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U.S. cities' integration and evaluation of equity considerations into climate action plans

Holly Caggiano^{1✉}, Diren Kocakuşak², Pranay Kumar² and Melissa O. Tier³

While cities in the United States play an active role developing and implementing climate policy, urban centers are often sites of socio-spatial inequity. Thus, we explore how cities grapple with these inequities in their Climate Action Plans (CAPs). While CAPs can empower cities to engage in equitable planning practices that prioritize marginalized communities, little empirical research examines how equity goals are measured and evaluated. We find that among large U.S. cities with CAPs, less than one third include measurable indicators to evaluate progress towards achieving equity goals. Across climate adaptation and mitigation planning, nineteen cities consider equity goals as they relate to ten thematic areas, six outcomes, and five dimensions of equity. We suggest ways forward for cities to develop, implement, and measure a diverse and holistic set of equity indicators to use in their climate planning efforts and beyond.

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INTRODUCTION

As U.S. cities propose ambitious climate plans, many question if and how they can be implemented equitably within and between cities^{1–3}. New funding mechanisms present in the Inflation Reduction Act and associated legislation will likely provoke renewed interest from state and local governments as they seize a window of opportunity to implement projects^{4,5}. Whereas the impacts of climate change will disproportionately affect vulnerable populations, planning solutions like mega infrastructure projects, managed retreat, and other large-scale climate mitigation and adaptation efforts have potential to displace communities, negatively impact marginalized communities, or protect others at their expense^{6,7}. Additionally, equity and vulnerability considerations are likely to differ in scope and scale for affected populations across adaptation and mitigation strategies^{8,9}. Considering climate change as a social equity issue, asking who gains and who loses from mitigation and adaptation efforts prompts conversations about equity planning^{10–13}.

A large body of literature suggests that climate impacts serve to exacerbate existing socio-economic inequalities in the U.S. and globally^{14,15}. Some environmental justice scholarship, however, contends that city planning responses to climate change present opportunities—if successfully harnessed—to combat social, racial, and economic inequality¹⁶. Such efforts would not only address historical and ongoing legacies of systematic inequality but would also reduce future disproportionate impacts of climate change. For example, economic risks as a result of climate impacts are not evenly distributed throughout the country—the poorest third of counties in the U.S. are projected to see the greatest income losses by the end of the century (between 2 and 20%) under business-as-usual emissions scenarios¹⁷.

In the U.S., climate governance takes place across a multi-level system, involving federal, state, and local jurisdictions¹⁸. Over the past few decades, cities have played a visible role in climate mitigation and adaptation planning by developing and promoting climate action plans (CAPs)¹⁹. In some cases, the presence of these

plans is correlated with quantifiable positive climate outcomes. For example, research finds that cities with CAPs implement more greenhouse gas mitigation strategies (e.g., green buildings, green transit infrastructure) than cities without CAPs⁹. Though often cited as a central focus of planning theory for sustainability and climate change, equity considerations often fall to the wayside in comparison to other economic and environmental imperatives when plans are implemented^{20,21}. One analysis of climate plans from 28 medium and large U.S. cities found that few cities made equity a central component of their plans²¹. More recent work shows that U.S. cities have increasingly integrated justice into climate planning efforts, but additional work is needed to unpack how justice is measured and actualized through specific strategies on the ground²².

This paper explores: (1) How U.S. cities integrate and evaluate equity considerations in their climate mitigation and adaptation plans; (2) How cities prioritize and reconcile equity across adaptation and mitigation efforts in their climate action plans; And (3) Which equity considerations in cities' climate action plans include measurable metrics for evaluation. Exploring these objectives will improve our knowledge on equity in local climate and sustainability plans, which will be useful for planning educators, researchers, and practitioners. We provide an updated review of city-level CAPs and address a gap in the literature by investigating how equity goals are conceptualized, measured, and evaluated.

To assess how equity considerations are posed in mitigation and adaptation agendas, we use the American Planning Association's 2019 Planning for Equity Policy guide, a document created to guide planners at all levels of the U.S. government to center equity throughout decision making processes and outcomes²³. To successfully implement just urban climate action, we argue that in addition to including end goals to enhance equity in their plans, cities should provide measurable targets that can be monitored for regular benchmarking and evaluation²⁴. As climate plans can potentially result in socio-spatial inequities, planners should build

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in opportunities for equity checks as plans are crafted as well as leverage emerging policy tools and data sources to meet these goals.

Our analysis echoes previous findings that climate plans have further integrated equity into their processes and goals over time. Our central contribution, however, illustrates how climate plans conceptualize equity and how they propose to measure its achievement. We find that plans contain indicators across ten thematic categories, including (1) transportation, (2) housing, (3) air quality, (4) disaster risk, (5) food and water, (6) energy, (7) green space, (8) green jobs, (9) public participation, and (10) general planning and vulnerability assessment. Further, these indicators measure equity across these thematic categories either spatially, by income, by race, by gender, or by other types of vulnerability assessments. Our analysis finds that indicators cover six different outcomes: (1) health outcomes, (2) ecological outcomes, (3) financial investment, (4) new or updated hard, soft, and green infrastructure, (5) behaviors across individuals, groups, businesses, and government actors, and (6) the measurement of aggregated scores that assess vulnerability across overlapping inequalities. We find that while many types of equity across various categories are represented in indicators, there are few efforts to include comprehensive equity indicators across thematic areas, types of equity, or types of metrics.

RESULTS AND DISCUSSION

Mitigation, adaptation, and equity in climate action plans

Among the 68 most populous cities we focused on, 55 cities have a comparable CAP focusing on targeted mitigation and adaptation actions. We elaborate on our sampling and data collection as well as the demographic, geographical, political, and socioeconomic diversity of these cities in our methods section. In this section, we present how different equity dimensions are integrated into the plans, how the results correlate with other variables we controlled for, and how measurable equity indicators compare across different cities.

The focus of climate planning efforts in recent years seems to be shifting away from an exclusive mitigation approach to a more holistic one. Growing attention on adaptation and equity needs might be especially true at the local scale, where stakeholders are more attuned to current and expected regional climate impacts²⁵. However, a well-documented and substantial adaptation gap remains where the scale of the need for “planning, financing, and implementing adaptation actions” far outpaces what is actually occurring globally - as does a far less documented equity gap²⁶. The IPCC further notes in its 6th Assessment Report that far more cities globally are creating adaptation plans than are successfully implementing them, and there is a pressing need for the development of metrics and evaluation methods.

In this analysis, our coding for each city included three binary indicators: (1) presence of mitigation goals; (2) presence of adaptation goals; (3) presence of equity goals—as well as whether these goals were measurable and how much overlap existed between indicator types. Of the 55 CAPs reviewed, the vast majority, 53, addressed mitigation and 42 addressed adaptation. A large number, 41, also addressed equity. Many cities have a mitigation goal along the lines of Cleveland’s greenhouse gas reduction goal: “80% below 2010 emissions by 2050, with interim goals of 16% reduction by 2020 and 40% reduction by 2030” and associated sectoral emissions targets. Overarching adaptation or equity goals of this kind were far less common, but instead listed specific sectoral or planning efforts that would target these dimensions.

The level of overlap between these three indicators was highly variable. For example, Philadelphia’s *Greenworks* plan provides a concrete metric for a mitigation/equity goal (“Increase bike share

trips by 100 percent and those taken by minority or low-income populations by 120 percent”) and another for an adaptation/equity goal (“Provide critical long-term home repair in 25,000 low and moderate income single and multi-family homes by 2026”). Going a step further, five cities developed clear equity metrics that are intended to be applied to all the mitigation and adaptation goals listed within their CAPs—these are: Oakland’s Equitable Implementation Appendix, Raleigh’s Equity Impact Matrix, San Antonio’s Climate Equity Screening Tool, San Diego’s Climate Equity Index, and San Francisco’s Equity Metrics.

Additionally, among the equity indicators, only 19 of the plans had measurable parameters of success. Measurable equity indicators were more common among bigger cities than smaller cities. Among 55 cities with a CAP, all nine cities with over 1 million residents reported measurable indicators. On the other hand, only 22% of the remaining cities (10 out of 46) included measurable parameters of success.

Dimensions of equity considered in climate action plans

We coded climate plans for their inclusion of six APA policy measures from their Climate Change and Resilience framework: (1) partnership with communities to exchange information about community risks; (2) empowerment of communities through community-based participatory planning; (3) proposed funding for projects identified by communities (local knowledge); (4) prioritization of equitable procurement of planning services (disadvantaged, minority-owned, and women-owned firms and planners of all protected classes) in future projects; (5) consideration of social equity in all adaptation and mitigation decisions; and (6) inclusion of equity in cost-benefit analyses²³. We assigned each plan a score from one to six based on how many APA policy measures the plan included. Figure 1 illustrates the APA Index scores for each plan and linear trend line over the years. Plans between 2018 and 2023 have a higher average score (3.29) than those published in the earlier period (1.84), indicating an overall improvement in the plan equity considerations over time, which is similar to previous findings for European city plans²⁷. Two plans scored the maximum of six (Portland, OR and Dallas, TX), incorporating all key policy criteria. Four cities (Henderson, NV; Oklahoma City, OK; Tampa, FL; and Santa Ana, CA) did not include any APA policy measures in their plan text.

We further investigated the relationship between the APA Index score and other variables by running correlation tests (Table 1). Test results reveal a statistically significant positive correlation between the APA Index score and plan year ($p < 0.01$). Next, the mayor’s political affiliation is also statistically significant at $p < 0.05$ level. We coded the mayor’s political affiliation variable as a dummy variable: (1) Democratic, (2) Independent, and (3) Republican (in the US context, Democratic and Republican parties correspond with liberal and conservative ideologies, respectively). The negative correlation between the APA Index score and this variable indicates cities governed by Democratic mayors have a higher score than Republican mayors. Being a member of an international climate city network is positively correlated at $p < 0.05$ level.

GINI Index provides a summary of income inequality by measuring dispersion of income across the entire income distribution. The GINI coefficient ranges from 0, representing perfect income equality, to 1, representing perfect income inequality²⁸. Our findings indicate a positive and statistically significant correlation between the GINI index and the APA Index score at $p < 0.1$ level, suggesting cities with higher income inequality have higher APA Index scores. On the other hand, we did not find a statistically significant correlation between the APA Index score and income and race variables. One reason for this could be the GINI Index measures dispersion across the income distribution, while income and race variables measure the central

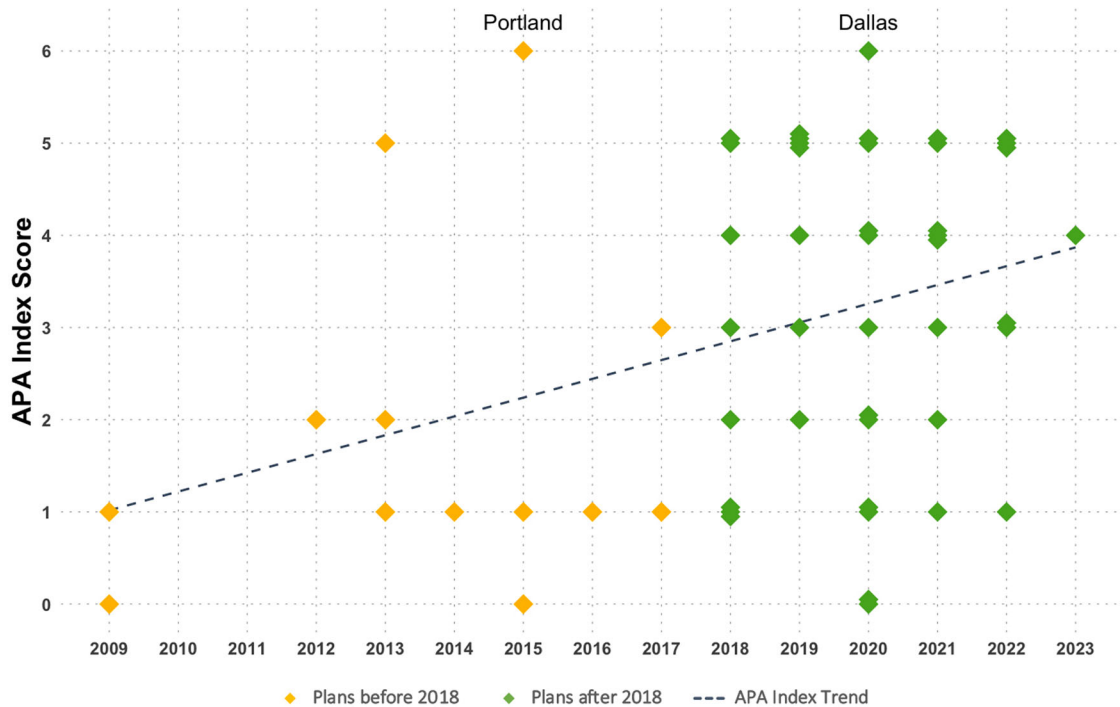


Fig. 1 American planning association equity measures over time. This figure includes each plan’s APA Index Score on the y-axis and plan year on the x-axis. Yellow diamonds indicate plans before 2018, green diamonds indicate plans after 2018, Black dashed line indicates trend over time.

tendency. It should also be noted that variables reported at the aggregate level are susceptible to ecological fallacy²⁹. Variables used in this correlation test use cities as the unit of measurement, and interpretations of the results may not reflect the characteristics of individuals. Finally, included geographical variables, the U.S. Census region and being a coastal city, are not correlated with the APA Index score.

Figure 2 examines each of the six dimensions of equity policy implementation outlined by the APA. The most frequently cited tools for cities fall under the first two dimensions, ‘partner with communities to exchange information about risks’ and ‘empower communities through community-based participatory planning’. Most CAPs included at least some details of how community members were engaged as a part of the plan development process. Far fewer plans, however, explicitly described funding mechanisms for projects identified by communities.

Indicators and measurement in climate action plans

In our sample of CAPs, we identified measurable equity indicators to understand what types of equity impacts could be clearly evaluated in practice. To meet these criteria, an indicator had to be quantifiable for future monitoring while targeting a particular neighborhood, demographic group, or otherwise identified vulnerable population (as opposed to measuring change for all groups). Of the 55 reviewed CAPs, 40% (22 cities) included indicators to evaluate if equity goals had been met, and 35% (19 cities) included measurable indicators in their plans (35%). Supplementary Table 1 includes a full list of indicators identified from each CAP. After identifying measurable equity indicators in plan document, we categorized them into ten thematic areas: (1) transportation, (2) housing, (3) air quality, (4) disaster risk, (5) food and water, (6) energy, (7) green space, (8) green jobs, (9) public participation, and (10) general planning and vulnerability assessment. Figure 3 presents an example application for each thematic area and how these thematic areas are associated with equity indicators: gender, income, race and ethnicity, equity across

Table 1. Correlation test results.

	APA index score	
	Correlation coefficient	p value
Population	0.23	0.09*
Median Household Income	0.03	0.82
People of color	-0.07	0.61
GINI Index	0.26	0.06*
U.S. Census Region	-0.04	0.77
Coastal City	0.15	0.28
Plan Year	0.36	<0.01***
Mayor’s Political Affiliation	-0.28	0.04**
Climate City Network Member	0.28	0.04**

Pearson Correlation Coefficient test is used to measure the correlation with continuous variables and Point-biserial Correlation test is used to measure the correlation with categorical variables. Significance levels: ***p < 0.01; **p < 0.05; *p < 0.1.

spatial areas, and general vulnerability indicators (including social vulnerability indices that aggregate overlapping and compounding inequities). Numbers under each thematic area indicate how many indicators are identified for specific equity issues.

Further, we coded each indicator to understand what type of outcome it measures, outlined in Fig. 4. These outcomes included (1) health outcomes, (2) ecological outcomes, (3) financial investment, (4) new or updated hard, soft, and green infrastructure, (5) behaviors across individuals, groups, businesses, and government actors, and (6) the measurement of index scores to aggregate vulnerability across overlapping inequalities. Figure 4 contains information for the 19 cities that have measurable equity indicators out of the 55 cities with CAPs we coded. The number of equity indicators per CAP is demonstrated by the size of the city

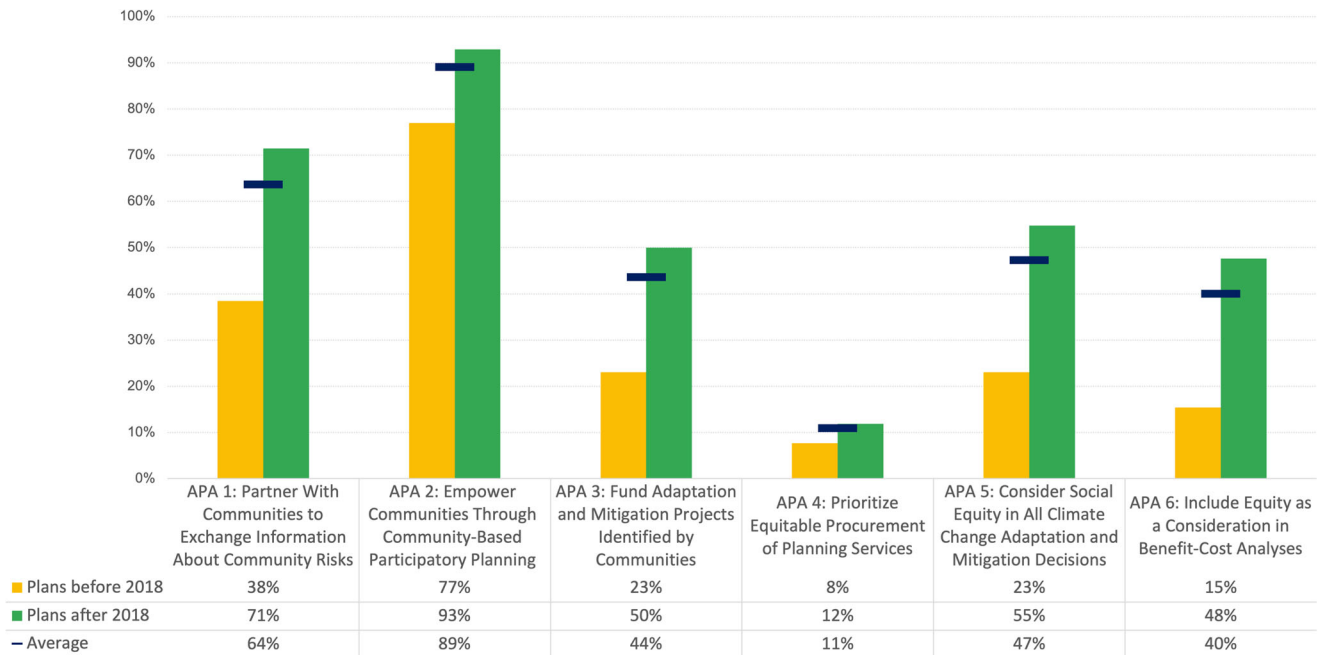


Fig. 2 American planning association dimensions of equity across plans. This bar graph illustrates plan inclusion of six APA equity dimensions. The y-axis shows percentage of plans, and the x-axis shows plans over time. Black lines indicate the average. Yellow bars indicate plans before 2018, green bars indicate plans after 2018.

point (indicator count). The graph also displays the types of outcomes listed by one or more equity indicators for that city (outcome types).

DISCUSSION

With growing realization of the harmful and disproportionate impacts of climate change, it is no surprise that the implementation of CAPs by cities has become an increasingly popular tool to grapple with climate change mitigation and adaptation efforts at the local level. The increased consideration of and attention to equity issues in CAPs over time echoes previous findings in the U.S.^{21,22,30}. Our results reveal that the discourse around equity has considerably evolved in the past decade, from when Schrock et al. found that as of 2012, many large U.S. cities either ignored equity goals or treated them as secondary or tertiary relative to environmental and economic goals²¹.

There are also spatial and sociodemographic reasons why some cities may prioritize equity goals in their CAPs over time. For example, Hess & McKane find that U.S. cities with greater attention to equity as it relates to sustainability in their plans are more likely to lean toward the center-left Democratic Party with higher levels of income and education³⁰. Our correlation analysis suggests similar results about mayor's political party affiliation. To this end, Schrock et al. argue that while cities with greater proportions of racial minorities may have more motivation to engage with equity in their plans, local officials in high needs cities are less likely to pursue strategies that may be considered anti-business²¹.

Further, our finding of a correlation between climate city network membership and APA Index score points to the significance of national and international coordinating bodies and movements through which cities have collaborated to engage in climate policy – especially in the absence of national-level policy in the U.S.³¹. Some examples include the 'We Are Still In' movement after U.S. withdrawal from the Paris Agreement, the Global Covenant of Mayors for Climate and Energy, the C40 Cities Climate Leadership Group, and the ICLEI Local Governments for Sustainability network. City networks such as these have been praised for facilitating knowledge exchange and networking³².

ICLEI, for example, provides resources for cities to develop and implement CAPs and to act as intermediating actors that contribute to exchange of knowledge and skill development³³. These coordinating bodies enable the diffusion of policies, knowledge, and resources in ways that can facilitate equitable planning efforts. Other studies note, however, that membership in these organizations is often unevenly distributed across the Global North and South, prioritizing highly globalized and higher income cities^{34,35}. Local, regional, and national environmental justice movements and organizations also likely play a strong role in urging cities to prioritize equity in their climate planning efforts as part of their comprehensive urban planning efforts. Previous studies have illustrated the power of social movements to drive city-level change. For example, Liechenko et al. outline how environmental justice activism can be traced back decades in New York City but has only recently become recognized in formal planning efforts through workgroups that engage activists to collaboratively plan for equitable climate adaptation³⁶.

Many contemporary urban CAPs feature some combination of mitigation (i.e., reducing emissions), adaptation (i.e., reducing risk exposure), and equity (i.e., addressing social justice concerns) strategies to varying degrees. Urban CAP goals thus closely align with the three-pronged discussions of the Conference of Parties to the UN Framework Convention on Climate Change, which continue to actively negotiate mitigation, adaptation, and loss & damage (a global social justice endeavor)³⁷. Furthermore, CAPs link Sustainable Development Goals 10 (Reduced Inequalities) and 11 (Sustainable Cities and Communities), and 13 (Climate Action). By detailing mitigation and adaptation strategies at the local level, CAPs align with the goals of SDG 11.b by developing a holistic disaster risk management framework and implementing integrated resource efficiency, mitigation, adaptation, resilience, and inclusion policies³⁸. It should also be noted that mitigation targets have consistently been prioritized across climate governance scales due to several reasons, including: the urgency of meeting the 1.5–2°C Paris Agreement target²⁵; concerns about the moral hazard effects of adaptive actions³⁹; the relative tangibility of a quantifiable emissions target versus more abstract adaptation and equity targets⁴⁰; and the possibility that mitigation goals are seen



Fig. 3 Equity indicators in climate action plans. This figure indicates thematic areas of equity considerations across five equity areas. The left-hand side provides illustrative example applications of each thematic area. Under each thematic area, bars represent the number of equity areas addressed by the full set of indicators. Green bars represent gender equity, purple represent income equity, blue indicate race/ethnicity equity, red indicates spatial equity, and yellow indicates general vulnerability indicators.

as easier hanging fruit (or an avenue to displace attention from systemic fossil fuel extraction onto individual carbon footprints) compared to their adaptation and equity counterparts⁴¹.

Considering the dimensions of equity in climate planning proposed by the American Planning Association, our results reveal interesting trends. While the most frequently targeted APA goal by plans aims to “empower communities through community-based participatory planning”, these goals are not always met in practice or easily measurable with quantifiable metrics. For example, Frick et al. find, in the context of California, that planning for community collaboration is not without challenges, conflict, and unintended consequences⁴². Other scholarship has

identified potential adverse outcomes of climate plans including reduction in community sense of security and wellbeing⁴³. We note that more plans explicitly describe efforts toward participatory planning goals than the following, “fund adaptation and mitigation projects identified by communities”, which would presumably be an ideal outcome of community-based participatory planning. Further, the least common APA tool utilized in plans urges planners to “prioritize equitable procurement of planning services.” While this goal also targets notions of procedural justice, it is less commonly noted in U.S. city CAPs.

The primary contribution of this analysis is to draw existing examples of measurable equity indicators in CAPs to both assess

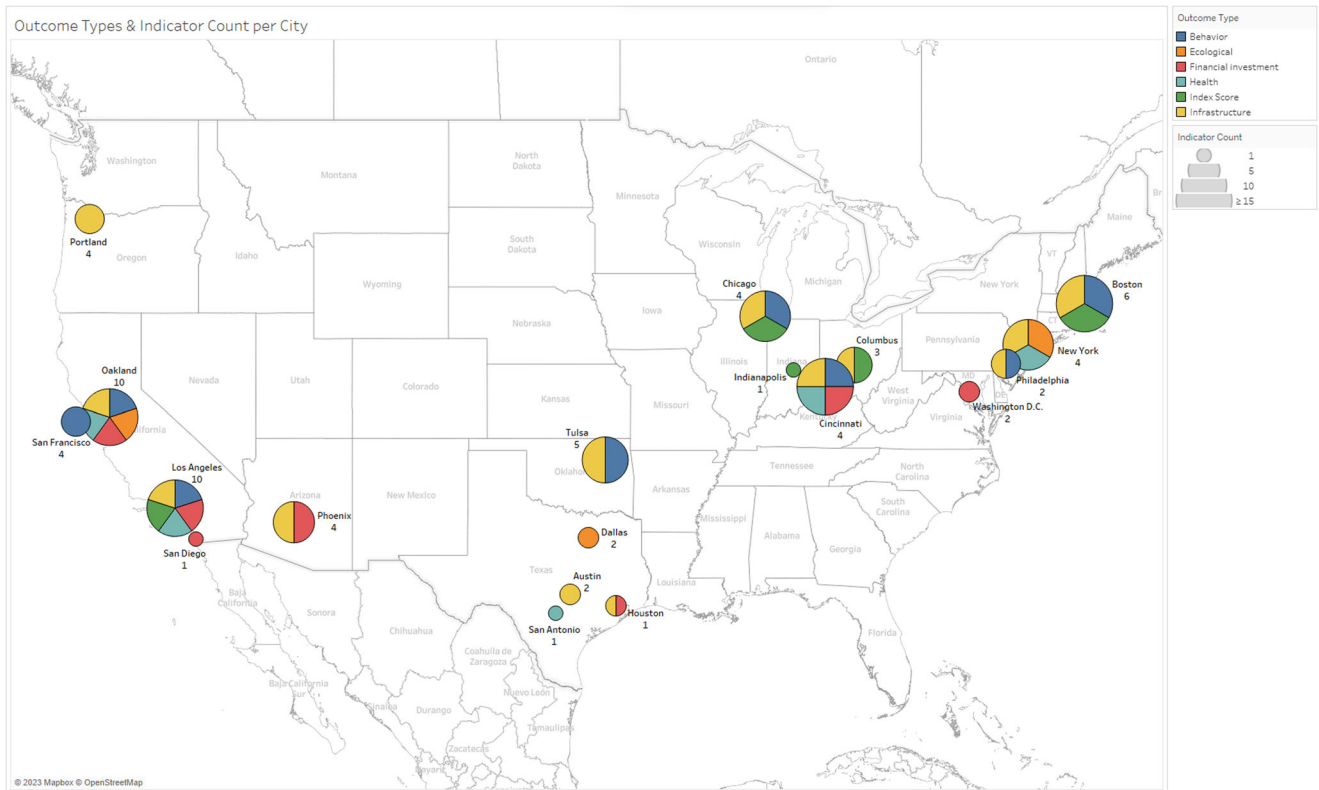


Fig. 4 Outcome type and indicator count per city. This map presents information for the 19 cities that have measurable equity indicators. The number of equity indicators per CAP is demonstrated by the size of the city point (indicator count). The types of outcomes listed by one or more equity areas for that city (outcome types). Dark blue represents behavioral outcomes, orange ecological outcomes, red financial investment, light blue health, green index scores, and yellow infrastructure outcomes.

what has been done and call for increased coordination and imagination across cities. Other studies of CAPs and sustainability plans often stop short of assessing implementation as it is not often feasibly measurable. We propose that transparent indicators, here, can help cities and communities evaluate their own plans, as well as facilitate evaluation by researchers. Hess & McKane compile a list of goals and initiatives from city government plans, identifying examples that address GHG mitigation while also benefiting historically marginalized residents³⁰. We build on this analysis by identifying specific indicators, the outcomes they measure, and the type of equity the indicator targets (categorized as gender, income, racial or ethnic, spatial, and general vulnerability indicators).

Our findings raise questions about what cities might do to develop, implement, and measure a diverse and holistic set of equity indicators to use in their climate planning efforts and beyond. We suggest that cities, their networks, and their communities work together to create new frameworks in ways that are feasible to measure and evaluate, especially for less-resourced cities. While city networks have acted as important intermediaries to communicate norms around equity planning to large numbers of cities and facilitate shared learning, we suggest additional room for universities and non-profits with capacity for software development, data collection and analysis, and methodological expertise to engage with cities in their climate planning processes. California provides a unique example of a state with a relatively robust set of equity indicators, many of which are measurable through the California Communities Environmental Health Screening Tool (CalEnviroScreen), created by the state Office of Environmental Health Hazard Assessment on behalf of the California Environmental Protection Agency⁴⁴. Researchers are well positioned to work with additional states and cities on similar

tools that aggregate multiple data sources, spatially and temporally.

One significant limitation of our analyses is that we were only able to evaluate published plans as they were publicly presented. In this, we may miss efforts in other city plans, initiatives, or implementation strategies that are not explicitly mentioned in their CAPs. Many cities conduct additional reporting and analysis after the initial publication of a climate action plan to address implementation and outline detailed paths forward. Cleveland, for example, published their Clean and Equitable Energy Report in 2021, 3 years after their CAP, including measurable indicators surrounding equity of energy sustainability goals⁴⁵. Further, as argued by Fitzgerald, Schmitz, and Stephens, the analysis of climate action plans alone can be limiting, as some cities aim to integrate equity, social justice, and climate action throughout various planning documents (like Boston and Seattle)⁴⁶. Future research could take a broader scope to consider follow-up reporting and track city progress over time. Other research efforts might conduct in-depth case studies featuring interviews with planners to explain the development, adoption, and implementation process around equity indicators focused on a variety of stakeholders including but not limited to city planners, political actors, activists, non-profits, and academics (for case study examples, see Leichenko, Foster, & Ngyuen³⁶ and Fitzgerald¹). To ensure accountability and replicability, however, we believe that how equity goals are specifically reported and presented in initial plans is of critical importance. This transparency is necessary not just for researchers, but also for community members to effectively participate in local climate governance efforts. With this limitation in mind, our goal is to provide a snapshot of climate equity awareness and equity considerations that can be measured, quantified, or otherwise evaluated.

Table 2. Descriptive Statistics for cities with more than 300,000 population in the U.S.

Statistics	Reviewed cities	Cities with CAP
Number of cities	68	55
Population (<i>n</i> = 68)		
≥1 million	9 (13%)	9 (16%)
500,000 to 999,999	28 (41%)	22 (40%)
300,000 to 500,000	31 (46%)	24 (44%)
Median Household Income (<i>n</i> = 60)		
Above 70,000\$	22 (32%)	20 (36%)
Below 70,000\$	38 (56%)	30 (55%)
People of color (<i>n</i> = 60)		
Above 50%	44 (65%)	37 (67%)
Below 50%	16 (24%)	13 (24%)
GINI Index (<i>n</i> = 62)		
Above 50%	21 (31%)	21 (38%)
Below 50%	41 (60%)	30 (55%)
U.S. Census Region (<i>n</i> = 68)		
Northeast	5 (7%)	5 (9%)
Midwest	12 (18%)	10 (18%)
South	25 (37%)	18 (33%)
West	26 (38%)	22 (40%)
Coastal City (<i>n</i> = 68)		
Yes	22 (32%)	20 (36%)
No	46 (68%)	35 (64%)
Plan Year (<i>n</i> = 68)		
After 2018	–	42 (76%)
Before 2018	–	13 (24%)
Mayor's Political Affiliation (<i>n</i> = 68)		
Democratic	–	44 (80%)
Republican	–	8 (15%)
Independent	–	3 (5%)
Climate City Network Member (<i>n</i> = 68)		
Yes	44 (65%)	40 (73%)
No	24 (35%)	15 (27%)

Notes: Median household income reflects 2021 inflation-adjusted dollars in the past 12 months. The cutoff point for the summary table is determined based-on national median household income for the same year⁵⁰. People of color variable indicates the percentage of the population who did not identify as "White alone, not Hispanic or Latino" in the American Community Survey estimates. Mayor's political affiliation variable is coded based on each city's most recent CAP publication time. Climate City Network Member information is gathered from two major city networks that focus on climate action at the urban scale—ICLEI and C40.

As we center the importance of equity in policy design and evaluation in the context of climate change, we recognize that there is no single interpretation of equity or 'right' way to design equitable policy. In practice, one policy may be supported for its impact on equity by one group and rejected for inequity by another⁴⁷. For example, in the five types of equity we identified in plan indicators, notions of equity around disability or age are notably absent from plans, a gap noted by other scholarship⁴⁸. It is for this reason that we recommend transparency around equity goals in CAPs and other similar policy documents. We evaluate CAPs for quantifiable equity measures, but caution that additional data and detail do not inherently make policies more or less equitable, and many equity outcomes cannot readily be evaluated through numeric data. Qualitative evaluations of equity outcomes

of policies may often be more appropriate in specific contexts, and we suggest that these evaluations are deeply informed by the groups and communities disproportionately impacted by social and environmental pressures in particular places.

To better understand how cities in the United States grapple with inequality in climate planning, we conduct a thematic analysis of CAPs in large cities. Through this analysis, we highlight equity goals as they relate to ten thematic areas, six outcomes, and five dimensions of equity. We suggest cities interested in creating robust climate action plans that address equity adopt measurable indicators to benchmark progress and further involve affected groups in the planning process.

METHODS

Sampling and data collection

Our methodology targets the 68 most populous cities (see Supplementary Table 2) with populations greater than 300,000 in the U.S.⁴⁹. We collected these cities' most recent climate change plans through publicly available municipal websites. As of March 2023, 55 out of 68 cities have a publicly available comparable climate action plan focusing on targeted mitigation and adaptation actions (e.g., energy, sustainability, or sea-level rise). Table 2 summarizes the demographic, geographical, political, and socio-economic diversity of these cities.

Fifty-five cities included in the final selection cover about 15 percent of all population in the U.S.⁵⁰. All nine cities with over 1 million residents have CAPs, whereas 78% and 77% of cities in the next population groups have CAPs, respectively. The median household income is lower than 70,000\$ in most cities (38, 56%). About two-thirds of cities with CAP have more than half of residents identifying as African American, Native American, Asian, Native Hawaiian and Pacific Islander, Hispanic or Latino, some other race, or two or more races (37, 67%). Also, about one-third (21, 31%) of all cities have a GINI score higher than 50%. Interestingly, all these cities have CAPs. Among 41 cities with a GINI score lower than 50%, 30 (73%) had CAPs. Most cities in our study are located in the West (26, 38%) and South (25, 37%) U.S. Census regions. Figure 5 illustrates the geographical distribution of these cities in detail. Most plans we analyzed were published within the last five years (43, 78%). Next, mayoral political affiliations at the time of the most recent CAP seem to be significant, as 44 (80%) out of 55 cities had Democratic mayors published the most recent CAPs in their cities. Finally, a higher percentage of cities that are a member of an international climate network on climate change have CAPs. About 91% of all member cities have CAPs compared to 62% of non-member cities.

Analytical framework

The American Planning Association (2019) published the Planning for Equity Policy Guide. This document aims to outline recommended policy actions that address social equity issues across a range of areas of planning practice. The policy guide includes specific recommendations on integrating equity considerations in topics such as community engagement and empowerment, climate change and resilience, education, health, heritage preservation, housing, and transportation. We adopted this climate equity framework to evaluate the inclusive and community-centered planning processes in the most populated U.S. cities. The climate change and resilience field include six specific recommended policy actions, which we used to code the climate action plans. Additionally, we identified thematic areas through thematic analysis, taking an inductive approach to coding and theme development⁵¹. Here, the themes were the outcome of an analytic process, not the starting point. They were developed through a subjective and interpretive process and resulted from deep familiarization with the reviewed CAPs.

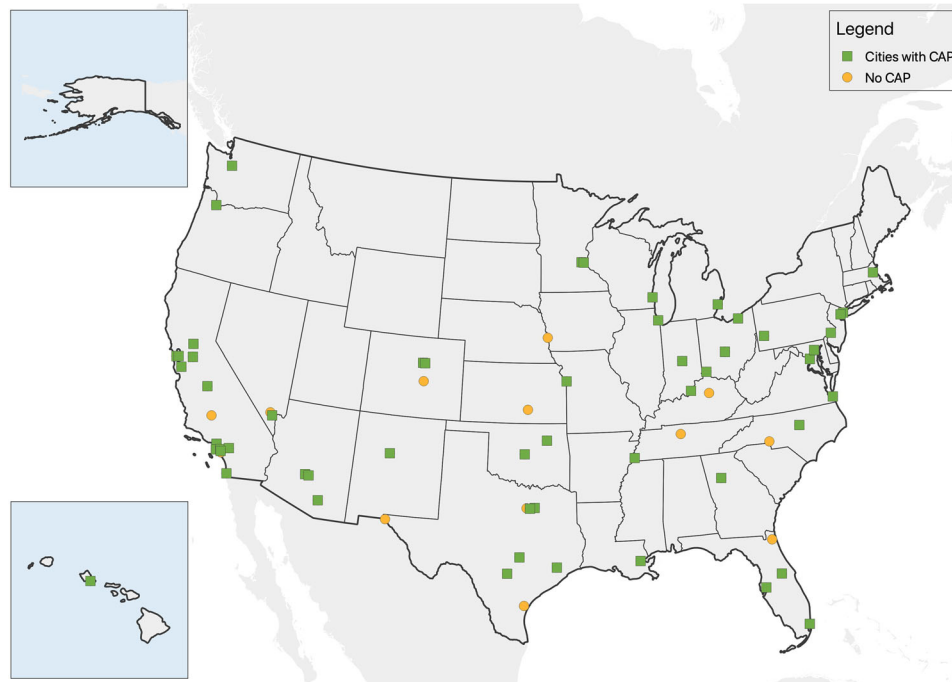


Fig. 5 Geographical distribution of analyzed cities. This map shows the geographical distribution of US cities that we analyzed. Green squares indicate cities with CAPs, yellow circles indicate cities without CAPs.

It should be noted that about half of the planning documents we assessed were prepared and published before the American Planning Association's policy guide. With this limitation in mind, our goal is to provide a snapshot of climate equity awareness and equity considerations that can be measured, quantified, or otherwise evaluated.

Coding

The analysis began with absorbing the content, in which the researchers examined the subset of planning documents to gain an understanding of the content. Upon the initial examination, researchers shared notes to reconcile potential discrepancies that may occur during the coding. Procedurally, the examination of the documents and developing codes were informed by the six policy actions recommended by the American Planning Association (2019). Furthermore, we created additional codes to capture whether the evaluated climate action plans set measurable or quantifiable equity considerations.

We collected cities' most recent climate change plans electronically through publicly available municipal websites. Supplementary Table 3 features the indicators coded independently by two researchers in each plan, whose notes were combined afterward. We also conduct inter-coder reliability testing to ensure the robustness of our results⁵². Supplementary Table 3 also presents Krippendorff's alpha and agreement percentage between the coders⁵³. Krippendorff's alpha provides a statistical measure for agreement for nominal, ordinal, interval, and ratio variables. Our Krippendorff's alpha values range from 0.30 to 0.97, indicating a non-unanimous but positive agreement in the first round of coding. Similarly, the agreement scores range from 85.45% to 98.18%, highlighting agreement for the majority of the plans between the coders. In the next round of coding, a third researcher verified the findings and resolved coding discrepancies. As a result, coding did not only reduce a large amount of qualitative data to readily accessible segments for the analysis but also revealed the best practices and gaps in these plans.

Reporting summary

Further information on research design is available in the Nature Research Reporting Summary linked to this article.

DATA AVAILABILITY

The data used and generated in this study (climate action plans, coding database, city metadata, and socio-demographic data) have been deposited in an open repository: <https://osf.io/xpzgu/>.

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AUTHOR CONTRIBUTIONS

H.C., D.K., and P.K. developed research questions and study design, collected data and coded plans for initial results. H.C. led manuscript preparation and writing with major contributions from D.K. and M.T. M.T. conducted additional analysis of adaptation/mitigation codes. D.K. and M.T. created manuscript figures. D.K. prepared data for sharing to open access repository. All authors read and approved the final manuscript.

COMPETING INTERESTS

The authors declare no competing interests.

ADDITIONAL INFORMATION

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