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Deliverable Phase 3 – Climate risk management

Strategies for Mitigating the Urban Heat Island (UHI) Effect in Antalya (Türkiye): Integrating High-Resolution Local Data for Enhanced Climate Resilience (MUHIR)

Türkiye, Antalya / Antalya Metropolitan Municipality

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Document Information

Deliverable Title	Phase 3 – Climate risk management
Brief Description	This deliverable presents the Phase 3 Climate Risk Management (CRM) work for Antalya, translating the Phase 2 climate risk assessment for extreme heat into prioritized adaptation measures, responsibility mapping and a draft Heat Action Plan, based on a participatory prioritization process. Phase 3 delivered a 106-participant stakeholder workshop spanning 30+ institutions, 285 digitized participatory records, an AHP prioritization of 29 measures across five themes, a co-designed early-warning and risk-communication chain, measurable 2026 baselines for monitoring, and the institutionalized Antalya Urban Heat Island and Heat Action Plan (Mayoral approval), to be launched at COP31 (Antalya, November 2026). The work has been recognized internationally through Antalya's selection to UNEP's "50 Cities at 50°C" (Beat the Heat 50@50) initiative and the engagement of the Global Chief Heat Officer as volunteer advisor and co-lead editor of the plan. The report intentionally exceeds the indicative page length of the reporting template: this participatory evidence base is documented in full because it feeds directly into the Heat Action Plan and is intended to be reusable by other CLIMAAX regions, and further condensation would have broken the traceability between what stakeholders contributed and what the plan adopts.
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Abbreviations and acronyms

Abbreviation / acronym	Description
AFAD	Disaster and Emergency Management Authority (Türkiye)
AHP	Analytic Hierarchy Process
AMM	Antalya Metropolitan Municipality
ASAT	Antalya Water and Wastewater Administration
CLIMAAX	CLIMAte risk and vulnerability Assessment framework and toolboX
COP31	31st Conference of the Parties to the UNFCCC (Antalya, November 2026)
CR	Consistency Ratio
CRA	Climate Risk Assessment

CRM	Climate Risk Management
EWS	Early Warning System
FSTP	Financial Support to Third Parties
GIS	Geographic Information System
HAP	Heat Action Plan
INECPAC	International Nature and Environmental Conservation and Protected Areas Congress
MUHIR	Strategies for Mitigating the Urban Heat Island Effect in Antalya (project acronym)
SCI	Science Citation Index
SECAP	Sustainable Energy and Climate Action Plan
TÜİK	Turkish Statistical Institute
İRAP	Provincial Disaster Risk Reduction Plan (Türkiye)
KRA	Key Risk Assessment
LST	Land Surface Temperature
MGM	Turkish State Meteorological Service
M&E	Monitoring and Evaluation
NbS	Nature-based Solutions
NGO	Non-Governmental Organization
RCP	Representative Concentration Pathway
SOP	Standard Operating Procedure
TAMP	Türkiye Disaster Response Plan
UHI	Urban Heat Island
UHRHO	Urban Heat Risk Hotspot Overlay
UNEP	United Nations Environment Programme

Executive summary

This deliverable presents the Phase 3 Climate Risk Management (CRM) work of the CLIMAAX-MUHIR project for Antalya. Phase 2 established, with a province-wide Climate Risk Assessment (CRA), that extreme heat and heatwaves constitute a high-priority risk for the province: current severity was rated Substantial (3), future severity Critical (4), urgency 4 (immediate action needed) and resilience capacity Medium (2) on the Key Risk Assessment Evaluation Dashboard. Phase 3 was designed to answer the question that follows from that finding: which measures, in what order, under whose responsibility, and through which institutional mechanism should Antalya act? The phase therefore concentrated on converting the Phase 2 evidence base — satellite-derived urban heat island (UHI) and Land Surface Temperature (LST) risk maps, the Urban Heat Risk Hotspot Overlay (UHRHO) and projection-based risk change — into a prioritized, responsibility-mapped programme of measures feeding a draft Heat Action Plan (HAP) for the city.

The centerpiece of Phase 3 was the second stakeholder workshop, “From Science to Action II – Contribution Workshop for the Antalya Urban Heat Island and Extreme Heat Action Plan”, held on 19 June 2026 with 106 participants; the 76 registration records, complemented by the attendance notes of the project team, span 30 distinct institutions and organizations. The workshop was structured as three consecutive activities. Activity 1 measured participants' knowledge and risk perception, collected lived experience of past heat events, mapped perceived hot and cool spots, and prioritized heat-vulnerable groups. Activity 2 measured perceived adaptive capacity across six dimensions and prioritized 29 candidate adaptation measures — organized in five themes and distilled from an inventory of international good practice — through pairwise comparison using the Analytic Hierarchy Process (AHP). Activity 3 designed the demand side of the early warning chain: expected citizen and institutional actions at each warning level, preferred communication channels, red-day message drafting, monitoring signals and anticipated coordination frictions. All individual records were captured digitally through structured forms and processed into the datasets underlying this report.

The prioritization produced a clear and internally consistent result. Aggregated across 82 valid comparison matrices, group judgements were highly consistent (Consistency Ratio 0.03–0.05 per theme) and identified the following leading measures: a graded color-coded early warning system

(weight 0.32 within its theme); adjustment of work and school hours with outdoor-worker protection (0.32); green corridors and cool walking routes together with satellite-targeted urban tree planting (0.26 and 0.25); critical-infrastructure resilience and cool/reflective pavements (0.31 and 0.29); and real-time impact monitoring with vulnerability/UHI mapping for spatial targeting (0.30 and 0.27). The capacity pulse identified finance and resources (mean 2.12 of 5) and citizen engagement (2.17) as the weakest dimensions of Antalya's adaptive capacity, and knowledge and data (3.18) as the strongest — a direct validation of the project's data-first strategy and a clear signal of where the HAP must concentrate institutional effort. The results were carried straight into implementation structures. The Antalya Urban Heat Island and Heat Action Plan was approved by Mayoral decision, a municipal working team was assigned, and a Volunteer Scientific Advisory and Editorial Board — including the UNEP Global Chief Heat Officer and senior Turkish climate scientists — was appointed on 2 July 2026 to carry the plan to international standards. The draft HAP, structured in thirteen sections, will be launched at COP31 in Antalya (9–20 November 2026) and continued under UNEP's 50@50 and Beat the Heat programmes.

Phase 3 concludes that Antalya now possesses what it lacked at the start of the project: a spatially explicit, health-validated evidence base; a stakeholder-endorsed priority list of measures with named responsible institutions; a designed early warning and risk communication chain grounded in residents' actual channel behavior; and an institutional vehicle — the HAP with its advisory board — to sustain the work beyond the project. The main open challenges are the sustainable financing of the measures and the formalization of inter-agency coordination, both identified by stakeholders themselves as the weakest capacity dimensions.

1 Introduction

1.1 Main objectives of the project

The objective of Phase 3 of CLIMAAX-MUHIR is to translate the outputs of the Phase 2 climate risk assessment — particularly the identification of extreme heat/heatwaves as a high-priority risk concentrated in urban hotspots — into actionable climate risk management for Antalya. In line with the work plan set out in the Phase 2 deliverable, the phase pursued four specific objectives: (i) operationalize the risk priorities by compiling priority districts and focus areas from the risk maps and the UHRHO layer; (ii) identify, package and prioritize adaptation measures with stakeholders, within the framework of intervention type, target group, responsible institution and implementation scale; (iii) design the early warning, risk communication and monitoring components of the response with the people expected to use them; and (iv) institutionalize the results in a draft Heat Action Plan (HAP) to be launched at COP31 in Antalya in November 2026. Phase 3 deliberately shifted the mode of stakeholder engagement. Whereas the Phase 2 workshop (21 November 2025, 149 participants) collected severity and urgency scores to feed the Key Risk Assessment, the Phase 3 process asked stakeholders to make management decisions: to rank concrete measures against each other, to assign responsibility, and to design the warning chain from the citizen's point of view. The central engagement event of the phase was the second stakeholder workshop, “From Science to Action II – Contribution Workshop for the Antalya Urban Heat Island and Extreme Heat Action Plan”, held on 19 June 2026 with 106 participants. It was organized as three consecutive facilitated activities, referred to throughout this report as Activities 1–3: Activity 1, “Heat in Antalya: Where, Who, How?”, measured knowledge and risk perception, collected lived experience of past heat events, mapped perceived hot and cool spots and prioritized heat-vulnerable groups; Activity 2, “What to Do, and Who Should Do It?”, measured perceived adaptive capacity and prioritized the candidate adaptation measures through pairwise comparison; and Activity 3, “When the Warning Comes: What Do We Do, and How Do We Communicate It?”, designed the demand side of the early warning chain, its communication channels and messages, its monitoring signals and the anticipated coordination frictions. This report documents that process, its quantitative and qualitative results, and the institutional steps already taken to carry the results into implementation.

1.2 Project team

The project is led by the Climate Change Branch of the Department of Climate Change and Zero Waste of Antalya Metropolitan Municipality (AMM), with the GIS Branch of the IT Department and the EU Projects Branch of the Foreign Relations Department. The core team remained as in Phase 2: Dr. Fulya Kandemir (project manager, senior researcher, climate governance, GIS-RS and climate modelling), Mustafa Kaynarca and Volkan Sepetci (GIS, data processing and online survey frameworks), Esra Aksoy (project staff, action-plans and stakeholder networks), Özlem Kılıçarslan (environmental engineering, policy and action-plans), Mehmet Doğan (support) with Güliz Yaman (budget management and EU projects), Melike Kireççibaşı (head of department) and Lokman Atasoy (mayoral representative); additions for phase 3; Sena Saraç (project staff, GIS, mapping), Merve Kıran-Hergün (project staff, facilitator of action-plan). During Phase 3 the team was reinforced, by Mayoral approval of 2 July 2026, with a Volunteer Scientific Advisory and Editorial Board for the Heat Action Plan: Prof. Dr. Murat Türkeş (Boğaziçi University, volunteer chief advisor and lead editor, also CLIMAAX-MUHIR volunteer advisor), Dr. Eleni Myrivili (Global Chief Heat Officer, UNEP/Cool Coalition, volunteer advisor and co-lead editor), Assoc. Prof. Dr. Nusret Demir (Akdeniz University, section editor and also CLIMAAX-MUHIR volunteer advisor), Prof. Dr. Ecmel Erlat (Ege University, section editor), Prof. Dr. Dilek Koç San, Prof. Dr. Evrim Öztop and Assoc. Prof. Dr. Mehtap Pekesen (Akdeniz University, section editors), Prof. Dr. Hüseyin Gül (Süleyman Demirel University, section editor), Özden Akkaya (municipal staff), and Mekke Yıldız (Head of the Climate Change Branch of AMM) all serving on an entirely voluntary basis. No paid external consultancy was used at any stage of the project.

1.3 Outline of the document's structure

Section 2 profiles the local risk and governance context: a summary of the Phase 2 Key Risk Assessment results and resilience capacity, the policy instruments and implementation mechanisms available for CRM in Türkiye and Antalya, the key actors and how they were engaged, and lessons learned from past heat events as reported by residents themselves. Section 3 presents the Phase 3 CRM work: CRM objectives with assessment indicators, the state of supportive elements measured through the capacity pulse, the prioritized measure portfolio produced by the AHP exercise, and the integration of results into planning, decision-making and monitoring. Section 4 evaluates the usability of the results, and the lessons learned in this phase. Section 5 draws conclusions, Section 6 reports progress against the work plan, and Section 7 lists the outputs produced. Throughout the report, workshop data are reported with their sample sizes; participant statements are translated from Turkish.

2 Local profile

2.1 Summary of Key Risk Assessment results

Phase 2 assessed extreme heat/heatwave risk for the whole province of Antalya (approximately 20,177 km², more than 2.6 million residents and over 15 million visitors per year) through two complementary lines of evidence. Current risk was mapped by combining satellite-based LST/UHI exposure with the density of vulnerable population (ages 0–5 and 60+; WorldPop 2025 projection cross-checked against TÜİK 2024) through the CLIMAAX risk-matrix logic (CLIMAAX, 2024), and refined with the Urban Heat Risk Hotspot Overlay (UHRHO), which intersects Medium/High/Very High risk classes with built-up areas to produce an intervention-ready spatial layer. Future risk was assessed through projection-based change in heatwave indicators under RCP4.5 and RCP8.5 with locally derived thresholds (MGM 1950–2024 observations and NASA NEX-GDDP), integrated with vulnerability classes into risk-change maps. The pattern is unambiguous: risk is not homogeneous across the province but concentrates where urban density and vulnerable populations overlap. The central districts (Muratpaşa, Kepez, Konyaaltı, Aksu, Döşemealtı) fall in the Very High class for current risk, with Alanya and Gazipaşa High; under RCP8.5 the central region remains Very High in the far future while the eastern coast rises to High. District-level summer mortality data (circulatory and respiratory causes, 2018–2024, provided by the Provincial Health Directorate) align spatially with the modelled risk, providing field validation.

On the Key Risk Assessment Evaluation Dashboard, heatwave risk was scored as follows: current severity Substantial (3); future severity Critical (4); urgency 4 – immediate action needed; resilience capacity Medium (2). The combination of high severity and urgency with medium capacity led to a risk priority of High. These scores combined the technical CRA outputs with stakeholder scoring collected at the first workshop (21 November 2025, 149 participants) and the associated survey. For this priority risk, the resilience capacity assessment of Phase 2 is summarized in Table 2-1, updated with the Phase 3 developments described in this report.

Table 2-1 Resilience capacity for the priority climate risk (Phase 2 assessment updated with Phase 3 evidence). Scores in the form x/5 are mean scores from the Phase 3 capacity pulse (n = 65), rated on a five-point agreement scale (1 = strongly disagree, 5 = strongly agree).

Priority climate risk	Resilience capacity	Description of the resilience capacity	Stakeholders, experts and priority groups involved
Extreme heat / heatwaves	Medium (with clear short-term potential to increase)	Strengths: growing institutional interest; spatially explicit risk products (LST/UHI, vulnerable-population density, risk classes, UHRHO); health-data validation; expanding stakeholder network; HAP process formally initiated with a scientific advisory board. Weaknesses (confirmed by the Phase 3 capacity pulse, n=65): finance and resources (mean 2.12/5) and citizen engagement (2.17/5) rated weakest; monitoring and warning infrastructure (2.37/5) and public awareness and behavior (2.45/5) also weak; knowledge and data strongest (3.18/5).	Metropolitan and district municipalities, Governorship, MGM, AFAD, Provincial Health Directorate, Provincial Directorate of National Education, Provincial Agriculture and Forestry Directorate, utilities (ASAT, electricity distributor), universities, professional chambers, NGOs, mukhtars; priority groups: chronically ill, outdoor workers, older adults, pregnant women, young children, people with disabilities, homeless people, low-income households, tourists

2.2 Key implementation mechanisms and policy context for CRM

The policy context for heat-risk management in Türkiye changed substantially during the project period, in ways that favor implementation. At the national level, Türkiye's first Climate Law (Law No. 7552) entered into force on 9 July 2025 (Official Gazette No. 32951), establishing a binding framework for climate change mitigation, adaptation, green transition and the related institutional responsibilities, and giving local governments a defined place in national climate governance. It is complemented by the Climate Change Adaptation Strategy and Action Plan 2024–2030, published in March 2024, which organizes national adaptation around eleven sectors — including Public Health, Urban Development and Disaster Risk Reduction, the three sectors most directly engaged by a municipal Heat Action Plan — with 40 strategic targets and 132 actions into which local measures can be docked and reported.

At the provincial level, the operative instruments are the disaster-management plans coordinated by AFAD: the Antalya Provincial Disaster Risk Reduction Plan (İRAP, 2022) on the prevention side, and the Türkiye Disaster Response Plan (TAMP, updated by the Official Gazette of 15 September 2022, No. 31954) on the response side. A graded heat-warning system must connect to both — İRAP for pre-season risk-reduction actions and TAMP for the activation machinery on red-level days; workshop participants explicitly referenced TAMP activation when designing the red-level institutional response (Section 3.4). Sectoral mandates complete the frame: occupational health and safety legislation (Law No. 6331) and the working-time instruments of the labor administration are the implementation mechanism for the highest-ranked measure of the prioritization exercise (adjustment of outdoor work hours with worker protection); the zoning framework (Law No. 3194) and metropolitan and district spatial plans are the mechanism for the built-environment measures; and provincial directorates of health, education, agriculture and social services carry the corresponding service mandates (AFAD, 2022a;b; Republic of Türkiye, 2024;2025).

At the municipal level, the mechanisms established within the project period are concrete: the Mayoral approvals of 30 March and 22 April 2026 formally initiated the Antalya Urban Heat Island

and Heat Action Plan and assigned the working team from CLIMAAX-MUHIR; the Environmental Board of AMM reviewed the Phase 2 findings and the action component on 15 May 2026 and functions as the standing institutional anchor for the plan; metropolitan and district spatial-planning powers allow UHRHO hotspot targeting to be reflected in plan revisions and urban-renewal decisions (participants argued for block-scale rather than parcel-scale renewal to secure green space); and Antalya's international commitments; membership of UNEP's 50@50 High-Level Engagement Cohort and the Beat the Heat programme, and the announcement of the HAP at COP31 in Antalya (9–20 November 2026) — bind the plan to an external calendar and community of practice. Relevant policy goals at all levels point in the same direction: reducing heat-related health impacts, protecting vulnerable groups and the outdoor workforce, and embedding climate adaptation in spatial planning.

2.3 Key actors and systems for CRM

Actor mapping in Phase 3 was produced by the stakeholders themselves: in Activity 2 of the 19 June 2026 workshop, each table matched its priority measures to a lead institution, supporting institutions and the groups that must be informed. Table 2-2 consolidates these assignments across all tables, supplemented by the institutional composition of the workshop itself. Two features of the mapping deserve emphasis. First, participants converged on a small set of lead institutions; MGM for issuing the graded warning, the Governorship for announcing it, the metropolitan municipality and district municipalities for most territorial measures, and the Ministry of Labor framework for work-hour regulation indicating that responsibility is legible to stakeholders.

Second, participants repeatedly demanded that role-sharing be agreed before the season, not negotiated during an event ("task division must be in place before problems occur; do not start in autumn", as one table recorded). Engagement across the analysis steps was continuous rather than episodic: scoping and risk exploration were supported by the first workshop (November 2025); the Key Risk Assessment combined technical outputs with that workshop's severity–urgency–capacity scoring; the Environmental Board reviewed Phase 2 findings and the action component (15 May 2026); the second workshop (19 June 2026, 106 participants; 30 distinct institutions and organizations — AMM departments, the Governorship, AFAD, MGM, provincial directorates, district and coastal municipalities, seven universities, utilities, private firms, professional chambers and NGOs (Figure 2-1)) produced the prioritization and design inputs reported here; and the closing meeting (17 July 2026) presents the results and the HAP progress to the same stakeholder community. Registration records of 19 June 2026 show a balanced participant profile: 59% women and 41% men of those reporting gender — among registered attendees; predominantly university-educated, including 11 doctorate holders (14% of registered attendees).

The expectations participants recorded at registration (59% response rate among registered attendees) cluster overwhelmingly on one demand — applicable, concrete outcomes: "implementable results for our city in the field", "concrete proposals and urgent measures for reducing the urban heat island effect", "a feasible and sustainable action plan for Antalya". This expectation profile shaped the workshop design: every activity was built to produce a named input to the action plan rather than open-ended discussion.

Table 2-2 Key actors for CRM in Antalya, consolidated from stakeholder assignments at the 19 June 2026 workshop. Measured figures cited in the table refer to the workshop datasets: warning reach 33 of 79 respondents (Activity 1); capacity-pulse means x/5 on a five-point agreement scale (Activity 2, n = 65). Measure codes such as 1D, 2F and 4E refer to the prioritized adaptation measures introduced in Section 3.3 (Table 3-4 and Figure 3-3).

Key actor	Role and responsibility	Motivation and needs	Opportunities for involvement	Barriers	Type of engagement in MUHIR
Turkish State Meteorological Service (MGM)	Sets thresholds; decides warning color; issues graded heat warnings	Mandated warning authority: needs agreed local thresholds and dissemination protocol	Direct link of its warnings to municipal and health action	Warning reach: only 33 of 79 participants had received a warning during past events	Workshops; assigned lead for early warning by participants

Key actor	Role and responsibility	Motivation and needs	Opportunities for involvement	Barriers	Type of engagement in MUHIR
Antalya Governorship	Announces warnings; coordinates provincial institutions; work/school arrangements on red days	Public-safety mandate; needs clear trigger levels	Chairs provincial coordination; connects to TAMP/İRAP machinery	Overlapping authority with municipality and MGM (a friction named by participants)	Workshops; named co-lead for warning dissemination
Antalya Metropolitan Municipality (AMM)	HAP owner; cool areas and shading; green/grey infrastructure; transport; water points; social support vehicles	Leads the project; needs financing instruments and cross-department coordination	Environmental Board as standing anchor; spatial-planning powers; COP31 visibility	Finance rated weakest capacity dimension (2.12/5); staff capacity	Project lead; convener of all workshops
District municipalities	Neighborhood-level implementation (shade, parks, local services)	Frontline delivery; need targeting data and budget	UHRHO identifies where to act first	Coordination with metropolitan level	Participants in workshops (Konyaaltı, Muratpaşa, Döşemealtı, Gazipaşa, Alanya)
Provincial Health Directorate	Clinical protocols; family-physician monitoring of risk groups; mortality/morbidity data	Health mandate; provided 2018–2024 mortality data under permission	Health-data validation loop; heat-health protocols (measure 1D)	Data-sharing procedures; workload and no determination/record of mortality by heat directly	Data provider; workshop participant
AFAD Provincial Directorate	Emergency coordination; TAMP activation; protection of field responders	Disaster mandate; İRAP owner	Integration of heat into provincial disaster planning	Heat not yet treated as a formal disaster type by the public	Workshop participant; named lead for red-level response
Provincial Directorate of National Education	School-hour adjustment; school hydration programmes	Duty of care for students	Measures 1E and 2F name schools directly	Calendar rigidity	Workshop participant
Utilities (ASAT water; electricity distribution)	Supply continuity during peaks; backup power for critical facilities	Grid strain during heat (melted cables and outages reported by residents)	Measure 4E ranked first in its theme	Investment cost	Workshop participants
Universities (Akdeniz, Ege, Boğaziçi, SDÜ, Belek, Bilim)	Scientific advice; thematic editing of the HAP; method development	Research interest; visibility	Volunteer Scientific Advisory and Editorial Board (appointed 02.07.2026)	Volunteer time	Advisory board; workshop participants
UNEP / Cool Coalition	International guidance: 50@50 and Beat the Heat programmes	Global heat agenda; COP31 in Antalya	Global Chief Heat Officer serves as volunteer co-lead editor of the HAP	–	Advisory board member
NGOs, professional chambers, mukhtars	Outreach to vulnerable groups; door-to-door channels; feedback	Community trust; local knowledge	Ranked channels include mukhtar and mosque announcements for specific groups	Weak citizen engagement (2.17/5)	Workshop participants (TÜRÇEV, chambers, mukhtars)

Key actor	Role and responsibility	Motivation and needs	Opportunities for involvement	Barriers	Type of engagement in MUHIR
Media (TV/radio, social media)	Warning amplification	Reach: TV/radio and social media are top channels for most groups	Named support institution for warning dissemination	Message consistency	Named by participants as supporting actor



Figure 2-1 Some of the participating institutions and organizations that contributed to the 19 June 2026 workshop and to the measure-prioritization (pairwise comparison) matrices, compiled from registration records and the project team's attendance notes. Word size is scaled to the square root of registered participant count; colors group organization type (municipal, government, university, NGO/chamber, private) (see the general information document about the events in supporting documents of Phase 3, Kılıçarslan, 2026).

2.4 Lessons learned from past events

Phase 3 collected the lived experience of past extreme-heat events systematically: in Activity 1 of 19 June 2026 workshop (see the methodology of this activity in supporting documents of Phase 3-Zenodo; Kandemir and Sepetci, 2026a), 79 participants completed individual structured records of the most severe hot days they remembered (predominantly the summers of 2023–2025). The pattern of impacts is concrete. Asked what strained them most, participants most frequently selected transport (49 mentions), work (43) and health (41), followed by infrastructure failures (electricity and water, 9), housing (5) and care burden (5). Sleep disruption during tropical nights, exhaustion during commutes, and the impossibility of outdoor work in the midday hours recur throughout the records. Participants also reported infrastructure and safety consequences: melted cable insulation on balconies, and a power outage in Kaleiçi during a heat episode that was associated by participants with one fatality. Agricultural stakeholders emphasized irrigation stress; a participant who was pregnant during the summer of 2024 described that season as barely manageable.

The early warning gap is the single clearest lesson. Only 33 of 79 respondents (42%) had received any warning or information before the events they described; 46 had received none. Those who had been warned named MGM announcements, television news and social media as the sources. This baseline, fewer than half of an engaged, institutionally literate audience reached, frames the priority that stakeholders subsequently assigned to the graded early warning system in Activity 2 of 19 June 2026 workshop. Residents' own conclusions anticipate much of the measure portfolio. Recurrent "lessons and wishes" include restricting outdoor activity and work in midday hours on extreme days; more shaded areas, drinking-water points and cooling centers across the city; earlier and more

actionable warnings; attention to people who live alone; and treating extreme heat with the seriousness of a disaster. One table's closing note states the reframing directly: “Increases in extreme temperatures should be treated as a disaster requiring serious management.” Participants were also skeptical of process without delivery — one record notes that workshops are perceived as “programmes that convene, disperse and leave no visible application”, a warning this project addresses through the institutionalized HAP process described in Section 3.4. Perception data complete the picture of the starting point. In the closing pulse of Activity 1 (n=79, five-point agreement scale), participants broadly agreed that they personally know what to do in extreme heat (mean 3.59) — consistent with the high baseline knowledge score (94% correct answers on the seven-item true/false test) — but disagreed that Antalya is prepared (2.04; only 5% agreement), that there is a cool place in their neighborhood (2.58), or that there is a person or institution they could ask for help (2.77). Timeliness of warnings sat in between (3.05). The gap between individual knowledge and systemic preparedness is precisely the space the Heat Action Plan is designed to fill (Figure 2-2).

The closing reflections collected at the end of Activity 1 (39 substantive individual notes) condense the day's learning into three recurring themes. First, reframing: extreme heat should be treated with the seriousness of a disaster (“increases in extreme temperatures should be treated as a disaster requiring serious management”). Second, unpreparedness: many participants stated plainly that neither institutions nor households are ready (“we are not prepared; I do not want to imagine the hottest day coinciding with a water or power cut”, “I realized there is no help mechanism in place for hot days in Antalya”). Third, causes in the built environment: several notes single out dense construction and the loss of green space as the root of the urban heat problem and call for science-based public awareness. These reflections, produced by participants without prompting, correspond closely to the priorities that emerged from the structured exercises.

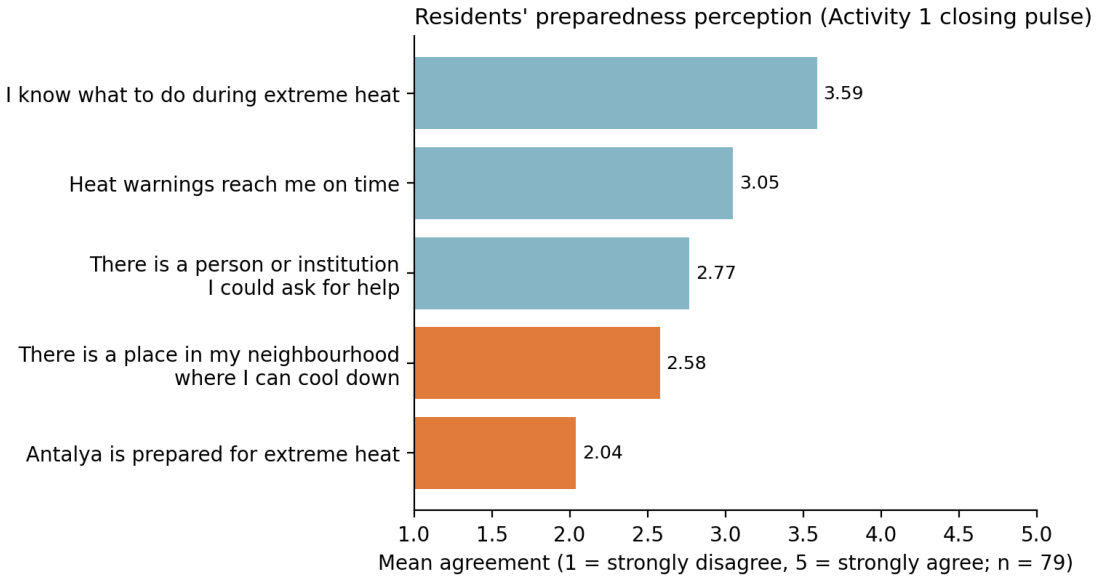


Figure 2-2 Residents' preparedness perception from 19 June 2026 workshop, Activity 1 closing pulse (n = 79). Mean agreement on a five-point scale.

Finally, participants mapped their thermal experience of the city. Asked to mark the most oppressive locations, they overwhelmingly pointed to the dense central fabric; Muratpaşa and the city center (30 mentions), unshaded asphalt and concrete surfaces, bus stops without shade, open car parks and squares, while the places they use to cool down are dominated by shopping malls (47 mentions), parks and green areas (29) and the coast (22), with mosques, libraries and upland areas mentioned occasionally. Here, the perception map reproduces the satellite-based UHI and UHRHO pattern of Phase 2 with striking fidelity; residents feel the hotspots where the Phase2 studies measure them, which strengthens confidence in both. Second, the dominance of commercial air-conditioned space

(malls) as the de facto cooling infrastructure exposes an equity problem: publicly accessible cooling (parks, shaded corridors, water points, designated cool rooms) is exactly what the prioritized measures should address (Figure 2-3).

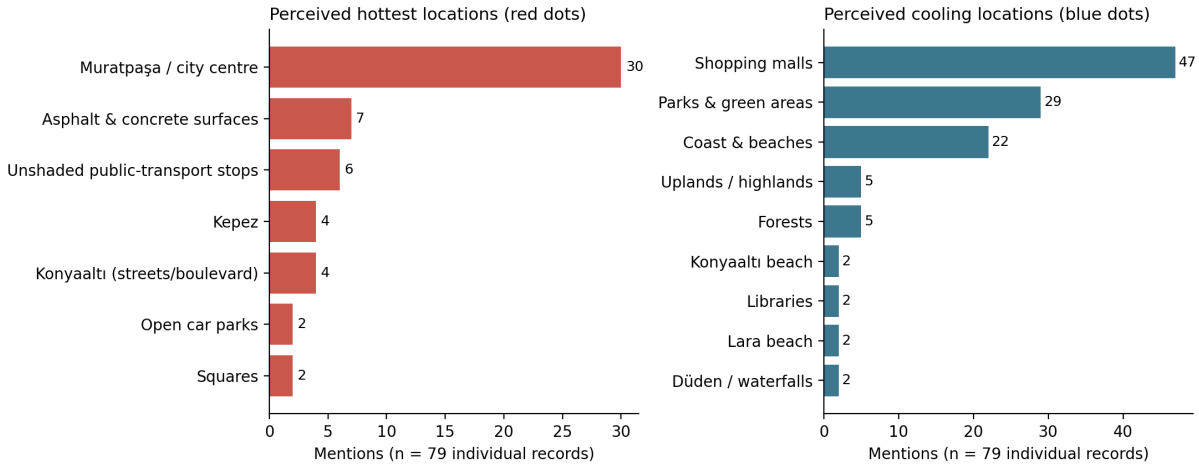


Figure 2-3 Perceived hot spots and cooling locations named by participants in the mapping exercise of 19 June 2026 workshop (n = 79; locations with at least two mentions).

3 Climate risk management – Phase 3

3.1 CRM objectives

The CRM objectives for Antalya follow directly from the priority risk established in Phase 2 and from what stakeholders defined as success in Phase 3. In Activity 2 of the 19 June workshop (see the methodology of this activity in supporting documents of Phase 3-Zenodo; Kandemir and Sepetci, 2026b), participants answered "what does success look like?" in their own words; in Activity 3 of the 19 June workshop (see the methodology of this activity in supporting documents of Phase 3-Zenodo; Kandemir and Sepetci, 2026c), they defined the everyday monitoring signals by which success would be recognized at the end of each summer (fewer heat-related deaths and emergency admissions, visible use of cool points, warnings that demonstrably reach people, feedback surveys after red days).

These formulations were consolidated with the technical evidence into five primary objectives (Table 3-1) and four additional objectives (Table 3-2). Wherever the workshop produced a measurable baseline, it is stated and used as the reference value for the indicator; quantified target values will be fixed during HAP drafting, once the responsible institutions confirm the resourcing of each measure.

Table 3-1 Primary CRM objectives and assessment indicators from 19 June 2026 workshop. Baseline percentages are shares of workshop respondents (Activity 1, n = 79); x/5 values are mean scores on a five-point agreement scale.

Primary objectives	Assessment indicators (with 2026 baselines where measured)
O1 – Reduce heat-related mortality and morbidity, concentrating on UHRHO hotspot zones	Summer (JJA) circulatory and respiratory mortality by district vs 2018–2024 baseline series; heat-related emergency admissions; heatstroke cases treated in dedicated capacity
O2 – Ensure graded heat warnings reach the whole population, including vulnerable groups, in time to act	Share of residents reached by a warning on orange/red days (baseline: 42% — 33 of 79 workshop participants had received a warning during past events); channel coverage per target group; post-event feedback-survey response
O3 – Guarantee publicly accessible cooling within reach of residents in high-risk zones	Share agreeing "there is a place in my neighborhood where I can cool down" (baseline 29%, mean 2.58/5, n=79); number of designated cool points/climate shelters and drinking-water points in Very High-risk zones

Primary objectives	Assessment indicators (with 2026 baselines where measured)
O4 – Protect outdoor workers and reduce exposure during peak hours	Adoption of work/school-hour adjustment on orange/red days; rest-shade-water provision on worksites; heat-related occupational incident reports (construction, agriculture, couriers)
O5 – Institutionalize data-driven heat governance through the HAP	HAP formally adopted and launched at COP31; annual post-summer review completed; UHRHO and risk layers updated; real-time impact monitoring operational (measure 5C)

Table 3-2 Additional CRM objectives and assessment indicators from 19 June 2026 workshop. The 94% knowledge baseline is the mean share of correct answers on the seven-item true/false test (Activity 1, n = 79); the 5% figure is the share agreeing that Antalya is prepared for extreme heat.

Additional objectives	Assessment indicators
Public health system readiness	Clinical heat protocol adopted; family-physician follow-up of registered risk patients (measure 1D); dedicated emergency capacity on red days
Social well-being and equity	Coverage of vulnerable-group registry; proactive-call volume on hot days; share of low-income households reached by cooling support; needs of personas (older adults living alone, outdoor workers, new mothers, seasonal agricultural workers, people with mobility limitations, street-animal carers) reflected in service design
Environmental quality and urban cooling	Trees planted in satellite-identified hotspots; km of green/cool corridors; m² of shaded public space; measured LST reduction in treated zones
Awareness and engagement	Pre/post knowledge and perception scores in future engagement events (2026 baseline: 94% knowledge score; 5% agreement that Antalya is prepared); participation in heat drills and volunteer schemes

Justice and equity are embedded in the objectives through the vulnerability prioritization produced by participants themselves. Asked to rank ten population groups by how severely extreme heat affects them (n=79), participants placed the chronically ill first (mean rank 3.1), followed by outdoor workers (3.7), older adults, especially those living alone (4.0), pregnant women (4.8) and young children (5.3); homeless people, people with disabilities, street animals, low-income households and tourists complete the ranking (Figure 3-1).

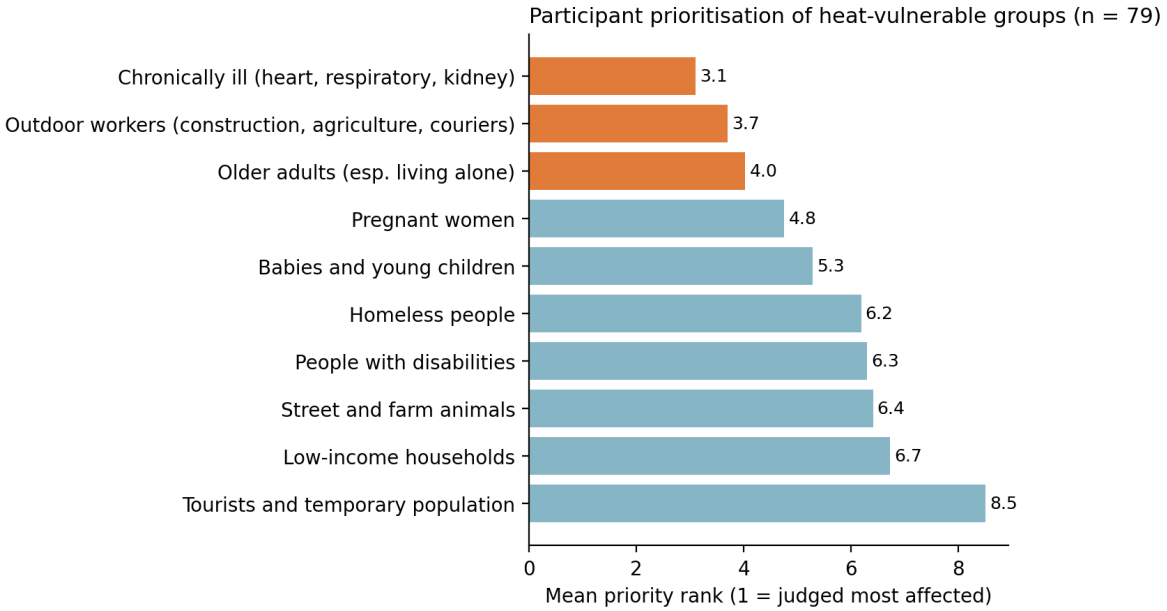


Figure 3-1 Participant prioritization of heat-vulnerable groups from 19 June 2026 workshop (n = 79; lower mean rank = judged more severely affected).

The persona exercise attached concrete, service-level needs to each group: a 78-year-old living alone on a fourth floor without a lift needs proactive calls, transport to cool spaces and home support rather than information alone; a construction or seasonal agricultural worker needs enforceable work-hour rules, shaded rest areas and drinking water on site; a new mother on a tight budget needs

affordable cooling and electricity-bill relief on red days; a resident with mobility limitations needs accessible cool points and door-to-door services. The objectives O2–O4 are formulated so that meeting them requires reaching precisely these groups, and the additional social-equity objective carries the corresponding indicators.

3.2 Supportive elements for effective CRM

The state of the supportive elements for effective CRM was measured directly in Phase 3. At the opening of Activity 2, all workshop participants rated six statements about Antalya's adaptive capacity on a five-point agreement scale (n=65). The result (Figure 3-2) is a capacity profile with one moderate strength and five deficits of varying depth, and it corroborates, now with a measured, sector-diverse sample, the medium capacity rating assigned in the Phase 2 Key Risk Assessment.

Two properties of this measurement should be kept in view when reading the results. It is a structured self-assessment by the people who operate the system, a perception measure used as a complement to, not a substitute for, the Phase 2 capacity assessment; and the sample consists of institutionally engaged, largely university-educated stakeholders rather than the general public, which makes the low scores more telling, not less: even the audience closest to the system rates its warning infrastructure, financing and citizen engagement as weak. Table 3-3 reads each dimension against the evidence and against what Phase 3 contributes.

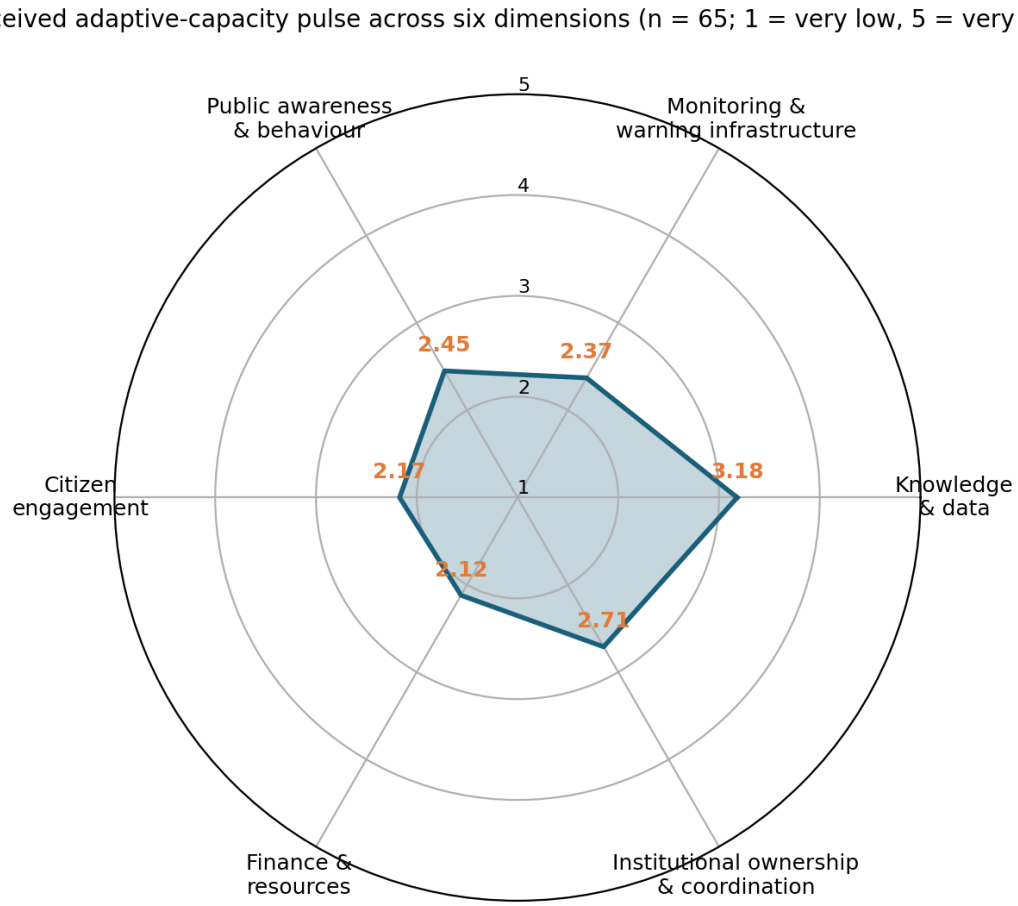


Figure 3-2 Perceived adaptive-capacity pulse across six dimensions (n = 65; 1 = very low, 5 = very high).

Table 3-3 Supportive elements for effective CRM: measured state and Phase 3 response. Means (x/5) are averages over the capacity pulse (Activity 2, n = 65) on a five-point agreement scale (1 = strongly disagree, 5 = strongly agree); percentages are the shares answering agree/strongly agree or disagree/strongly disagree, as indicated.

Supportive element	Assessment (workshop capacity pulse, n = 65) and Phase 3 contribution
Knowledge and data	Strongest dimension (mean 3.18/5; 49% agree we know where heat strikes and whom). Reflects the visibility of the Phase 2 risk products. Phase 3 adds the participatory layer: perception maps, vulnerability rankings, channel behavior and measure priorities.
Tech and infrastructure (early warning, monitoring)	Weak (2.37/5; 62% disagree that monitoring and warning systems are adequate). Consistent with the 42% historical warning reach. Addressed by the top-ranked measure overall (graded color-coded EWS, weight 0.32) and by real-time impact monitoring (0.30).
Social-behavioral aspects	Weak (2.45/5; 62% disagree that people know and care what to do). Individual knowledge in the tested sample is high (94%), suggesting the deficit is population-wide reach and behavior, not information content. Addressed through channel-matched risk communication (Section 3.4).
Citizen engagement	Second weakest (2.17/5; 74% disagree that the public is part of the process and heard). The workshop series itself is the countermeasure; 41 of 42 Activity 3 participants recorded a personal post-workshop commitment, most frequently to inform others.
Finances and resources	Weakest dimension (2.12/5; only 4.6% agreement). Identified by stakeholders as the binding constraint. The HAP therefore carries a dedicated financing section, and measure 5E (integrated plan with explicit financing and timeline) ranked third in the governance theme.
Governance arrangements and political leadership	Below midpoint (2.71/5) but the least negative deficit. Mayoral approvals, the Environmental Board anchor, the advisory board and the COP31 commitment are the Phase 3 response; participants' demand for pre-season role clarity is carried into the HAP's institutional section.

3.3 Potential CRM measures

The measure portfolio was built in three steps. First, the project team reviewed fifteen action plans from cities and regions worldwide, ten of them dedicated heat action plans (including Ahmedabad, Paris, Barcelona, Seville, Athens, Melbourne, Phoenix, Stuttgart, Vienna and Singapore), and extracted an inventory of 72 documented real-world measures. Similar applications were merged, and the inventory was consolidated into 29 candidate measures, organized in five themes: (1) public health and early warning; (2) protection of vulnerable groups and community services; (3) green and blue infrastructure and nature-based solutions; (4) urban (grey) infrastructure and the built environment; (5) data, science and governance (see Activity 2 methodology framework in supporting documents of Phase 3-Zenodo; Kandemir and Sepetci, 2026b).

The themes were deliberately aligned with the content structure of the Antalya's Heat Action Plan, so that each theme's workshop output flows into a named section of the plan (see Section 3.4). Each measure carries a card code combining its theme number and a letter — 1A through 5E — used consistently on the workshop cards, in the figures and tables of this report and in the HAP working documents; each card also carried its international reference examples so that discussion remained anchored in practice rather than abstraction.

Second, at the 19 June workshop the measures were prioritized within each theme by pairwise comparison using the Analytic Hierarchy Process (Saaty, 1980). Participants compared every pair of measures in their theme on the standard scale (1 equal, 3 moderate, 6 strong, 9 extreme importance, with reciprocals), producing 82 valid comparison matrices across the five themes (17, 17, 16, 16 and 16 respectively).

The individual matrices were aggregated cell-by-cell by geometric mean into one group judgement matrix per theme; priority weights were derived from the aggregated matrix and consistency was verified for every matrix (group Consistency Ratios 0.03–0.05, well below the 0.10 acceptability

threshold). As a robustness check, weights were also computed by aggregating individual priority vectors; the theme leaders are identical under both procedures.

Figure 3-3 presents the full results; Table 3-4 details the fifteen priority measures (top three per theme) with responsibility assignments taken from the participants' own "who should do it" mapping. Third, tables could propose Antalya-specific measures on blank cards. Proposals recorded include climate-conditioned cabins at mosques and market places, drinking-water points, web-based rapid communication, limits on parcel-scale densification in favor of block-scale renewal with green space, incentives for self-generating buildings to relieve summer grid load, shaded and cooled public-transport stops, and combining the early warning system with family-physician follow-up (measures 1A and 1D) — this last suggestion is carried into the HAP design.

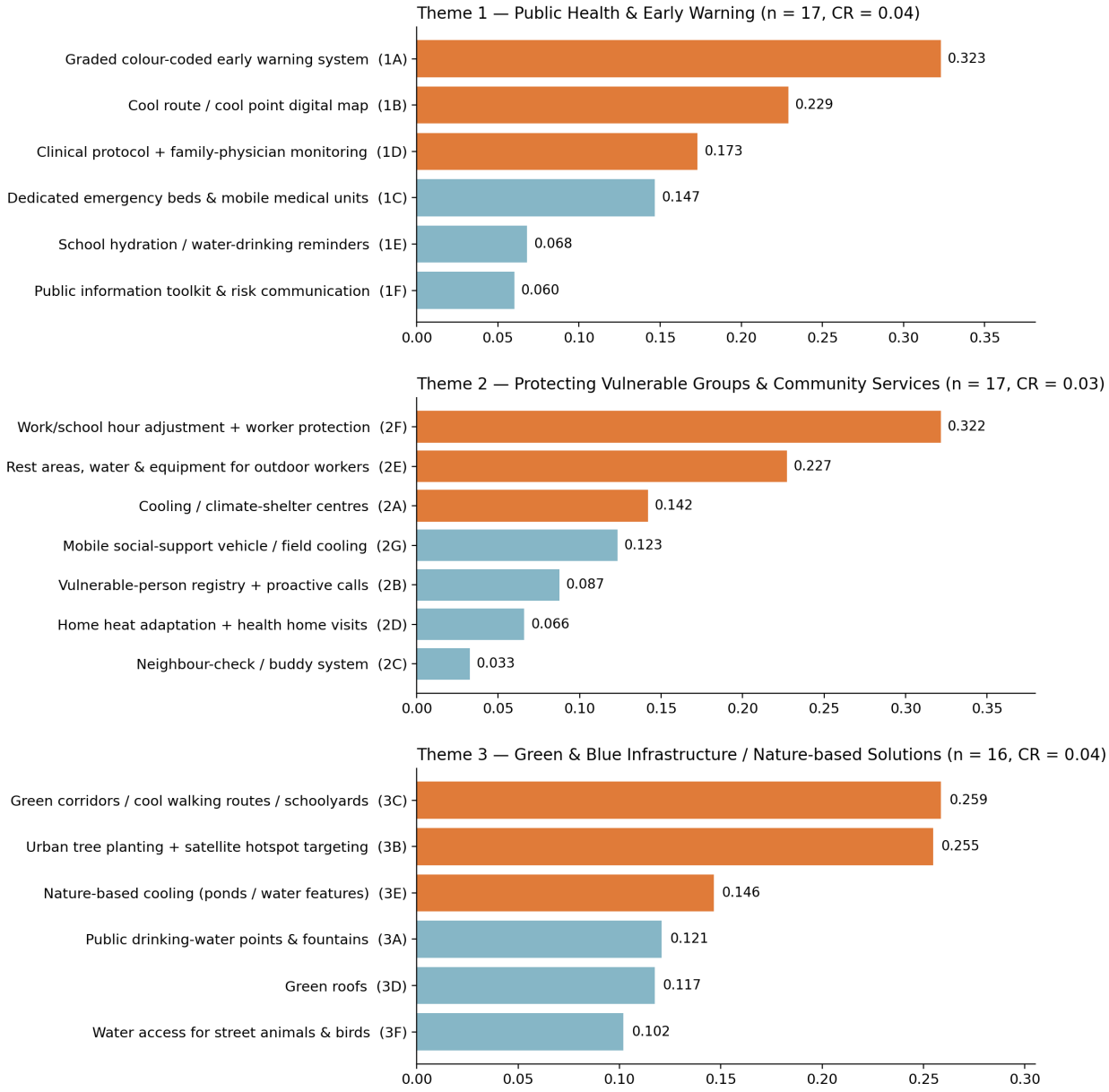


Figure 3-3 Group priority weights of all 29 candidate measures by theme (AHP; geometric-mean aggregation; n = number of valid matrices; CR = consistency ratio of the group matrix). Orange bars mark the top three measures per theme. Themes 1–3; continued below.



Figure 3-3 (continued) Themes 4–5.

Table 3-4 Priority CRM measures for the key climate risk (extreme heat / heatwaves): top three measures per theme with stakeholder responsibility assignments. Decimal figures in the first column are AHP group priority weights: the relative importance of each measure within its theme, derived from the aggregated pairwise-comparison matrix; weights sum to 1 across all measures of a theme (Figure 3-3 shows the full set).

CRM measure (card; AHP weight within theme)	Effectiveness / risk reduction	Contribution to CRM objectives (O1–O5, see Table 3-1)	Possible co-benefits	Timeline	Responsible organization (participant assignment)	Possible adaptation limits
Graded color-coded early warning system - thresholds, color codes, level-specific actions (1A; weight 0.32)	High	O1, O2	Relieves emergency services; single trigger for all institutional protocols; usable for tourism communication	Short	MGM (lead sets thresholds, decides color); Governorship (announces); AMM, media (disseminate)	Warning fatigue if levels are mis calibrated; reach limited by channel coverage (42% baseline)
Cool route / cool point digital map (1B; 0.23)	Medium –High	O3	Walkability; a public alternative to mall-based cooling; service for visitors	Short	AMM (GIS); district municipalities	Needs continuously updated facility data; digital access unequal — print and mukhtar channels required
Clinical protocol for risk groups + family-physician monitoring (1D; 0.17)	Medium –High	O1, equity	Strengthens primary care; participants proposed pairing it with 1A, so warnings trigger patient follow-up	Medium	Provincial Health Directorate (lead); family physicians; AMM social services	Registry completeness; health-data privacy procedures

CRM measure (card; AHP weight within theme)	Effectiveness / risk reduction	Contribution to CRM objectives (O1–O5, see Table 3-1)	Possible co-benefits	Timeline	Responsible organization (participant assignment)	Possible adaptation limits
Work/school-hour adjustment on extreme days + outdoor-worker protection (2F; 0.32)	High	O4, O1	Safety and productivity; legal clarity for employers; protects couriers and seasonal agricultural workers	Short–Medium	Ministry of Labor framework; Governorship (provincial decisions); employers; unions	Enforcement in informal employment; economic pressure to keep working
Rest areas, water and equipment for outdoor workers (2E; 0.23)	High	O4	Immediate, low-cost relief; visible institutional commitment on worksites	Short	Employers; AMM; AFAD (for field responders)	Site-by-site compliance monitoring effort
Cooling / climate-shelter centers (2A; 0.14)	Medium	O3, equity	Publicly accessible cooling: participants proposed climate cabins at mosques and marketplaces	Medium	AMM; district municipalities; mosque/market premises (participant proposal)	Operating and staffing cost; accessibility for mobility-limited residents
Green corridors / cool walking routes / schoolyard conversion (3C; 0.26)	High	O3	Shade, air quality and active mobility; cooler school environments	Medium–Long	AMM (lead); district municipalities; Education Directorate	Land scarcity in the dense central fabric; irrigation and maintenance under drought conditions
Urban tree planting targeted by satellite hotspot analysis (3B; 0.25)	High	O3, O1	Directly consumes the UHRHO/LST targeting; biodiversity and amenity gains	Medium–Long	AMM (lead); Forestry Directorate; agriculture faculty (species advice)	Canopy takes years to mature; water demand; underground-utility conflicts
Nature-based cooling: ponds and water features (3E; 0.15)	Medium	O3	Microclimatic cooling and public amenity	Medium	AMM; ASAT	Water availability; evaporation losses during extreme heat
Critical-infrastructure resilience: backup power for health and water facilities (4E; 0.31)	High	O1	Prevents cascade failures — outages during past episodes were reported by residents, including one associated fatality	Medium	Utilities (electricity distributor, ASAT); Provincial Health Directorate; AMM	Investment cost; regulatory split between energy, water and health actors
Cool / reflective pavements and asphalt (4B; 0.29)	Medium–High	O3	Lower surface temperatures on identified hot corridors; night-time works align with worker protection	Medium	AMM roads department (lead); Highways for arterial roads; district municipalities	Unit cost and durability; glare — a pilot-first approach on UHRHO corridors is advisable
Financial incentives: green roof / solar subsidies (4D; 0.18)	Medium	O5	Engages the private building stock; relieves summer grid load (participants proposed incentives for self-generating buildings)	Medium–Long	AMM; ministry programmes	Budget dependence: uptake by low-income households requires deliberate design
Real-time impact monitoring + plan evaluation (5C; 0.30)	High	O5, all objectives	Makes every other measure evaluable; post-red-day feedback surveys were proposed by participants themselves	Short–Medium	AMM (lead); Provincial Health Directorate (health signals); MGM (event data)	Data-sharing agreements; sustained analytical staffing

CRM measure (card; AHP weight within theme)	Effectiveness / risk reduction	Contribution to CRM objectives (O1–O5, see Table 3-1)	Possible co-benefits	Timeline	Responsible organization (participant assignment)	Possible adaptation limits
Vulnerability / UHI mapping for intervention targeting (5A; 0.27)	High	O5, equity	Already operational (UHRHO); first local module contributed to CLIMAAX from Türkiye	Short (operational)	AMM GIS (lead); universities	Update cycle; neighborhood-scale health data still needed
Integrated plan with explicit financing and timeline (5E; 0.18)	High	O5	Directly answers the weakest measured capacity dimension (finance, 2.12/5)	Short–Medium	AMM (HAP); Governorship; national programmes	Multi-year budget commitment beyond the project horizon

Reading notes for Table 3-4: the measure list, priority weights and responsibility assignments are workshop results; the effectiveness, co-benefit, timeline and adaptation-limit entries are the project team's assessment, informed by the workshop discussion records and by the international reference examples carried on each measure card. The portfolio deliberately includes not only dedicated adaptation investments but also investments that will need a climate-adaptation component — most directly measure 4C (building-code revision requiring solar shading and ventilation in new construction), which ensures that ordinary building activity in a growing city does not keep reproducing the heat problem the plan is trying to solve. Facilitator records add useful nuance to the weights: tables working on Theme 1 noted that mobile medical units (1C) were judged nearly equal in short-term priority to the warning system by some groups, and that the low weight of public-information measures (1F) reflected skepticism that information alone changes behavior, the same signal as the social-behavioral capacity deficit measured in Section 3.2, rather than a judgement that communication is unnecessary.

Three cross-cutting readings of the portfolio matter for implementation. First, the two highest weights in the entire exercise belong to the early warning system and to work-hour adjustment with worker protection, one institutional-informational, one regulatory, confirming that stakeholders give the highest priority to organizational and regulatory measures rather than capital-intensive construction. Second, structural and nature-based measures (trees, corridors, reflective surfaces, backup power) form the backbone of the built-environment response and all depend on the spatial targeting the project has already built. Third, equity is not a separate measure but a property of the portfolio: the top-ranked measures directly serve the groups ranked most vulnerable (chronically ill, outdoor workers, older adults), and several lower-weighted measures that serve specific groups strongly (e.g. water access for street animals, ranked last in its theme at 0.10) were nonetheless defended by participants in the qualitative record and remain in the HAP inventory; the ranking allocates emphasis, it does not delete measures.

3.4 Integration into planning and decision making

Integration pathways

The results are integrated into planning through a defined institutional chain. The Antalya Urban Heat Island and Heat Action Plan (HAP) — initiated by Mayoral approval of 30 March 2026, staffed by approval of 22 April 2026 and reinforced with the Volunteer Scientific Advisory and Editorial Board on 2 July 2026 — is the primary vehicle. Its thirteen-section structure is set out in Table 3-5, together with the Phase 3 outputs that feed each section — the mapping is one-to-one by design, in the 19 June 2026 workshop, 5 themes were constructed from the plan's content structure.

The AHP portfolio populates the measures section, the warning-level design and channel analysis populate the early-warning and risk-communication sections, the persona and vulnerability work populate the vulnerable-groups section, and the workshop records themselves constitute the participation documentation.

The draft plan will be launched at COP31 in Antalya (9–20 November 2026) and carried forward under UNEP's 50@50 and Beat the Heat programmes. In parallel, the UHRHO layer gives metropolitan and district planners an operational instrument for spatial decisions — plan revisions,

block-scale renewal, siting of cool points and green corridors — and the risk products are available for integration into the provincial İRAP and, for red-level events, the TAMP response machinery.

Table 3-5 Structure of the Antalya Urban Heat Island and Heat Action Plan (thirteen sections) and the Phase 3 outputs feeding each section. The x/5 value cited is a capacity-pulse mean on a five-point agreement scale (n = 65).

HAP section	Main content	Fed by (Phase 3 outputs / workshop themes)
01 Executive Summary	Purpose and scope; Antalya's temperature regime; key priorities	Synthesis of all outputs
02 Scope of the Plan	Heatwave and UHI definitions; what a HAP is; time horizon	CLIMAAX-MUHIR framework (Phases 1–3)
03 Heatwave Risk in Antalya	Climatology, trends, past events; satellite UHI distribution; vulnerability maps	Phase 2 CRA products (LST/UHI, UHRHO); lessons from past events (Section 2.4); perception mapping (Figure 2-3)
04 Vulnerable Groups	Older people, children, chronically ill, animals; outdoor workers; disadvantaged groups	Theme 2; vulnerability ranking and personas (Section 3.1, Figure 3-1)
05 Institutional Structure and Responsibilities	AMM role, departments, roles, inter-institutional coordination	Actor mapping (Table 2-2); participants' responsibility assignments; SOP measure 5B; coordination-friction findings
06 Early Warning System and Alarm Mechanisms	Monitoring, thresholds, color codes, activated units, data sharing	Theme 1 (measure 1A, top-ranked overall); warning-level design (Table 3-6)
07 Public Information and Risk Communication	Information strategy; channels and tools; tailored messaging for vulnerable groups	Channel analysis (Figure 3-4); red-day message templates; measure 1F
08 Measures and Actions against Heatwaves	Short-, medium- and long-term measures	Prioritized portfolio, all five themes (Table 3-4, Figure 3-3)
09 Monitoring, Evaluation and Updating	Plan monitoring; performance indicators; periodic review; data management	Measure 5C (top-ranked in Theme 5); the M&E design of this section; indicator baselines (Tables 3-1, 3-2)
10 Financing and Resources	Municipal resources; central-government support; international funds	Measure 5E; finance identified as the weakest capacity dimension (2.12/5, Table 3-3)
11 Stakeholder Participation Reports	Documentation of the participatory process	285 digitized workshop records; reports of both workshops
12 Glossary of Terms	Definitions	Abbreviations and terminology of this deliverable
13 Data and References	Sources and datasets	Project datasets (Section 7); Phase 2 deliverable

The early warning chain as designed by its users

Activity 3 of 19 June 2026 workshop (see the methodology of this activity in supporting documents of Phase 3-Zenodo; Kandemir and Sepetci, 2026c) produced the demand-side specification of the warning system. Its opening pulse illustrates why an authoritative graded warning is needed at all: asked to rate the warning level of the same June day, the same room split 25 Green, 15 Yellow and 2 Orange (n=42) — perception of identical conditions varies too widely to be left to individual judgement. The same pulse recorded where participants last heard a heat warning: social media leads (24 mentions), ahead of TV/radio (15) and SMS (9), with one participant having never heard one — the existing reach habit that the channel design below builds on. For each warning level, tables recorded what citizens should do and what they expect institutions to do (Table 3-6). Channel analysis (n=42) shows SMS with the best mean rank (3.45), TV/radio (3.88) and social media (3.95) close behind, and the municipal app/web fourth — but with clear group differentiation: mosque announcements, mukhtars and door-to-door channels were selected specifically for older adults and residents with limited digital access, and workplaces/schools for workers and families (Figure 3-4).

Participants drafted red-day messages that consistently contain the same three elements — what is happening, what to do, where to get help — e.g.: “Temperatures of 45 °C are expected on [date]. Do not go outside unless necessary. Cooling and water points for those who must outdoors be published at [link].” Monitoring proposals from the same activity include post-red-day feedback surveys (“Were you outdoors? Did you use a cool point?”), which are incorporated into the M&E design below.

Table 3-6 Citizen actions and institutional expectations by warning level, consolidated from Activity 3 table records

Warning level	What citizens do (participant design)	What institutions are expected to do (participant design)
Yellow – Attention	Continue normal life with precautions: hydration, hats/light clothing; vulnerable residents prepare; stock essentials	General readiness check: awareness messaging begins; schools inform students; hydration reminders
Orange – Warning	Avoid midday outdoor exposure; chronic patients enroll in home-care follow-up; employers offer flexibility; light-colored clothing	Health system tracks risk patients and manages appointments/transfers; work-hour adjustments; leave arrangements for pregnant women and chronic patients; road works shifted to night; targeted warnings to risk groups
Red – Alarm	Stay indoors unless unavoidable; check on dependents and neighbors living alone; never leave people or animals in vehicles; use designated cool points	Coordinated action by Governorship–MGM–municipalities; TAMP-style activation; emergency line with mobile response; distribution of water and equipment; electricity-bill relief and water support; shift changes for field workers; cooling centers open and announced

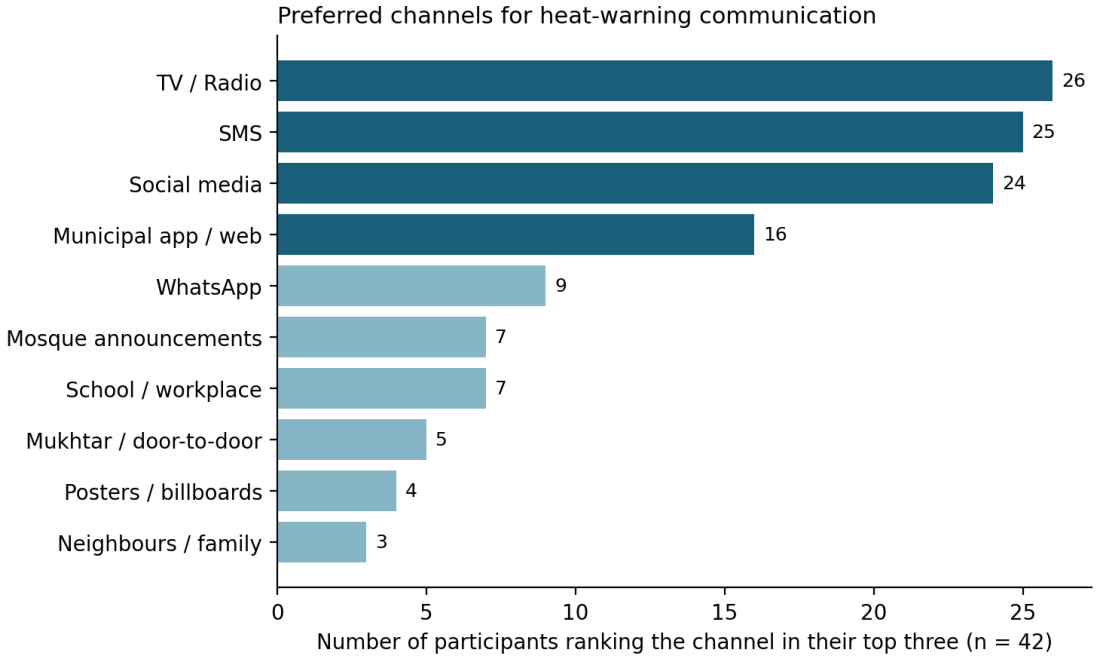


Figure 3-4 Preferred channels for heat-warning communication: number of participants ranking each channel in their top three (n = 42) (19 June 2026 workshop).

Synergies, tensions and coordination

Participants were asked directly where inter-institutional friction will arise. Their answers cluster on four points: (i) authority overlap in the warning chain: MGM decides the level, the Governorship announces, municipalities act, and the hand-offs between them are not yet codified; (ii) timing: role-sharing must be agreed before the season (“do not start in autumn”); (iii) bureaucracy and mandate fragmentation between national directorates, the metropolitan level and districts, including utilities; and (iv) the gap between planning and visible delivery, which erodes public trust in participatory processes. The corresponding actions are codification of the warning Standard Operating Procedure

(SOP) in the HAP institutional section (measure 5B), a pre-season coordination calendar anchored at the Environmental Board of AMM, and early visible implementations (short-term measures 1A, 1B, 2E) to demonstrate delivery.

New data and remaining needs

Phase 3 added substantial new data on the system: the capacity pulse (n=65), the vulnerability ranking and persona needs (n=79), channel behavior and message design (n=42), the AHP priority structure (82 matrices), perception maps, and 285 digitized participant records overall. Remaining needs identified through the process: neighborhood-scale and near-real-time health indicators (emergency admissions during heat episodes; the current mortality series is district-level and annual); systematic occupational heat-incident reporting; energy-grid stress data at feeder level to plan measure 4E; tourist-exposure data for the summer population; and sustained analytical staffing to keep the risk layers current.

Monitoring and evaluation

A monitoring system for the CRM objectives does not yet formally exist; its key elements are specified here and carried into the HAP measures-and-monitoring section. The design combines: (i) an annual post-summer review, anchored at the Environmental Board, reporting the indicator set of Tables 3-1 and 3-2 against baselines; (ii) event-triggered monitoring, after every red-level episode, a rapid feedback survey (as proposed by participants) plus a health-signal check with the Provincial Health Directorate; (iii) periodic re-measurement of the perception and capacity instruments introduced in this phase (knowledge test, preparedness pulse, capacity radar), whose 2026 values constitute the baseline; and (iv) an update cycle for the spatial layers (LST/UHI, UHRHO, vulnerable-population density). Measure 5C (real-time impact monitoring and plan evaluation), ranked first in the governance theme, is the tool for institutionalizing this system.

4 Project Evaluation

4.1 Usability of the results

The Phase 3 results are usable in four concrete ways. First, the prioritized measure portfolio with responsibility assignments is the direct content of the Heat Action Plan's measures section — the plan does not have to invent its programme, it inherits a stakeholder-endorsed one. Second, the early-warning and communication design gives MGM, the Governorship and the municipality an implementable specification of the demand side: levels, expected actions, channels per target group, message templates and post-event feedback instruments. Third, the baselines created in this phase (warning reach 42%; cool-place access agreement 29%; preparedness perception 2.04/5; knowledge 94%; capacity profile across six dimensions) convert future progress into measurable claims. Fourth, the participatory evidence strengthens the municipality's position in seeking finance: the weakest capacity dimension is documented, quantified and matched to a measure (5E) and a dedicated HAP financing section. New knowledge was also created in method: the AHP exercise demonstrated that structured pairwise prioritization works with a large, sector-diverse, partly non-technical audience when organized theme-by-theme with facilitated tables; group consistency ratios of 0.03–0.05 place the aggregate result well inside accepted bounds.

Workshop participants themselves rated the process: all 42 respondents to the closing evaluation agreed that the workshop was useful and well-run (23 strongly agreeing, 19 agreeing), and 41 of 42 recorded a personal follow-up commitment, most frequently to inform others in their institution and community.

4.2 Lessons learned

What worked well: Designing every workshop activity to feed a named section of this deliverable and of the HAP meant that no participant effort was wasted; the digital capture of all individual records (i.e. structured forms with QR access, 285 records from 19 June 2026 workshop) made same-phase analysis possible without transcription; theme-based table allocation kept the pairwise comparisons tractable; and anchoring measure cards in named international practice kept discussion concrete.

The two-workshop architecture; assessment scoring in Phase 2, management prioritization in Phase 3 gave stakeholders a visible arc from evidence to decision.

Where difficulties arose: Individual pairwise-comparison matrices from a lay audience showed high inconsistency in many cases (as expected); the design response: group aggregation by geometric mean with consistency checking, plus a sensitivity comparison across aggregation methods — proved essential and is recommended to other CLIMAAX regions attempting participatory AHP. Some individual form fields were left unanswered on the day and the table-number field of the registration form was rarely completed, which limited person-level linkage across activities (analysis therefore reports per-activity samples: 79, 65 and 42). The planned post-test repetition of the knowledge quiz at the close of the workshop could not be executed in the available time, so learning change within the day is not measured; the 94% baseline will instead serve the next engagement event. Finally, participants' skepticism about workshops without visible follow-through is itself a finding: the HAP's short-term measures are the answer, and the project's credibility now depends on delivery.

Stakeholder role and feedback: Stakeholders were not consulted on a finished plan; they produced the prioritization themselves, and their institutional assignments were adopted as drafted. Their feedback on the CRM recommendations is embedded in the results: the demand for pre-season role clarity, for warning-chain codification and for financing realism shaped Sections 3.3 and 3.4 directly. Learning is secured through the published English-language report (10 July 2026) for UNEP Dr. Eleni Myrivili (Global Chief Heat Officer), the datasets and this deliverable, and institutionally through the advisory board and the Environmental Board cycle. Resources were used efficiently: the phase was delivered by municipal staff with volunteer scientific support, without paid external consultancy, and organization costs were covered from the project budget.

Impact on risk understanding: The phase demonstrably widened risk ownership beyond the technical team: 30 distinct institutions and organizations took part in the prioritization; registration shows a balanced and highly educated participant base; and the measured gap between individual knowledge (high) and systemic preparedness (perceived as low) reframed the problem for participants from “informing people” to “building the system that acts on warnings”; the central premise of the HAP.

5 Conclusions Phase 3

Phase 3 set out to convert a completed risk assessment into climate risk management and closes with that conversion materially achieved. The challenges addressed: the 29-measure portfolio distilled from international practice was prioritized by 106 stakeholders with high group consistency (CR 0.03–0.05), yielding fifteen priority measures with named responsible institutions; the early warning chain was specified from the demand side, level by level and channel by channel, with message templates and feedback instruments; vulnerability was translated from maps into ranked groups and persona-level service needs; adaptive capacity was measured across six dimensions, identifying finance (2.12/5) and citizen engagement (2.17/5) as the binding constraints; and the institutional progress, the Heat Action Plan with its Mayoral mandate, thirteen-section structure, municipal working team and international volunteer advisory board is established, with launch scheduled at COP31 in Antalya and continuity anchored in UNEP's 50@50 and Beat the Heat programmes.

The key findings are consistent across methods. Stakeholders prioritise organizational readiness — graded early warning, work-hour regulation, worker protection, real-time monitoring, deliverable before the next season — over capital works, while endorsing spatially targeted green and grey infrastructure as the medium-term backbone. Residents' perception maps reproduce the satellite-derived hotspot pattern, and their reported experience (42% warning reach; reliance on shopping malls as de facto cooling infrastructure; infrastructure failures during past episodes) grounds each priority in observed need. The main challenges not yet addressed are the sustainable multi-year financing of the portfolio and the codification of inter-agency hand-offs in the warning chain; both

are carried explicitly into the HAP with named mechanisms, and both were identified by stakeholders themselves, which is evidence that the participatory process measured the right constraints.

For the CLIMAAX community, Phase 3 demonstrates that the framework's management phase can be executed with a large non-specialist stakeholder base at province scale, that participatory AHP is feasible and defensible when aggregated and consistency-checked, and that pairing every engagement instrument with a named report section converts participation from consultation into co-production.

6 Progress evaluation

6.1 Project outputs

Progress against the Phase 3 work plan defined in the Phase 2 deliverable is summarized in Table 6-1 and Table 6-2, compiled from project records and the engagement documentation.

Table 6-1 Overview of key performance indicators

Key performance indicators	*Progress*
One (1) of workflows (Heatwave" hazard assessment using local data successfully applied on Deliverable 2.	*Achieved. The heatwave hazard workflow was successfully implemented using local thresholds and datasets; outputs, figures and methodological details are documented in this Deliverable 2 report.*
Three (3) multi-risk assessments (UHIs, heatwaves, and vulnerability analysis) completed by Month 16.	*Achieved. UHI/LST-based risk mapping, heatwave hazard indicators, and vulnerability layers were produced and integrated for multi-risk interpretation at provincial/district scale; full outputs are reported in Deliverable 2.*
Four (4) of potential stakeholders involved in the activities of the project	*Achieved. Core stakeholders engaged include Antalya Governorship, Akdeniz University (Health Sciences), Antalya Provincial Directorate of Health, Antalya Provincial Directorate of Meteorology, and Chamber of Surveyors and Cadastral Engineers. Engagement was via data exchange, technical consultations, and workshop participation.*
Three (3) of communication actions taken to share results reaching at least 200 citizens.	*Achieved (exceeded). Dissemination activities reached an estimated **~880 participants** via: City Expo 2025 (~150), "From Science to the Future: GIS for Climate & Environmental Resilience" Symposium (~100), Akdeniz University National GIS Day (~80), "Antalya's Vulnerability to Extreme Heat" Workshop (149), Environmental Board Meeting (~73), "Contributions to the Action Plan Against Urban Heat Island and Extreme Heat" Workshop (106), Program for "Sharing Project Examples and Experiences on Climate Change and Environmental Protection" (~80), "CLIMAAX-MUHIR Project Experience-Sharing and Climate Project Financing Working Group Meeting" under the MedCities MedCUC Program (~40) and Closing Meeting (102) (for details, supporting documents of Phase 3-Zenodo, Aksoy, 2026; Kılıçarslan 2026).*
Four (4) of notes for policy makers.	*On track. policy briefs shared with the Governorship and the AMM Secretary General's Office; the briefing documents underlying the three Mayoral approvals (30 March, 22 April and 2 July 2026) initiated and staffed the Heat Action Plan; the Environmental Board briefed on Phase 2 findings and the action component (15 May 2026). Additional notes are being drafted from the Phase 3 outputs for delivery ahead of the COP31 launch (November 2026).*
Three (3) Antalya Metropolitan Municipality Environmental Board's stakeholder meetings, workshops, or consultations	*Achieved. Environmental Board consultation in Phase 1; Environmental Board review of Phase 2 findings and the action component (15 May 2026); additional meeting with the Environmental Board's executive committee and its chair (11 June 2026), completing this KPI.*
Four (4) of publications (two-2 of SCI-based scientific journals, others-2 of TR-dizin (Turkish academic database-based journal)) and three (3) main dissemination actions	*Partly achieved. A conference contribution was produced, and a full paper was published under **INECPAC 2025 (Demre)**. Key dissemination actions were implemented, including the **CLIMAAX Barcelona Workshop** participation and multiple national dissemination events (for details, supporting documents of Phase 3-Zenodo, Aksoy, 2026). Two SCI journal manuscripts (a review and a research paper) are submitted, under review.*
Six (6) of articles in regional media mentioning the project.	*Achieved (exceeded). The dissemination tracker lists multiple media items. Examples include several links compiled in the tracker and additional media mentions (for details, supporting documents of Phase 3-Zenodo, Aksoy, 2026).*

Key performance indicators	*Progress*
Three (3) adaptation strategies (focused on UHI, heatwaves, and nature-based solutions) finalized and integrated into Antalya's urban planning.	*On track — strategies defined, prioritized and entering planning practice: (i) UHI — the UHRHO hotspot layer adopted as the spatial-targeting instrument for plan revisions, block-scale renewal and the siting of cool points and corridors; (ii) heatwaves — the graded early-warning, worker-protection and response strategy embedded in the draft HAP and linked to İRAP/TAMP; (iii) nature-based solutions — the green/blue infrastructure package (green corridors, satellite-targeted tree planting, water features) prioritized by stakeholders (Theme 3, Table 3-4). Finalization is scheduled with the HAP launch at COP31 (November 2026), anchored institutionally at the Environmental Board.*
Integration of at least two (2) adaptation strategies into Antalya's Sustainable Energy and Climate Action Plan (SECAP).	*Exceeded in scope: rather than integrating individual strategies into the existing SECAP, the project elevated the response to a dedicated, standalone instrument — the Antalya Urban Heat Island and Extreme Heat Action Plan, initiated by Mayoral approvals (30 March and 22 April 2026), structured in thirteen sections, and carrying all five strategy themes (early warning, vulnerable-group protection, green/blue infrastructure, built environment, data and governance) rather than the two originally targeted. The HAP is anchored at the Environmental Board and scheduled for launch at COP31 (November 2026); its adaptation measures remain available for incorporation into future SECAP revisions.*
At least two (2) cities or regions (in Türkiye or the Mediterranean region) express interest in adopting the project's methodologies and solutions.	*In progress: the methodology has been presented to replication audiences on four platforms — the Pathways2Resilience Knowledge and Data Innovation Practice Group session (24 October 2025); the CLIMAAX 'Heatwave Risk Assessment: Learning from Regions' webinar (27 November 2025), where the Antalya approach was shared directly with other CLIMAAX regions; the experience-sharing programme on climate and environmental projects (23 June 2026); and the MedCities MedCUC working group (13 July 2026), reaching local governments across the Mediterranean (all documented in the Zenodo supporting materials; Aksoy, 2026). Concrete adoption commitments will be pursued beyond the project horizon, including through a replication proposal under a forthcoming Horizon Europe call.*

Table 6-2 Overview of milestones

Milestones	*Progress*
M1: Test of the workflow "Heatwave" hazard assessment using EURO-CORDEX climate data (EuroHEAT and XClim).	*Completed in Phase 1 (Workflow test and initial implementation were finalized during the initial CRA phase).*
M2: Initial introductions of CLIMAAX project in Antalya International Science Forum	*Completed in Phase 1. Antalya Science Forum was attended. Prof. Dr. Murat Türkeş, Assoc. Prof. Dr. Nusret Demir and Assoc. Prof. Dr. Çağdaş Kuşçu Şimşek attended the forum (Nov 6-8, 2024).*
M3: Initial Risk Assessment using CLIMAAX tools completed.	*Completed in Phase 1. Initial CRA outputs were produced using CLIMAAX tools and formed the baseline for Phase 2 refinement.*
M4: Comprehensive Risk Analysis Report finalized	*Completed in Phase 2 (Month 16). This deliverable corresponds to **D2-Comprehensive Risk Analysis Report** (refined regional/local multi-risk assessment including local data and comparison of results).*
M5: Stakeholder meeting held to validate risk assessment results.	*Completed in Phase 2. "From Science to Action on Climate Change: Antalya's Vulnerability to Extreme Heat Workshop" was held (**Nov 21, 2025**) with **149 participants**, and feedback was collected through roundtables and survey tools.*
M6: Attend CLIMAAX workshop in Barcelona.	*Completed in Phase 2. The CLIMAAX Barcelona Workshop was attended (**June 10–11, 2025**, CosmoCaixa, Barcelona); Antalya shared UHI/heatwave analyses and implementation roadmap with other regions.*
M7: Pilot implementation of adaptation strategies initiated.	*Initiated in Phase 3 at the institutional and targeting level: the prioritised measure portfolio (15 priority measures, Table 3-4) was adopted with responsibility assignments; the UHRHO hotspot layer is operational as the targeting instrument (measure 5A); and the short-term measures identified for early visible implementation ahead of the next season (1A graded early warning, 1B cool-route map, 2E worker rest-water provision) are carried into the HAP with named responsible institutions. Physical pilots (e.g. reflective-pavement trials on UHRHO corridors) are scheduled under the HAP implementation calendar.*

Milestones	*Progress*
M8: Presentation of project results to local policy and decision-makers.	*Completed in Phase 3 and ongoing: Phase 2 findings and the action component presented to the AMM Environmental Board (15 May 2026), followed by a working meeting with the Board's executive committee and its chair (11 June 2026); three Mayoral approvals obtained (30 March, 22 April, 2 July 2026); policy briefs shared with the Governorship and the AMM Secretary General's Office; results presented to the full stakeholder community at the closing meeting (17 July 2026, AKM Perge Hall). The HAP launch at COP31 (November 2026) will carry the results to national and international decision-makers*
M9: Publications of MUHIR results in scientific journals	*Partly achieved. A conference contribution was produced, and a full paper was published under **INECPAC 2025 (Demre)**. Key dissemination actions were implemented, including the **CLIMAAX Barcelona Workshop** participation and multiple national dissemination events (for details, supporting documents of Phase 3-Zenodo, Aksoy, 2026). Two SCI journal manuscripts (a review and a research paper) are submitted, under review.*
M10: Introduction of CLIMAAX project to the stakeholders from Multi Level Governance Platform of EU4ETTR	*Completed in Phase 1. SECAP Masterclass event was attended and a presentation on CLIMAAX was made. We came together with MLGP Platform more than 200 participants (Feb 11, 2025).*
M11: Attend CLIMAAX workshop in Brussels.	*Scheduled after Phase 3.*

7 Supporting documentation

Outputs produced in this phase, to be shared in the project's Zenodo repository in the order listed:

-Main report: this deliverable (Phase 3–Antalya MUHIR_CLIMAAX_M22_Deliverable_Phase3_28.07.2026).
-Workshop materials: activity designs for the three sessions (in supporting documents of Phase 3-Zenodo; Kandemir and Sepetci, 2026a,b,c).
-Dissemination outputs in supporting documents of Phase 3-Zenodo, Aksoy, 2026 and Kılıçarslan, 2026.

8 References

AFAD: Antalya İl Afet Risk Azaltma Planı (Provincial Disaster Risk Reduction Plan, İRAP), Antalya Provincial Directorate of Disaster and Emergency Management, 2022a.
AFAD: Türkiye Afet Müdahale Planı (Türkiye Disaster Response Plan, TAMP), updated version, Official Gazette No. 31954, 15 September 2022b.
CLIMAAX Consortium: CLIMAAX Handbook — Climate risk assessment framework and toolbox, https://handbook.climaax.eu, 2024.
Republic of Türkiye: İklim Kanunu (Climate Law), Law No. 7552, Official Gazette No. 32951, 9 July 2025.
Republic of Türkiye, Ministry of Environment, Urbanisation and Climate Change: İklim Değişikliğine Uyum Stratejisi ve Eylem Planı 2024–2030 (Climate Change Adaptation Strategy and Action Plan), Ankara, 2024.
Saaty, T. L.: The Analytic Hierarchy Process: Planning, Priority Setting, Resource Allocation, McGraw-Hill, New York, 1980.
TÜİK (Turkish Statistical Institute): Address-Based Population Registration System results, 2024.
WorldPop: Population density projections 2025, University of Southampton, 2025.

Participations/ Disseminations in Phase 3 – CLIMAAX-MUHIR
1. Environmental Board Meeting – Evaluation of the Phase 2 Findings of the CLIMAAX-MUHIR Project (15 May 2026)



2. From Science to Action II – Contribution Workshop for the Antalya Urban Heat Island and Extreme Heat Action Plan (19 June 2026)



3. Programme on Project Examples and Experience Sharing in Climate Change and Environmental Protection (23 June 2026)



4. CLIMAAX-MUHIR Experience Sharing under the MedCities MedCUC Programme and Working Group Meeting on Climate Project Financing (13 July 2026)

5. CLIMAAX-MUHIR Closing Meeting (17 July 2026)



6. "Beating the Heat Together" Webinar – UNEP and City Diplomacy Lab, Our Urban Future Series (29 July 2026)

7. Visit of the UNEP Global Chief Heat Officer Dr. Eleni (Lenio) Myrivili to Antalya (29–31 July 2026)