Supplementary Information

Protective adequacy and institutional handoffs in urban heat governance

Violette Eljure Eljure

npj Climate Action | Article

Supplementary Table 1 | RPT coding dictionary

Code	Operational definition	Allowed status
T0 Risk change	Evidence that the protective requirement materially changed: forecast, heat index, night-time heat, health surveillance, spatial exposure, population or infrastructure change.	Observed / Partial / Unknown
T1 Risk update	Responsible institution receives or generates credible information and recognizes a material change relevant to a protective function.	Observed / Partial / Unknown
T2 Decision update	A threshold, rule, activation, schedule, budget, responsibility, inspection priority or other authorized response changes.	Observed / Partial / Unknown
T3 Delivery update	The authorized change alters operation: site opens, staffing changes, water is supplied, protocol is activated, inspection occurs or other function-specific action is verified.	Observed / Partial / Unknown
T4 Reach	The intended population can use or receives the intervention. Administrative outputs are not automatically treated as unique people reached.	Observed / Partial / Unknown
T5 Protection	Evidence that exposure or heat-related health risk changed in the intended direction. T5 is never imputed from T1-T4.	Observed / Partial / Unknown
Binding constraint	Condition that had to change for the transition to move: authority, resources, role clarity, operating capacity, information, coordination, incentives or enforcement.	Supported inference / Plausible / Unknown
Confidence	Strength of temporal ordering and source triangulation.	High / Moderate / Low

Supplementary Table 2 | Rival-explanation signatures

Alternative explanation	Observable implication
Aggregate administrative capacity	If city-level capacity were sufficient, functions within the same government should move more uniformly. Persistent within-city variation weakens a purely aggregate explanation.
Resources	Resource scarcity is most persuasive where the stalled step requires unavailable staff, facilities, infrastructure, supplies or inspection capacity.
Political commitment	Formal plans establish agenda attention but not implementation depth. A city-level commitment account is incomplete if functions diverge under the same plan.
Information quality	Poor information can block T0-T1. Downstream, information matters when delivery, access, compliance or outcomes are not observable.
Infrastructure availability	Physical capacity enables delivery but does not establish operating hours, staffing, accessibility or use.
Public / private control	Third-party control increases pathway complexity and creates a need for incentives, monitoring, inspection, enforcement or enforceable rights.

Supplementary Table 3 | Delhi transition evidence matrix

Function	Handoff exposure	Delivery / reach evidence	Protection status	Main inference
Warning / alerting	Low to moderate	Forecast-linked recognition and formal activation architecture documented; systematic population receipt not measured in this study.	Unknown at T5	Short administrative pathway; strongest evidence upstream.
Cooling access	Moderate	Facilities specified; targeted 2026 audit reports uneven operation, locatability and awareness in audited sites.	Unknown	Facility operation, local information and access handoffs.
Drinking water	Moderate	Distribution formally specified and some site-level delivery documented; output counts do not always establish unique people reached.	Unknown	Distribution and measurement of actual reach.
Health preparedness	Moderate	Protocols, staffing, supplies and surveillance responsibilities specified; systematic event-level verification incomplete.	Unknown	Organizational coordination plus surveillance.
Occupational protection	High	Protective measures and employer responsibilities specified; targeted audit reports limited worker-level provision and no heat-specific inspection drive in responding record.	Unknown	Employer control plus inspection and enforcement handoff.

Supplementary Table 4 | Illustrative RPS measurement architecture

Layer	Illustrative inputs	Decision question	Primary governance risk
Risk sensing	Forecast, heat index / UTCI, night-time heat, health surveillance, spatial vulnerability	Is the protective requirement materially different from baseline?	Model uncertainty; spatial or subgroup error
Decision	Alert level, activation order, schedule change, budget or resource authorization	Was an authorized action triggered when the rule required it?	Threshold drift; undocumented overrides
Delivery	Facility status, staffing, water, clinical readiness, inspection activity, mobile response	Did operations change as authorized?	False positives from administrative logs; stale data
Reach	Usable access, unique-person counts where appropriate, multilingual communication, worker or community reporting	Could the intended population actually use the protection?	Privacy; duplicate counts; digital exclusion
Protection	Exposure reduction, indoor or worksite conditions, morbidity or mortality signals where available	Did the protective condition change in the intended direction?	Attribution; lag; confounding
Learning	Unresolved alerts, response time, subgroup misses, overrides, corrective action	What failed, how quickly was it corrected, and for whom?	Gaming metrics; punitive use of incomplete data

Supplementary Table 5 | Minimum specification for a prospective RPS pilot

Element	Minimum requirement
Protective functions	Choose a small set with different pathway structures: warning, cooling, health preparedness, water and occupational heat.
Pre-registered trigger	Define the risk threshold and protective action required before the heat season.
Named authority	Identify the actor accountable for each transition and the actor with escalation authority.
Verification evidence	Specify what counts as T3 and T4 evidence before deployment; do not substitute scheduled status for verified operation.
Transition deadline	Set a function-specific maximum lag tied to the hazard rather than a universal response time.
Failure alert	Trigger when a required state is missing, late, inconsistent or below requirement; show uncertainty and source freshness.
Equity check	Audit false negatives and missing-data patterns for high-dependence populations and neighborhoods.
Human review	Require accountable human validation for escalation and corrective decisions.
Post-season evaluation	Assess detection time, correction time, reach, unresolved alerts, subgroup misses, administrative burden and outcome signals.