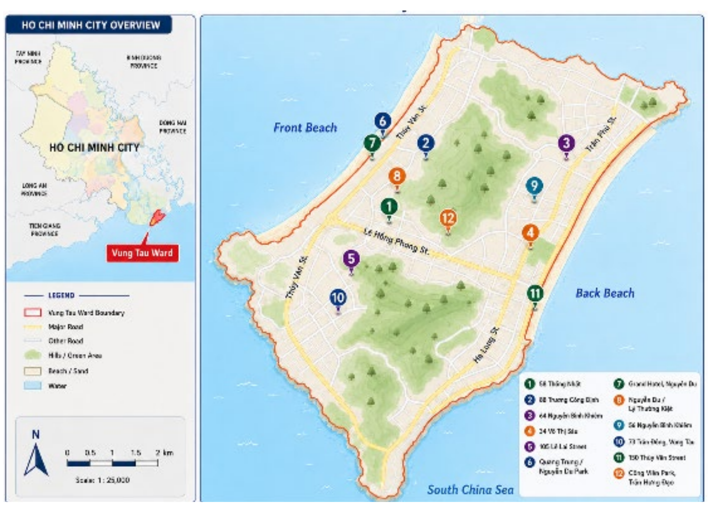


Source: Generated by Robert W. Taylor on May 23, 2026

Twelve Study Sites and Heat Stress

Data was gathered for twelve study sites, ranging from arterial streets, local streets, parks and tree-shaded boulevards. Figure ( ) shows the locations of the 12 sites. Each site was measured for

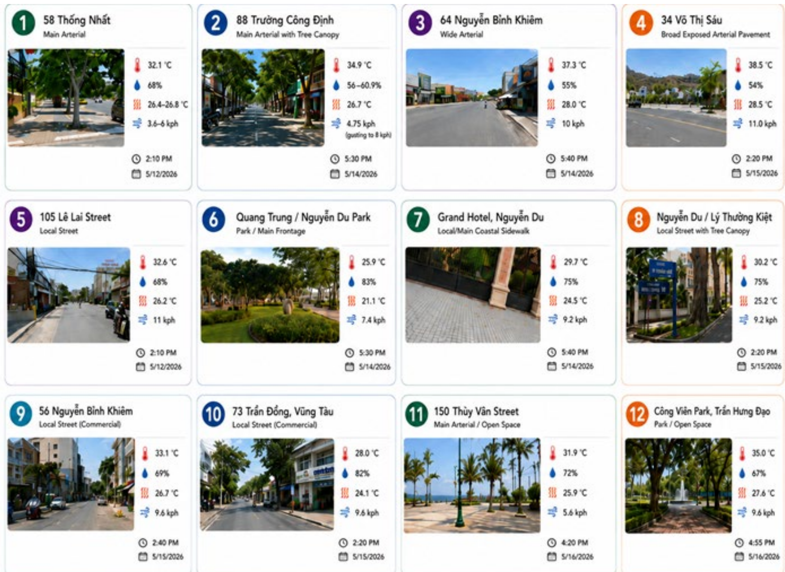
Figure 6: Map of Study Sites



Source: Generated by Robert W. Taylor on May 23, 2026

ambient temperature, relative humidity, heat stress and wind speed. Figure 7 displays the data from the 12 study sites. The Observations from the twelve sites are in Table 2.

Figure 7: Twelve Study Sites and Heat Stress



Source: Generated by Robert W. Taylor on May 23, 2026

Table 2: Twelve Study Sites and Observations

Site	Observations
Site 1 - Main Arterial	Moderate thermal exposure; paved areas retained heat.
Site 2 - Main Arterial with Tree Canopy	Tree cover helps, but midday heat remains significant along this arterial corridor.
Site 3 - Wide Arterial with Limited Shade	One of the most heat-vulnerable sites studied; dark exposed pavement and limited canopy intensified heat loading.
Site 4 - Broad Exposed Arterial Pavement	Hottest site measured; requires immediate heat mitigation.
Site 5 - Local Street	Largely exposed roadway with a moderate heat burden; limited shade and dark pavement contribute to surface heat.
Site 6 - Park/Main Frontage	Shaded green park setting with grass and trees; lowest measured heat-stress reading.
Site 7 - Local Main Coastal Setting	Paved pedestrian space along the coast; cooler than exposed commercial streets; shade and open circulation improve comfort.
Site 8 - Local Street/Tree Canopy	Strong tree canopy shades the roadway and sidewalk; a model for designed street heat mitigation.
Site 9 - Local Street/Commercial	Local commercial street with limited shade and awnings; exposed surfaces and frontage contribute to local heat loading.
Site 10 - Local Street/Commercial	Mostly exposed commercial roadway with lower-to-moderate heat stress.
Site 11 - Main Arterial/Open Space	Open paved area adjacent to a park in a coastal setting; large paved surfaces retain heat and affect pedestrian comfort.
Site 12 - Park/Open Space	Green parkway with walkability and a water feature.

Source: Robert W. Taylor from Field Research, May 2026

Analysis, Interventions, And Recommendations

Key Findings

The 12 study sites reveal a consistent relationship between pavement exposure, continuity of shade, vegetation, and pedestrian heat stress. Heat-stress readings ranged from 21.1°C at Site 6, to 28.5°C at Site 4, a difference of 7.4°C across the study locations.

Overall, the hottest sites were dominated by broad, sun-exposed pavement with limited continuous shade. The coolest sites combined tree canopy, vegetation, shaded pedestrian areas, and less direct exposure to heat-retaining surfaces. The major findings are as follows.

1. Broad, exposed arterial streets produced the greatest Heat-Stress burden. The highest heat-stress readings were recorded at sites characterized by extensive pavement and limited protection from direct solar exposure. Site 4 had the highest recorded heat stress at 28.5°C due to a broad exposed arterial pavement with minimal shade. Sites 3, 12, 2 and 9 also had heat stress ranging from 28.0°C to 26.7°C. All exhibited similar characteristics. Wide arterial corridors with limited canopy, extensive dark pavement, park areas with exposed paved surfaces that retained heat, and moderate-to high head burden associated with arterial or commercial pavement exposure. These results suggest that large expanses of exposed roadway and hardscape are major contributors to localized pedestrian heat stress. Even where trees or nearby green space are present, the cooling benefits may be limited when paved surfaces remain broadly exposed to sunlight.

2. Continuous tree canopy and shaded green space were associated with lower heat stress. The coolest or most thermally comfortable sites were locations where shade, vegetation, and more protected pedestrian conditions were present. Sites 6, 10, 7, and 8 showed a heat stress ranging from 21.1°C to 25.2°C. These sites were characterized by dense vegetation, grass and substantial shade. These sites indicate that tree canopy, shaded pedestrian environments, landscaped surfaces, and open-air circulation are associated with improved thermal comfort. Sites 6, 7, and 8 therefore provide useful local examples of heat-resilient urban design.

3. Trees provide cooling benefits, but are insufficient without partial shade on large paved corridors. Sites 1 and 2 included roadside trees or tree canopy, yet both retained moderate heat stress readings. The comparison suggests that isolated trees or discontinuous canopy cannot fully counteract the heat generated by wide asphalt surfaces and high solar exposure. Heat Resistant Planning should therefore focus on creating continuous shade networks along streets and pedestrian corridors, rather than relying on individual trees alone.

4. Commercial and local streets can offer practical retrofit opportunities. Sites 5 and 9 recorded moderate heat-stress conditions and represent realistic opportunities for targeted urban improvements. Both sites contain exposed roadway and commercial frontage that contribute to pedestrian heat exposure. While they have a high heat stress level of 26.2°C and 26.7°C, retrofits such as shaded sidewalks, storefront awnings, building-mounted canopies, cool or more reflective paving materials; and reductions in unnecessary exposed asphalt where feasible, can reduce temperature. These interventions may be especially appropriate for commercial streets because they can improve both pedestrian comfort and the quality of the public realm.

5. Coastal or park settings do not automatically eliminate heat stress. The coastal and open-space sites produced mixed results, indicating that location near the sea or within a park does not, by itself, guarantee cooler pedestrian conditions. Sites 7, 11, and 12 are in locations that are more parklike, but still have elevated heat stress levels. These findings suggest that coastal airflow and open space can moderate heat, but they do not replace the need for shade, vegetation, and heat-responsive surface materials. Parks and waterfront public spaces may still require canopy trees, shaded seating areas, vegetated surfaces, and cooler paving treatments.

Analysis and Interventions

Figure 8 establishes a criteria for measuring urban design interventions in locations with a high heat stress level. A triage model is designed to prioritize the most vulnerable locations for immediate intervention. It establishes a procedure for action in urban locations with either high

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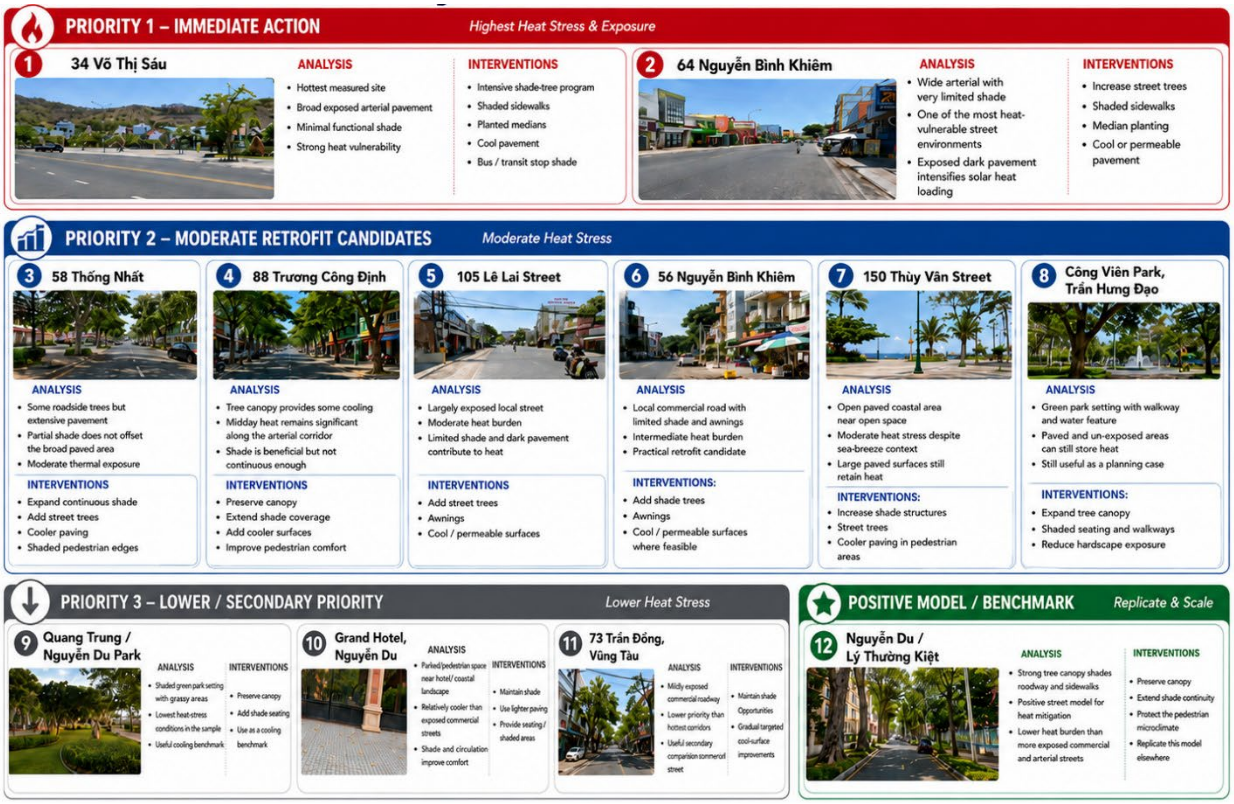
Figure 8: Analysis and Interventions – Triage Model



Source: Generated by Robert W. Taylor on May 23, 2026

heat stress or the potential for high heat stress. For the study sites, Site 4 and Site 8 constitute high priority design interventions. Site 8 establishes a positive model or benchmark for urban design that reduces heat stress. Urban Planners can use this model to prioritize interventions in their communities based on the findings from both WBGT and Thermal Mappings technology.

Designing for Urban Heat Stress

While data to reveal heat stress is essential, and the need to prioritize hotspot areas is required, urban planners need to design retrofits for urban streets that can minimize UHII. Figure 9 provides a redesign or retrofit of three streets in Vung Tau. The retrofits are based on expanding vegetation through planters and the addition of trees, often reducing the space for vehicles. For local commercial streets that have storefronts directly on the street, an effective retrofit might include changing the street from two-way to one-way. This would make the local environment cooler, less polluted and more desirable, which can improve commercial activity. Another retrofit would be to take a mixed commercial/residential street and key it two-way but slow the movement of vehicles through traffic calming methods. This would make the street safer, cooler, and less pollution. A third retrofit is to convert a residential alley into a shared space that benefits more vulnerable people in a community and elevates the safety of the community while making it cooler and more liveable. All of these redesigns or retrofits are derived from the data gathered by urban planners on heat stress and vulnerabilities that can lead to productive solutions.

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Figure 9: Three Designs for Heat Resilience

Source: Generated by Robert W. Taylor on May 23, 2026

Conclusion

This study proposes a methodology and approach to urban heat resilience that emphasizes the use of low cost thermal mapping and WBGT instruments by urban planners to analyze the hotspots in their communities that produce the greatest heat stress and UHII. After gathering this data, they can then prioritize the most vulnerable locations and design effective retrofits for immediate intervention. Vung Tau Ward is used as a model of how such a methodology can be translated into real life problem-solving. As a tourism dependent and seacoast community, it is necessary for its continued commercial prosperity and citizen health to maintain a cooling and healthy environment. This study concludes that Vung Tau Ward can move to a more heat resilient community by adding more tree canopy, vegetation, shaded commercial areas, and reduced hardscape exposure. It should minimize exposed dark hardscape that produce the hottest urban surface conditions; introduce passive cooling with trees and vegetation, and retrofit the most heat vulnerable locations.

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