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REVIEW

A global research and evaluation agenda for centering health and equity in city Climate Action Plans

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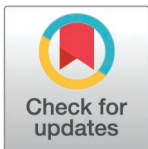
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Abstract

City climate policy is one of the most powerful levers that can address environmental, health and equity challenges simultaneously. Yet large gaps exist in research and evaluation of city Climate Action Plans (CAPs) to guide and improve their impact, especially regarding public health and equity. We propose a conceptual framework and a global, interdisciplinary research agenda to ensure CAPs deliver on their full potential for climate, health, and justice.

Introduction

As the dominant human habitat and driver of global economic activity, cities are a major source of greenhouse gas (GHGs) emissions [1]. Urban areas are estimated to account for approximately 70% of global carbon dioxide emissions, largely due to concentrated energy demand, transportation systems, buildings, industry, and consumption-related patterns [2]. Emissions vary across cities and regions, and per capita levels can differ substantially across urban, suburban, and rural contexts. These differences are shaped by settlement patterns, infrastructure, mobility systems, and income levels [3]. At the same time, urban populations face escalating health and economic impacts from climate change, including extreme heat, flooding,



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air pollution, and disruptions to food, water, and health systems [4,5]. To meet the Paris Agreement goal of limiting global warming to 2°C while pursuing efforts to restrict temperature rise to 1.5°C, global emissions must decline rapidly in the near-term and reach net zero by 2050 [6]. Achieving these targets requires coordinated mitigation and adaptation efforts across governance scales, from international agreements to national policies, as well as subnational and local action.

International climate governance frameworks such as the United Nations Framework Convention on Climate Change (UNFCCC) and the Paris Agreement provide the overarching architecture for collective global climate ambition [6]. Within this multilevel governance context, cities are increasingly recognised as critical sites of implementation, experimentation, and innovation [7]. City governments are tasked with simultaneously advancing mitigation efforts to reduce emissions within their jurisdictions and adopting adaptation strategies to address intensifying local climate impacts [8]. These efforts span multiple urban sectors and departments, including energy, transport, economic development, waste management, urban design, housing, and public and community health. They also require collaboration with diverse stakeholders, ideally informed by scientific evidence and local data [9].

While cities are often described as agile actors capable of piloting innovative policies, tailoring interventions to local conditions, and responding quickly to emerging risks, their capacity to act is shaped by political, institutional, and fiscal constraints [10]. In many governance systems, including federal contexts such as the United States, substantial funding for climate action flows from national and state governments. However, key policy levers such as energy supply, large-scale infrastructure, or watershed management remain outside municipal authority [11]. As a result, local climate action often depends on vertical coordination, intergovernmental funding, and policy alignment across levels of government [12]. Under these constraints, city governments must navigate limited jurisdictional authority while pursuing ambitious emissions reductions and implementing adaptation strategies that address local climate risks and community needs.

This paper examines the roles of cities in managing climate change challenges, with a specific focus on the health impacts of climate-related disruptions [13,14]. Climate change is increasing the frequency and intensity of extreme weather events. These events pose serious risks to human health, including respiratory and cardiovascular diseases, infectious diseases, heat-related illnesses, air pollution-related harms, injuries, population displacement, mental health impacts, and growing pressures on food, water, and healthcare systems [14–16]. These risks are unevenly distributed. Health inequities are significant, with disadvantaged and vulnerable populations—including low-income communities and indigenous communities—bearing a disproportionate burden of climate-related hazards, illness, and morbidity. Such inequities are often rooted in historical marginalisation and worsened by limited access to resources and services that could buffer impacts during climate-related crises [17,18]. Communities with limited access to resilient infrastructure and healthcare services are less able to adapt to climate impacts [19]. As a result, inequities

in exposure, vulnerability, and access to resources are expected to widen existing health disparities and intensify public health challenges [20,21].

Within this context, city-level Climate Action Plans (CAPs) have emerged as key instruments. CAPs are formal municipal strategies or frameworks that outline mitigation and adaptation goals, priority actions, timelines, responsibilities, and monitoring approaches [22]. Their legal status and scope vary across jurisdictions, but they serve as primary mechanisms for translating global and national climate commitments into locally actionable plans. CAPs and related strategies (i.e., frameworks for urban climate action) offer a potential mechanism to align global and national climate commitments with local contexts and to generate co-benefits for population health [5,23]. Although cities account for a substantial share of emissions, their authority to address all emissions sources varies. Many major sources of GHGs, such as energy production or agriculture, lie outside direct municipal control. Nonetheless, cities retain significant influence over sectors such as transport, land use, buildings, waste, and public space, making them important actors in climate action implementation.

City governments operate at a scale conducive to cross-sector climate action. Urban governance is often more agile than national politics, with city leaders closer to public needs and less constrained by political gridlock [24,25]. In some cases, this agility has enabled cities to adopt more ambitious climate policies, even where national action has lagged [26]. However, this relative agility must be understood within the realities of multilevel governance. Even in national systems, substantial funding, regulatory authority, and policy direction flow from state or national governments. These factors shape the scope, ambition, and feasibility of city CAPs. Cities therefore exercise autonomy within constraints, negotiating competing priorities, budgetary pressures, and political dynamics that influence CAP design and implementation.

Over the past decade, substantial scholarly attention has been devoted to assessing CAP content and quality [26,27]. By contrast, evidence on real-world CAP implementation and impacts remains scarce. This gap reflects several challenges, such as difficulties attributing emissions reductions or health outcomes to specific plans, overlapping policies across governance levels, spillover effects beyond city boundaries, limited baseline data, and constrained evaluation capacity within municipal administrations [28]. As a result, understanding of how CAPs translate from plans into measurable outcomes, particularly for health and equity, remains incomplete [5,29,30].

Transnational city networks have played an important role in supporting CAP development and initiating preliminary CAP evaluations [31]. Prominent groups, such as C40 Cities Climate Leadership Group [32], ICLEI—Local Governments for Sustainability [33], and the Covenant of Mayors (CoM) [34] support local governments with technical and financial tools, while fostering peer collaboration. However, their reach remains heavily concentrated in high-income contexts, with limited engagement in Global South cities due to resource constraints, institutional capacity gaps, and governance challenges [35].

Health and equity must be key pillars of city climate action

We propose an international research and evaluation agenda for city CAPs and related climate strategies that explicitly centres health and equity across all stages of planning, development, and implementation. Building on existing conceptual models, this agenda addresses critical evidence gaps and responds to growing recognition that climate change is a public health crisis [36–38]. Many climate actions—such as promoting active, low-carbon transport or urban greening—offer significant health co-benefits [39,40]. Yet, when health considerations are absent or marginal in CAPs, opportunities to improve health and build public support for climate policies are missed [41,42]. Similarly, without explicit equity considerations, climate interventions may inadvertently exacerbate social and health disparities [43,44]. Poorly designed policies can contribute to gentrification, rising housing costs, or uneven benefit distribution, reinforcing existing inequities [45–47]. A rigorous research agenda on CAPs, integrating public health and equity goals, can reveal current shortcomings and guide more just and inclusive policies.

Recent research has advanced understanding of CAP design, evaluation, and implementation. Frameworks such as the Urban Climate Action Planning (UCAP) model [28], Urban Climate Change Integration Index (UCCII) [30], ADAptation

plan Quality Assessment index (ADAQA) [27], the Adaptation Policy Credibility (APC) framework [48], and the Integration of Mitigation and Adaptation (IMA) framework [49] highlight integrated mitigation and adaptation strategies, cross-sectoral collaboration, and alignment with sustainability objectives [27,28,48,50,51]. However, these frameworks often assess mitigation, adaptation, or environmental dimensions in isolation and place limited emphasis on health and equity as cross-cutting, measurable outcomes. While these models increasingly acknowledge public health and equity, more work is needed to systematically incorporate and evaluate these dimensions across CAP development, implementation, monitoring, and evaluation in diverse contexts.

Public health considerations in CAPs remain limited [52]. An international review of 350 city CAPs found that only 35% explicitly mentioned public health, with health departments rarely central to planning [53]. Similarly, an analysis of 400 large cities reported that just 10% of adaptation plans included specific health actions [7]. Given the time elapsed since these studies were conducted, and especially after the COVID-19 pandemic strained health systems, it is unclear whether these patterns have persisted, evolved, or deteriorated. This uncertainty underscores the need for updated research to assess current integration of health in CAPs and the evolving role of public health actors in climate governance. It is also important to examine actions in transportation, land use, food systems, and other sectors for their health effects, both positive and negative, since many health benefits of CAPs are likely to arise indirectly through non-health sectors. Existing evidence suggests these cross-sectoral linkages and associated health impacts are rarely made explicit or systematically tracked.

While many CAPs acknowledge disproportionate impacts of climate change on marginalised communities, few incorporate measurable equity indicators or targeted interventions to reduce disparities [7,42,54]. Future research is critical to address questions such as: to what extent CAPs explicitly include health and equity goals, what barriers prevent their inclusion, what facilitators enable their inclusion, and how these goals influence implementation outcomes. Moreover, little is known about whether health and equity goals are systematically monitored or evaluated over time. Achieving equity in CAPs requires not only fair outcomes but also procedural justice, including transparent and inclusive decision-making processes that ensure marginalized communities actively influence both the planning and implementation of climate actions.

We identify two additional gaps in CAP literature. First, research on CAP implementation and impact is notably sparse, particularly with respect to health and equity outcomes [28,55]. Evidence from practice illustrates these challenges. A 2023 review of 37 Indian city heat action plans found most were not designed for the local context. Only ten established locally defined heat-wave thresholds, and just two conducted explicit vulnerability assessments [56]. Similarly, in several African cities, the rapid adoption of global green building standards faced resistance because they did not align with local economic realities, highlighting how top-down plans can be constrained by political, institutional, and resource limitations [57].

Second, existing CAP research is heavily skewed toward high-income cities, whereas cities in the Global South, which often face greater climate risks and structural constraints, remain underrepresented [58,59]. Our proposed framework is designed to be universally relevant but adaptable to context-specific governance constraints, acknowledging that institutional capacities, resources, and regulatory environments vary widely across cities. Robust evaluation methods and standardised yet flexible metrics are needed to assess whether CAPs reduce vulnerabilities and health disparities over time.

We address these gaps by proposing an international research and evaluation agenda for city CAPs. This agenda builds on substantial literature evaluating urban climate plans, including frameworks such as UCAP, ADAQA, APC, and IMA, which have largely focused on assessing CAP design and content (what CAPs say) rather than their implementation and outcomes (what they do). Prior frameworks also tend to treat mitigation, adaptation, and environmental domains separately, which can create gaps and overlook important synergies and trade-offs. In contrast, our framework positions public health as a central, cross-cutting lens through which we can advance integrated urban climate policy. This approach provides a socio-political rationale for climate action, strengthens accountability, and enables a more comprehensive assessment of CAP performance and progress.

Rather than proposing another plan-scoring or content-assessment approach, we present a framework to guide research and evaluation across the full CAP policy cycle. Our contribution advances existing approaches in three ways:

(1) systematically embedding health and equity as integrative, cross-sectoral dimensions across all phases of the CAP process; (2) emphasising implementation, real-world impacts, and measurable outcomes; and (3) treating public opinion and communication as cross-cutting factors influencing CAP feasibility, durability, and political legitimacy.

We conceptualise research and evaluation as overlapping in methods and goals and present a conceptual model alongside high-priority recommendations. The model was developed through consensus among a geographically and professionally diverse group of authors in climate change, public and community health, urban planning, evaluation science, and equity-focused policymaking. Our aim is to guide policy- and practice-relevant research that strengthens CAP design, implementation, and impact. We want to ensure that health and equity are core pillars of effective urban climate action.

A conceptual framework for city CAP research and evaluation centred on health and equity

Our proposed framework defines five key research areas essential for evaluating and informing CAPs and related city-level climate strategies. It is based on the premise that systematic, inclusive research—aligned with the inter-related policymaking elements of development, content, implementation, and outcomes [60,61]—can enhance CAP quality and increase effectiveness in advancing climate action, health, and equity [62,63]. Communication, public opinion, and stakeholder engagement influence all phases of the model (see Fig 1).

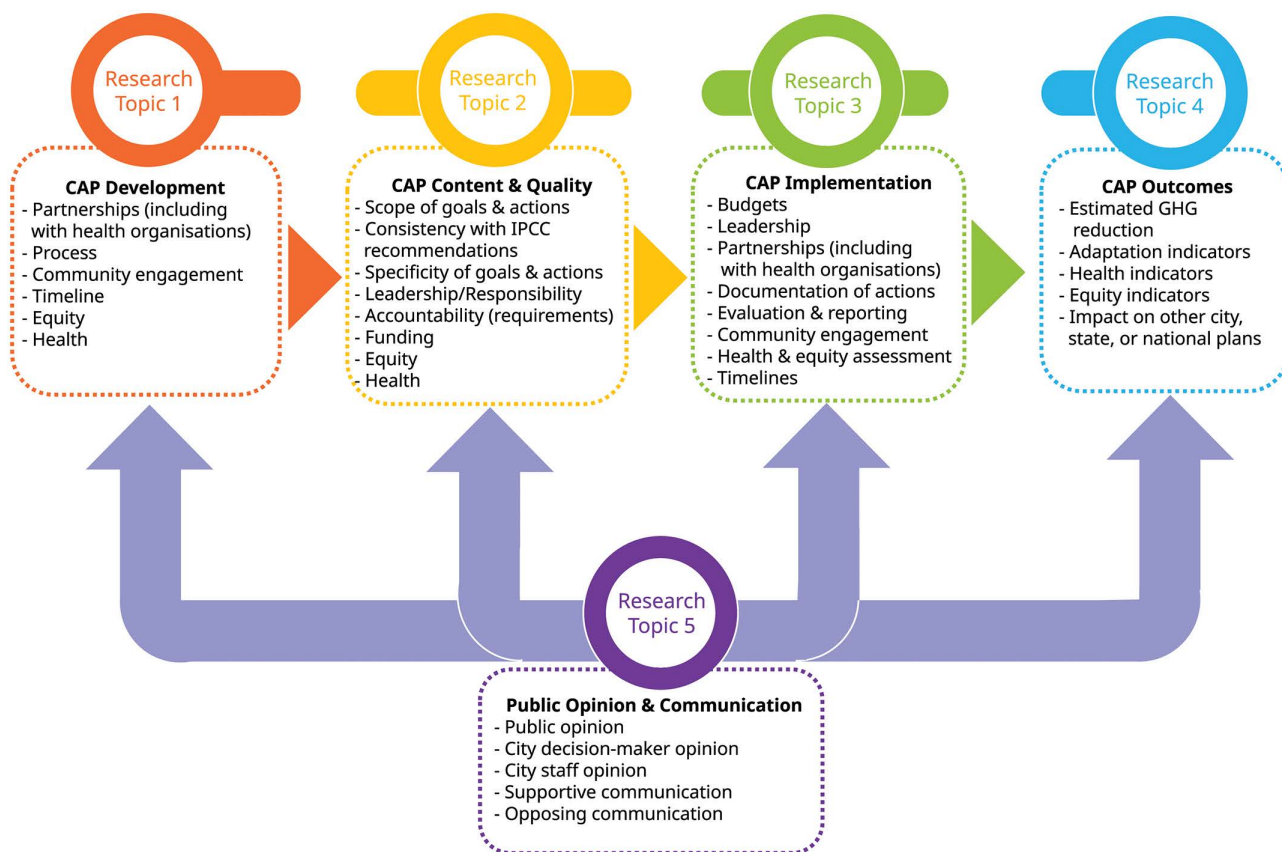


Fig 1. Conceptual framework for research and evaluation of Climate Action Plans centred on health and equity. The framework organizes priority research areas across CAP development, content and quality, implementation, and outcomes, with health and equity considerations embedded at each stage. Although depicted sequentially, these stages are iterative: evidence from implementation and outcomes can inform revisions to CAP content and future planning cycles. Public opinion and communication are expected to influence all stages of the process.

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Our framework begins with **CAP development and governance**, because the processes of plan creation, including leadership, inclusiveness (e.g., stakeholder engagement), and transparency fundamentally shape CAP effectiveness [64–66]. Development of CAPs also depends on factors that make certain cities more likely than others to pursue climate action. Policy ideas and innovation can spread from one city to another through policy diffusion mechanisms, which may involve learning from peer cities, emulating successful practices, responding to economic competition, or complying with directives from higher levels of government [67].

The second focus is **CAP content and quality**. Content refers to the mitigation and adaptation goals and actions included in the plan, as well as their alignment with authoritative recommendations such as IPCC guidance [4]. Quality indicators reflect the likelihood of effective implementation, considering goal specificity, responsibility for implementation, timelines, consistency with evidence, evaluation plans, and identified funding sources [68]. Inclusion of health and equity goals and actions is a key quality indicator. While alignment with global recommendations signals adherence to widely accepted standards, high-quality CAPs also incorporate locally relevant evidence, context-specific priorities, and actionable measures to ensure strategies are both feasible and effective.

The third and most essential aspect of CAPs is **implementation**. Success depends on the presence of actionable plans, sufficient budgets, leadership, partnerships, and robust evaluation and reporting mechanisms [69]. The fourth component is **CAP outcomes** reflecting how implemented actions translate into increased adaptation preparedness, GHG emission reductions, improved health, and enhanced equity [70]. Assessing outcomes is often the most challenging aspect due to time lags, attribution issues, and data limitations.

Finally, **public opinion and communication** influence all the components of CAPs. Informing citizens and eliciting their input and support is likely essential for the political viability and longevity of the CAP. While climate action is highly political in many contexts, this is not limited to national or state levels. Local-level advocacy and lobbying can also shape CAP development and implementation. Evidence from some cities shows that interest groups, including supportive advocacy organizations and opposing industries, can influence priorities, and in some cases, public opposition has delayed or altered CAP implementation [71,72].

Identifying CAP research and evaluation priorities

We propose a prioritised agenda for the five research and evaluation topics presented in our framework (Fig 1), which aligns with established policy theories [62,63]. These research recommendations are interconnected yet flexible, allowing exploration individually or collectively, in any order. Several recommendations aim to enhance methods for advancing both scientific understanding and practical implementation of city CAPs. Each Priority Area is briefly described to offer flexibility in study design, measurement approaches, and data availability, acknowledging varying constraints faced by evaluators and researchers.

A critical methodological challenge is disentangling local-level CAP effects from broader national or regional trends. Theoretically, multilevel governance and policy diffusion frameworks can guide the identification of local drivers, barriers, and innovations, distinguishing them from national policy signals [73]. Methodologically, both qualitative and quantitative approaches including comparative case studies, hierarchical/multilevel modelling, and mixed-method triangulation can isolate local CAP dynamics while accounting for broader contextual influences [74].

We emphasize international collaborations to develop and customize consensus measures and methods feasible across diverse contexts, enabling cross-city, cross-country, and cross-regional comparisons. Such collaboration can enhance methodological rigor, incorporate diverse perspectives, and support resource sharing. Standardised and contextually-relevant measures will help cities with limited capacity adopt credible, ready-to-use tools that could, for example, integrate guidance on indicator selection, data collection templates, and analytic protocols, enabling rapid assessment of CAP implementation, health and equity impacts, and mitigation outcomes. Our recommendations are relevant to city CAPs as well as related city documents such as heat plans, disaster preparedness strategies, water infrastructure upgrades, social capital initiatives, and nature-based solutions.

Proposed research and evaluation priorities

Research and Evaluation Topic 1: Assess the development of CAPs

The CAP development process shapes its scope, quality, and implementation, making its documentation essential for understanding CAP content, effectiveness, and outcomes. CAPs may originate internally through city staff, and/or externally through volunteers, grassroots political efforts, or voter-initiated referenda. The lead actors can influence who participates, the degree of departmental buy-in, the professionalism and reach of public engagement, and the integration of CAPs into formal city processes. Key areas of focus could include which sectors or city departments were involved in development, the nature and extent of stakeholder and public engagement (e.g., health professionals, public health departments, representatives from vulnerable communities), use of evidence, identification of potential funding sources, and decision-making. Data collection should capture *when* and *how* stakeholders were engaged (e.g., during goal setting, design, or implementation), the *type* of engagement (e.g., consultation, co-production), and *transparency* of the process. Theories of policymaking processes and politics can guide both conceptual and methodological approaches by clarifying how problem recognition, policy solutions, and political contexts converge to enable CAP adoption [75]. Theories can also suggest how windows of opportunity, advocacy, and external pressures shape decision-making, stakeholder involvement, and policy prioritization [61,76].

Priority Area 1.1: Document and evaluate CAP development using mixed-methods and interdisciplinary approaches.

Rationale: Documenting political and decision-making processes provides lessons for advancing CAPs on city governments' agendas. Research should explore motivations for developing CAPs, particularly goals related to equity, health impacts, and economics. External influences, including supportive health-promoting organisations and opposing entities (e.g., fossil fuel interests), should be scrutinised. National or regional support or constraints on city CAPs should be documented. These insights can help (a) other cities develop or revise CAPs, and (b) support research across subsequent topic areas outlined below. Both qualitative and quantitative methods should be used to evaluate CAP development processes.

Research and Evaluation Topic 2: Evaluate the scope and quality of initial CAPs and revisions

Once CAPs are developed, content analysis can assess their scope, coherence, and alignment with the best available science [4]. Quality evaluations should consider goal clarity and specificity, inclusion of measurable targets and timelines, funding mechanisms, implementation responsibilities, and science-based emissions reduction targets. Inclusion of explicit health and equity goals is a CAP quality indicator. It is essential to evaluate anticipated co-benefits (e.g., improved air quality, increased active mobility) and potential unintended negative consequences (e.g., displacement or burdens on vulnerable populations).

Priority Area 2.1: Develop tools to assess CAP scope, quality, and consistency.

Rationale: A standardised yet flexible assessment tool is needed to evaluate city CAPs across diverse contexts. While global scientific benchmarks (e.g., IPCC-aligned mitigation pathways and adaptation principles) provide an essential reference point, assessment tools must also incorporate locally contextualized data, capacities, and priorities that shape what is needed, feasible, and politically viable at the city level. Effective tools should therefore balance alignment with best available science and sensitivity to local climate risks, governance structures, data availability, and socio-spatial inequalities.

Tools should systematically assess both mitigation and adaptation goals, as well as sectoral actions such as heat preparedness, water infrastructure, transportation, land use, and nature-based solutions, even when these are distributed across multiple policy documents. Although several CAP assessment tools exist, they largely focus on plan content, cross-sectoral integration, and alignment with climate or sustainability objectives [27,42]. These tools neglect health and equity variables, leaving critical social and public health dimensions largely unexamined. When health and equity are

considered, coverage is limited. Health metrics are typically restricted to sector-specific co-benefits, such as heat exposure reduction or improved air quality, without systematically assessing population vulnerability, disease burden, or indirect impacts from transport, land use, or urban greening interventions [77]. Equity measures rarely capture distributive outcomes (e.g., whether interventions reduce exposure to hazards across socio-economic groups) or procedural dimensions (e.g., inclusion of marginalized communities in decision-making and goal setting) [44]. Coverage of health co-benefits, population vulnerability, and equitable access to resources is minimal, and few tools explicitly track whether CAP implementation translates into measurable improvements in health or equity. This gap underscores the urgent need to expand assessment tools with context-sensitive indicators that link policy actions to both health and social justice outcomes.

CAP quality is not purely technical. At the local level, climate action is often contested, negotiated, or diluted through political processes, shaping plan ambition, coherence, and durability. Assessment tools should therefore move beyond plan content alone to consider political dynamics, stakeholder engagement, and institutional capacity that influence adoption and implementation. Quantitative scoring systems enabling cross-city comparison are valuable, but should be complemented by qualitative approaches that capture local political and contextual dynamics, especially in Global South cities where governance arrangements and data constraints may require adapted evaluation criteria.

Priority Area 2.2: Develop a shared framework to assess integration of human health and equity considerations in CAPs.

Rationale: A shared heuristics framework and methodological approach can clarify how and to what extent health and equity are explicitly or implicitly embedded in CAPs, and the assumptions behind these choices. Findings could inform research and advocacy by framing climate change as a public health issue, strengthening support for climate action through well-established health co-benefits [78,79]. Given the complexity of assessing equity across engagement, goals, implementation, and outcomes, collaboration among researchers, practitioners, and advocates will be essential.

Priority Area 2.3: Create a publicly accessible international database of cities with CAPs and related plans, which foregrounds health and equity considerations.

Rationale: A centralised CAP database that incorporates health and equity considerations could support research, advocacy, and peer learning by facilitating the sharing of best practices. It could include policy coding results from priorities 2.1 and 2.2. Another option is to incorporate health and equity measures into existing city CAP content databases, such as GCom [80], Carbons [81], and Climate Policy Database [82]. Ideally, the database would be sponsored and hosted by a credible climate science organisation, similar to the existing database for national climate plans and related documents [83]. The database should have clear inclusion criteria, as climate policies often span multiple documents. Such a resource would enable cross-country evaluations of CAP content and quality by region, income level, governance, and other characteristics.

Research and Evaluation Topic 3: Evaluate the extent and timing of implementation of CAP actions – adaptation and mitigation

Implementation is essential for CAPs to have impact. Yet evaluating it can be challenging due to limited public data at the city or sub-city level. Ongoing research could encourage more regular and transparent reporting. While city staff may assess implementation, involving external stakeholders—such as advocacy groups or academics—can reduce bias and tap into additional resources for data collection.

Priority Area 3.1: Develop methods to assess CAP implementation and identify the enablers and barriers for action.

Rationale: Given the diversity of climate goals and CAP actions, sector-specific evaluations—led by local experts (e.g., in energy, land use, transportation, food systems, public and community health, adaptation to sea level rise, flooding, and heat)—may be most effective. Publicly available methods and tools, with guidance for local adaptation, will support broader and more consistent use, improving the transparency and comparability of CAP implementation and reporting across contexts.

Priority Area 3.2: Evaluate progress on implementation of CAP actions across domains in multiple cities and countries, with attention to stakeholder engagement, political support, and procedural equity.

Rationale: Evaluating CAP implementation requires more than tracking technical metrics; it also involves assessing political support, social relevance, and active community engagement. This includes examining whether multi-sectoral coalitions formed during CAP development—civil society, businesses, universities, youth, health agencies, community-based non-profit organizations, and vulnerable groups—remain involved. These groups can inform leaders about progress and changing conditions, helping to keep CAPs relevant and responsive.

Comparative analysis across cities will likely require international collaboration. A coordinating centre for each action domain could enhance consistency. While baseline data and shared indicators (Priority Area 3.1) are essential, they should be paired with assessments of governance continuity, institutional backing, and public participation. Sharing results via a centralised platform can support technical benchmarking and peer learning on the political and social factors that sustain CAP implementation.

Priority Area 3.3: Evaluate how equity considerations are reflected in CAP implementation and evaluation to address disproportionate impacts on vulnerable populations.

Rationale: Equitable implementation requires evaluating how climate actions affect marginalised and vulnerable communities, monitoring for unintended harms, and promoting inclusive benefits. This includes assessing engagement of diverse community stakeholders, distribution and timing of resources, and how equity and justice are embedded throughout CAP implementation. Developing clear guidelines and tools can assist cities to identify and address health disparities.

Research and Evaluation Topic 4: Estimate the impact of CAPs on multiple outcomes

Assessing the effectiveness of city CAPs is complex, especially amid overlapping and sometimes conflicting local, national, and international efforts. An example is when a master plan mandates one action while the CAP mandates another, creating ambiguity over which to implement [48]. Challenges differ between mitigation and adaptation and include difficulties in attributing emissions reductions or risk mitigation to specific local policies, the time lags between implementation and observable health outcomes, and the implementation gap connected to plan quality and legitimacy [84]. Beyond case studies or comparative policy impact analyses, recent recommendations call for collaborative approaches that explicitly link climate science, health data, and stakeholder input to rigorously and transparently detect and attribute human health outcomes to climate change [85]. This approach could be replicated in the case of CAP evaluations. Evaluations should go beyond GHG emissions and climate hazards metrics to more explicitly include health and equity outcomes.

Equity indicators, including accessibility and affordability metrics, could include the spatial distribution of healthcare facilities, energy infrastructure, grocery stores, cooling centres, green spaces, and walkable routes to common destinations, as well as air quality and heat vulnerability indices. These indicators should be tailored to local contexts, particularly in lower- and middle-income settings. Data availability is likely to be limited in most cities, but the challenges are expected to be greater in low- and middle-income cities. Researchers should attempt to identify and leverage disaggregated data including neighbourhood-level, socioeconomic, and population-specific indicators (e.g., older adults, children, people with disabilities, and outdoor workers) to identify intersectionalities and priority communities for intervention [86]. Where data gaps exist, validated proxy measures, such as satellite-derived air quality estimates and structured community surveys, can be used to strengthen surveillance, inform decision-making, and guide targeted, equity-focused action. Undertaking research and evaluation will identify data gaps, which can be seen as opportunities for investigators to advocate for improvements in city-level data collection efforts.

Health-related metrics available at city level might include climate disaster-related hospitalizations and deaths (e.g., heatstroke, flood injuries). Psychological or physical impacts connected to energy poverty and extreme weather could be tracked. Traditional indicators that address flood resilience (e.g., permeable surfaces, restored floodplains), water or energy security (e.g., groundwater recharge, rainwater harvesting, renewables), and disaster preparedness (e.g.,

emergency shelters, early warning systems) should integrate health equity considerations from early stages of data collection and monitoring. Establishing baseline data is essential for effective evaluation.

Priority Area 4.1: Develop collaborative, consensus-based models and tools to estimate CAP impacts on mitigation and adaptation indicators.

Rationale: Estimating CAP impacts is inherently complex due to the diversity of indicators, measurement challenges, reliance on assumptions, attribution difficulties, and international variations. Coordinated, collaborative efforts to develop and validate shared methodologies will therefore be essential. Impact modelling can identify critical gaps, such as ambiguous goals missing baseline data, or insufficient long-term funding for climate action, and provide actionable feedback to enhance CAP clarity, feasibility, and effectiveness. Evaluating adaptation is particularly challenging when impacts relate to extreme events that have not yet occurred [87]. Preparedness and response assessments require readiness to act when such events occur. Sharing pre-developed, “off-the-shelf” research protocols, including ethical approvals, tested methodologies, and trained teams, can support timely, rigorous evaluation of emergency response and adaptation responses.

Priority Area 4.2: Model associations between CAP implementation and indicators of GHG emission reduction and adaptation.

Rationale: Gathering detailed data on CAP implementation and related GHG reductions and adaptation indicators will enable more accurate modelling of CAP effectiveness. Such analyses can clarify how implementation practices align with outcomes, facilitating more accurate evaluations, and informing improvements in CAP strategies.

Priority Area 4.3: Conduct equity and environmental justice evaluations to assess the impacts of CAPs on marginalised and vulnerable communities.

Rationale: Environmental justice evaluations extend beyond traditional equity measures. While equity metrics often focus on distributive outcomes such as fair allocation of services, infrastructure, and resources, environmental justice also emphasises procedural justice, which examines who participates in decision-making, whose voices influence policy, and how local priorities shape implementation. Applying this lens to CAPs is crucial for understanding whether climate action effectively reduces disproportionate impacts on marginalized and vulnerable communities. Procedural justice is particularly important because policies developed through inclusive and transparent processes are more likely to achieve equitable and sustainable outcomes.

Evaluations should address both distributive dimensions (e.g., access to parks, walkable streets, cooling centres) and procedural dimensions, ensuring meaningful participation in decision-making and goal setting. Evaluations should consider multiple levels, including processes (e.g., stakeholder engagement, public participation), outputs (e.g., allocation of resources and actions), and outcomes (e.g., reductions in exposure and health disparities). Developing robust, context-sensitive methodologies to measure these dimensions is key to ensuring CAPs deliver fair and inclusive benefits, address systemic disparities, and promote equitable climate action [88].

For example, a hypothetical city could integrate a spatial heat vulnerability index to identify neighbourhoods at highest risk of heat exposure, combine this with healthcare access metrics to assess local capacity to respond to heat-related illness, and overlay participatory budgeting outcomes to ensure community priorities shape investments in cooling infrastructure. Tracking these indicators over time would allow the city to monitor both distributive impacts (who benefits) and procedural equity (who influences decisions), providing a concrete framework to operationalize environmental justice in CAP evaluation. Neighbourhood-level data and indicators should be used to capture localized effects and monitor implementation outcomes, ensuring equity and justice objectives are both measurable and actionable.

Priority Area 4.4 Investigate whether CAPs have measurable impacts on human health outcomes, and if so, whether these effects result from implementation of adaptation and/or mitigation strategies.

Rationale: This research goal requires identifying human health indicators influenced by CAPs, collecting relevant data, and analysing health outcomes in relation to CAP implementation [89]. Relevant data could include morbidity and mortality rates, hospital admissions, respiratory and cardiovascular health metrics, heat- and air pollution-related illness records, or

survey-based self-reported health and well-being indicators. Understanding whether health effects stem from adaptation, mitigation, or both is valuable. Attention should also be given to potential inequities in health outcomes, to ensure CAPs improve health equitably across communities.

Priority Area 4.5. Examine the diffusion and adoption of innovative CAP practices across jurisdictions.

Rationale: Cities and states are often considered laboratories of innovation, with city CAPs offering a platform and examples of policy change in other jurisdictions. Policy diffusion research indicates that some cities, particularly larger, better-resourced ones, are more capable of learning from peers and designing innovative policies, while smaller or less-resourced cities may primarily imitate others, sometimes leading to sub-optimal outcomes [67]. If city CAP content and quality are systematically assessed and publicly shared (Priority Area 2.2), other jurisdictions may be more likely to adopt successful strategies. Research on how CAP innovations, such as development processes, goals, actions, implementation indicators, evaluation methods, and communication strategies, spread across cities, regional and national governments, international agencies, and advocacy groups could improve the dissemination of effective practices. Policy network research highlights how formal and informal networks, institutional alliances, and intermediary actors shape the diffusion of policy innovations, influencing which cities adopt new practices, how rapidly they spread, and the adaptation of policies to local contexts [90]. Established methodologies exist for studying diffusion of innovations [73,91].

Research and Evaluation Topic 5: Assess public opinion and communication about CAPs

Understanding the beliefs of local populations and leaders about climate change, CAPs, and level of public support for actions is crucial, as these perspectives influence adoption, content, and implementation of plans [92]. How CAPs are communicated and to whom, including during their development, adoption, and beyond, is likely to impact their effectiveness and long-term sustainability. Research is needed to examine how public opinion and communication strategies affect CAP implementation [93].

Communication dynamics can be investigated through a variety of approaches, including analysing the content and framing of official municipal messages, surveying residents and stakeholders about awareness and trust, or mapping the networks of advocacy and interest groups involved in climate policy. After evaluations are completed, findings and recommendations must be communicated clearly to diverse audiences. Scientific publications are only one mode of communication. Communication is most effective when it leverages trusted sources, which can vary by context. Seminal work on epistemic authority suggests scientific experts and communities shape policymaking because expertise confers credibility [94,95]. In contrast, research on peer communication and political networks shows that information from colleagues or trusted peers can be more persuasive and overcome motivated resistance more effectively than expert-only messaging [96]. Assessing the reach, credibility, and effectiveness of communications should therefore be an explicit evaluation goal.

Priority Area 5.1: Develop and implement methods (e.g., surveys, interviews, focus groups) to assess opinions on CAPs and recommended mitigation and adaptation actions, including broader climate change priorities.

Rationale: Insights from citizens, city decision-makers, and agency staff can help identify which CAP actions are widely supported, which face resistance, and what enables uptake. Standardised yet adaptable surveys, customizable for local contexts, hosted on a shared web platform could facilitate broader use, collaboration, dissemination, and comparative research. Surveys during CAP development can refine strategies for greater adoption, while follow-ups post-adoption can guide revisions, ensuring CAPs remain responsive and effective.

Priority Area 5.2: Assess communication by city officials, advocacy groups, and opposition groups to the public before and after CAP adoption.

Rationale: Clear, persuasive communication about the need for CAPs, their purpose, potential benefits, and public support can influence their content, adoption, longevity, revision, and implementation. Monitoring public messaging enables researchers to infer public attitudes toward CAPs, including levels of support, opposition, and perceived legitimacy. This

can be achieved by analysing the content of city documents, press releases, official statements, and social media, as well as coverage in local news outlets.

However, these sources should be interpreted with caution. Social media discourse, while offering rapid and accessible insights into public reactions, can be polarised and not fully representative of broader public opinion, even though it may still influence decision-making [97]. Similarly, public meetings and consultation processes, despite often being sparsely attended and subject to participation biases, are frequently treated by policymakers as indicative of community sentiment [98]. By triangulating across these sources, researchers can better assess how CAPs are communicated, contested, and perceived by different stakeholders, and how these dynamics influence adoption, implementation fidelity, and political sustainability of climate actions. Understanding these patterns can inform more effective communication strategies that enhance public engagement and promote equitable policy outcomes.

After CAP evaluation findings are shared, it is equally important to assess how decision-makers and stakeholders perceive the results, particularly regarding credibility, clarity, lessons learned, and intended follow-up actions. Identifying key audience segments and using both quantitative and qualitative methods to evaluate message reception can strengthen future dissemination efforts.

Conclusion

Research and evaluation of CAPs are inherently complex, involving multiple city departments and challenges such as data gaps, limited coordination, competing priorities, and the need to integrate CAPs with other planning documents that also address climate-relevant issues, such as master plans, zoning codes, and disaster preparedness plans [7,8,99]. Understanding how CAPs operate alongside or in relation to these documents, and why cities pursue dedicated CAPs despite existing guiding frameworks, is essential for a “whole-of-government” approach to climate action. Resource constraints and heterogeneous climate-related risks further complicate CAP development and implementation. City administrations vary widely in their authority, agency, and competencies. While many wield significant decision-making power over sectors such as energy, transport, building regulations, urban planning, health, recreation, waste, and water, their actions are often constrained by competing budgetary priorities, resistance from vested interests, and limits on municipal authority imposed by higher levels of government.

Priorities and needs also differ by geography, resource availability, and governance structures. For example, some cities must prepare for, or are already experiencing, the impacts of rising sea levels and heavy rains, while others focus on reducing emissions, adapting to extreme heat, drought, addressing declining food productivity, or transforming transport systems.

Even under ideal conditions, building a strong evidence base aligned with this research agenda will take time. However, findings from each research topic can inform local improvements in CAP development, implementation, and revision—especially if results are clearly and broadly communicated to decision makers and stakeholders. Incremental progress can build research capacity, encourage broader evaluation, and accelerate climate action.

We can anticipate some key determinants of success in realizing the recommendations of this research and evaluation agenda. First, funding is critical. Identifying and securing resources for CAP evaluation will be a major challenge. Some cities could support local evaluations in partnership with universities or advocacy groups, while national and international funders—including non-profits and governmental agencies—can help by prioritising CAP research, providing grants, and offering training programs. Ideally, funding would also support networks of city teams to collaborate and share learning, advancing climate action collectively.

Second, interdisciplinary and transdisciplinary collaboration is essential, particularly when research is participatory and driven by communities and their needs, ensuring that CAP evaluation and implementation reflect local priorities, knowledge, and lived experiences. Municipal climate action is deeply political. In Flagstaff, Arizona, local opposition to the 2018 climate plan revealed how shifts in leadership and framing can dilute or overturn CAPs [100]. In contrast, robust

engagement as in Oakland, California's 2030 Equitable Climate Action Plan, generated durable public support through town halls, workshops, and interactive digital platforms [101]. The Future Resilience for African Cities and Lands (FRAC-TAL) project embedded researchers within city governments and convened officials from multiple sectors to co-develop solutions to pressing local issues [102]. Such participatory and citizen-driven approaches strengthen legitimacy, improve data quality, and enhance equity and accountability.

The recommended research and evaluation topics require diverse expertise—including climate scientists, health researchers from multiple sub-disciplines (e.g., health equity), behavioural scientists, measurement experts, statisticians/modelers, communications experts, qualitative researchers, political scientists, community engagement experts, and dissemination and implementation experts. Not all areas will be needed for every study but given this research agenda's emphasis on health and equity, teams should include relevant expertise in these areas. Although interdisciplinary collaboration can be challenging, evidence increasingly supports the effectiveness of “team science” [103].

Third, international collaboration and coordination can amplify the impact of local CAPs, despite their local scope. Cross-city and cross-country coordination increases the applicability of methods and tools, facilitates shared learning from successes and setbacks, and enables comparative research that informs both local adaptation and global best practices.

Our recommendations aim to advance research and evaluation on CAPS and improve communication of findings to diverse stakeholders, ensuring results inform better CAP content and implementation. Given the agenda's international scope, methods for each research topic should balance local applicability with cross-context comparability. Coordination across jurisdictions and contexts will require substantial investment in developing metrics, building capacity, collecting comparable data, conducting comparative analyses, and effectively communicating results.

A driving motivation behind this proposed agenda is the promise of CAPs as locally-driven yet globally-relevant tools for climate mitigation and adaptation. However, the vast majority of CAP research to date has focused on the Global North [58]. More coordinated global research on CAPs can help identify shared challenges, surface innovative solutions, and guide local adaptations to strengthen CAPs, improve implementation, and deliver measurable outcomes. We hope this vision for CAP research and evaluation, with the explicit aim of enhancing CAP effectiveness, attracts the funding and leadership needed to support the ambitious yet essential research priorities proposed here.

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