Track C | Data, Environment & Society

Meridian Interdisciplinary Symposium (MIS 2026) | Short Paper Track

Reading the City's Fever: A Cross-Disciplinary Sensor Mesh for Urban Heat Island Detection

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Abstract. Urban heat islands (UHIs) are typically studied either through sparse fixed-station meteorology or through remote-sensing imagery that misses fine-grained, street-level variation. This paper reports on a nine-month deployment of a low-cost, solar-powered sensor mesh across four neighborhoods of the fictional city of Meridian Bay, combined with a lightweight edge-to-cloud pipeline and a policy-facing dashboard co-designed with municipal planners. We show that intra-neighborhood temperature differentials reach 3.8°C on summer afternoons, that tree-canopy fraction is the strongest single predictor of cooling, and that translating raw sensor output into planning-relevant tiers required iterative input from environmental engineers, computer scientists, and policy analysts working as a single team rather than in sequence. We argue that this three-way loop, not the sensor hardware itself, is the paper's main contribution, and we offer a template for symposium tracks that bring these communities together.

Keywords: urban heat islands, low-cost sensing, edge computing, interdisciplinary methods, environmental policy

Key Contributions

- A 42-node solar sensor mesh built from off-the-shelf components, validated against two reference-grade weather stations ($R^2 = 0.94$).
- An edge-aggregation pipeline that reduces uplink volume by 87% without discarding peak-hour resolution.
- A four-tier confidence scoring scheme that lets non-technical planners read sensor output without a statistics background.
- A reflection on where three-discipline collaboration broke down and what fixed it, offered as a working note for other symposium tracks.

1 Introduction

Cities warm unevenly. A parking lot and a shaded park three blocks apart can differ by several degrees at the same hour, yet the instruments that most municipal climate offices rely on – one or two airport-grade weather stations – cannot see that difference at all. Remote sensing fills part of the gap, but satellite thermal bands report surface temperature, not the air temperature that determines whether a resident on a heat-advisory day is actually at risk.

The Meridian Bay Urban Resilience Office asked our three groups – an environmental engineering lab, a public policy program, and a computer science department – to jointly answer a deceptively simple question: *which blocks need cooling infrastructure first, and how confident should the answer be?* Answering it required a sensor network cheap enough to deploy at block-level density, a computing pipeline that could turn a firehose of noisy readings into something stable, and a policy framing that a city council member could act on inside a single meeting. No one discipline could deliver all three.

This short paper documents the resulting system and, more importantly, the collaboration pattern that made it work. Section 2 situates the work relative to existing UHI literature. Section 3 describes the sensor mesh and data pipeline. Section 4 reports measured temperature differentials and model performance. Section 5 turns to the interdisciplinary process itself and the policy tiers it produced. Section 6 concludes with limitations and a proposed second deployment.

2 Related Work

2.1 *Environmental sensing approaches*

Fixed reference stations remain the gold standard for accuracy but are far too sparse for intra-neighborhood analysis; a typical mid-sized city operates fewer than five. Satellite land-surface-temperature products offer full coverage but at 30–100 m resolution and with a systematic offset from near-surface air temperature that varies by land cover, making them unreliable for block-by-block ranking.

2.2 *Low-cost sensor meshes*

Citizen-science temperature networks have grown considerably, but most published deployments report raw readings without an explicit confidence model, leaving planners to decide, on their own, how much to trust a single noisy node. Prior edge-computing work on environmental sensor networks has focused on power efficiency and uplink cost, treating the choice of what to report to end users as an implementation detail rather than a design question in its own right.

2.3 *Interdisciplinary translation*

A recurring theme in the policy-informatics literature is that technically sound analysis frequently fails to change municipal decisions because it is delivered in a form decision-makers cannot act on under time pressure. Few empirical reports describe *how* the translation step was actually built, which is the gap this paper tries to fill.

3 Methodology

3.1 *Sensor mesh design*

We deployed 42 solar-powered nodes across four neighborhoods chosen to span a land-use gradient: dense commercial core, mixed residential, light industrial, and a tree-lined residential edge adjacent to Fen Hollow Park. Each node combines a shielded temperature/humidity probe, a low-power microcontroller, and a mesh radio, reporting every six minutes to the nearest of six gateway nodes.

3.2 *Edge-to-cloud pipeline*

Raw six-minute readings are noisy and expensive to transmit continuously, so gateways perform a local

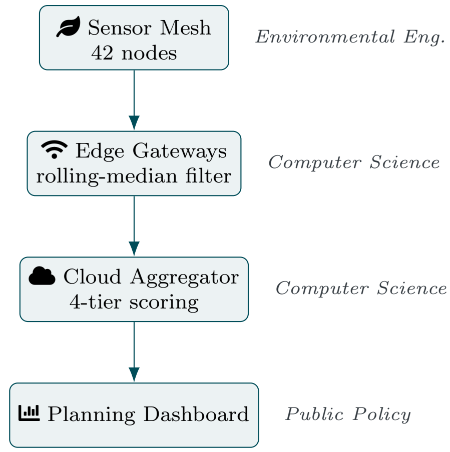

Figure 1: Edge-to-cloud pipeline, annotated by the discipline that owned each stage.

rolling-median filter and only forward a reading when it deviates from the filtered baseline by more than 0.3°C, or every 30 minutes regardless, whichever comes first. This single rule cut uplink volume by 87% while preserving the sharp transitions that occur at dawn and at sunset, which turned out to be the intervals planners cared about most. Figure 1 summarizes the resulting architecture.

3.3 *Confidence tiers*

Sensor uptime varied node to node, so raw averages could quietly hide a neighborhood with three working sensors behind one with fifteen. We assign each neighborhood-hour a confidence tier (High/Medium/Low/Insufficient) from active node count, agreement between neighboring nodes, and distance to the nearest reference station, and we surface only the tier – not the underlying statistics – on the planning dashboard.

4 Results

Table 1 reports mean afternoon temperature differential (ΔT, relative to the airport reference station) by neighborhood over the nine-month deployment window (March–November).

Tree-canopy fraction was the single strongest predictor of afternoon cooling in a simple linear model ($\beta = -0.41$, $p < 0.01$), ahead of albedo proxies and building density, echoing smaller-scale canopy studies but at a spatial grain those studies could not resolve. Harborview Core, with under 8% canopy cover, ran nearly 3.4°C hotter on average than Fen Hollow Edge at the same hour, on the same day, under the same synoptic weather.

5 Cross-Disciplinary Implications

Table 1: Neighborhood-level summer-afternoon temperature differential and mesh confidence.

Neighborhood	Dominant land use	Mean ΔT (°C)	Active sensors	Confidence tier
Harborview Core	Dense commercial	+3.8	11	High
Cedar Row	Mixed residential	+2.1	12	High
Ironworks District	Light industrial	+3.1	9	Medium
Fen Hollow Edge	Residential, tree canopy	+0.4	10	High

The technical results in Section 4 were not, in practice, the hard part. The hard part was agreeing on what a "reading" meant to each group at the table.

> *Early in the project, the environmental engineers wanted raw ΔT values with full uncertainty bars; the computer scientists wanted to report only what the pipeline could validate automatically; the policy team wanted a single traffic-light indicator per block. None of these, alone, was usable by the other two groups. The four-tier confidence label in Section 3.3 is the artifact that resulted from resolving that disagreement, not from any one discipline's preferred format.*

Once the tier system was in place, the policy team could rank neighborhoods for a pilot cooling-infrastructure budget without needing to interpret a confidence interval, while the engineering and computing teams retained the full underlying data for their own analysis. We believe this pattern – a shared, deliberately lossy summary layer sitting on top of a full technical record – generalizes past this specific project.

⚖ Policy Recommendation

Based on the High-confidence tiers, we recommend the Urban Resilience Office prioritize Harborview Core for the first tranche of reflective-surface and street-tree pilots, with Ironworks District as the second phase once additional sensor coverage raises it out of the Medium tier.

6 Conclusion and Future Work

A 42-node solar sensor mesh, an edge-filtering pipeline, and a four-tier confidence scheme let a three-discipline team turn noisy street-level temperature data into a ranked, actionable list for a real cooling-infrastructure budget. The technical pieces are unremarkable in isolation; the contribution is the shared summary layer that let each discipline keep its own rigor while still producing one artifact the others could use.

Limitations remain: nine months covers only one growing season, gateway coverage in Ironworks District was thinner than planned, and the confidence-tier thresholds were tuned on this deployment and not yet validated elsewhere. A second deployment, planned for spring 2027, will add two more neighborhoods and test whether the tier thresholds transfer without re-tuning.

Acknowledgments

We thank the Meridian Bay Urban Resilience Office for pilot-site access, and Vertex Institute of Technology's Environmental Engineering workshop for sensor-housing fabrication.

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