Evaluating Local Climate Policy: Municipal Action Plans through the Lens of Resilience and Environmental Justice

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In the US, local governments are increasingly crucial in driving climate action. Drawing upon Tang et al. (2010) and Baker et al. (2012), this study assesses nine local climate action plans in the state of Michigan. It introduces a comprehensive framework, integrating climate resilience and environmental justice (EJ) indicators to evaluate plan content. Despite recognizing global climate concerns, qualitative content analysis shows that plans lack localized analyses and actions, hampering planning due to insufficient data, minimal coordination, limited funds, and finite policy options. Key aspects like equitable resource distribution, environmental burdens, and community engagement are often overlooked. Without addressing these, local governments lack the tools to effectively implement just and climate-oriented policies.

Keywords: climate action plan; environmental justice; municipal government; city government; urban climate policy

Introduction

Climate change poses severe challenges to the environment, human and non-human health, economic stability, equity, and the organization of society. As described in the latest report published by the Intergovernmental Panel on Climate Change (IPCC), urgent and robust action must be taken to mitigate the worst effects of global climate change, which is already manifesting disproportionately in marginalized communities around the world (1).

In the last three decades, the global community has come together in an attempt to develop long-term strategies, leading to the establishment of treaties such as the Kyoto Protocol and the Paris Climate Agreement. In addition to collaboration across international borders, increasing attention is being given to scaling efforts across domestic levels of government. In the US, local governments play a crucial role in federal and state climate policies, possessing key decision-making powers over the development of renewable energy projects and investments in sustainable transportation, water, utility, and other energy infrastructure.

Many local governments are pursuing avenues to combat climate change in their communities. Since 2007, more than 1,000 localities have joined the US Conference of Mayors' Climate Protection Agreement, pledging to reduce greenhouse gas emissions in line with the Kyoto Protocol (2). Moreover, upwards of 750 municipalities have signed onto the Climate Mayors Network, which aims to fulfill the commitments agreed upon in the Paris Climate Agreement (3).

To facilitate policy action, pioneering municipalities have begun developing climate action plans, also referred to as sustainability plans. These typically outline specific strategies and targets for reducing greenhouse gas emissions, increasing renewable energy use, improving energy efficiency, and adapting to the impacts of climate change. They are often intended to inform policies that reduce municipal emissions by involving various stakeholders, including businesses, community organizations, and residents. At the local level, their development supports the transition to a low-carbon, climate-resilient future by guiding political decision-making, financial investments, infrastructure projects, and more.

Literature Review

Several studies have evaluated climate action plans in a municipal context. According to Wheeler (2008), first-generation climate plans enacted by cities lacked institutional support, long-term planning direction, and adequate progress measures (4). Others emphasize that first-generation plans were often isolated from other policy areas, limiting their impact on governance (5). To quantify how plans influence local policymaking, Tang et al. (2010) outlined a framework conceptualizing plan quality, focusing on local awareness, analysis, and actions (AAA) to mitigate and adapt to climate impacts (6). Their research shows that while municipalities may be actively conscious of the threats posed by climate change, most have insufficient analytical capacities to elevate these concerns to confront complexities and execute plans that generate substantive changes. Baker et al. (2012) supported this claim through an assessment of local plans against a multi-criteria framework, evaluating the content and quality of the plans (7). In doing so, they found vital structural, procedural, and contextual constraints influencing local adaptation planning, such as failing to consider climate change across multiple departments.

However, this does not preclude municipalities from effectively facilitating climate mitigation and adaptation endeavors. In many cases, success relies upon financial and technical resources. In an analysis of Copenhagen's climate plan, Damsø et al. (2017) determined that the city government was an essential incubator for coordinating efforts between the municipal administration and the local utility provider (8). Consequently, the climate plan receives high marks, particularly for energy supply and emission reduction goals. Furthermore, other studies go beyond qualitative measures, aiming to quantify the impacts of local plans on greenhouse gas (GHG) emissions. For instance, Millard-Ball (2011) concluded that cities with plans successfully implemented strategies to reduce emissions. However, there is not substantial evidence that climate plans themselves play a role in this success; instead, it is likely that the environmental preferences of those living in cities are the most significant factor (9). Additionally, researchers have conducted comparative analyses measuring the emissions impact of policy interventions in cities against business-as-usual (BAU) conditions. Morlet and Keirstead (2013) evaluated the carbon abatement costs of London, Berlin, Copenhagen, and Paris, comparing them against a set of urban and energy governance metrics (10). They ascertained that governmental structure and the elevation of climate-related concerns have a substantial impact on carbon abatement costs and mitigation.

While these studies were critical in assessing the effectiveness and implementation of first-generation plans, they do not touch upon the increasingly relevant issue area of EJ. In recent decades, EJ has become a key climate priority for campaigners, academic researchers, non-profit organizations, and policymakers. Meta-analyses and systematic literature reviews substantiate the stark environmental and socioeconomic injustices that negatively impact Black, Indigenous, and People of Color (BIPOC) communities in the US (11-13). Several scholars believe addressing environmental injustice is essential to achieving an equitable and robust transition toward decarbonization (14-17). Indeed, focusing climate action at all levels of government is essential to uprooting the inequities brought upon by structural and systemic racism (18-20).

Under federalism, municipalities have a significant role to play in determining key EJ outcomes. Although varying by state, local governments have the authority to enforce local

environmental regulations, monitor pollution, and ensure access to clean air and water (21). In addition, local jurisdictions decide upon industry and energy infrastructure placement, zone properties, and shape communities' access to sustainable transportation and green spaces. Historically, these powers have marginalized lower-income communities and people of color, perpetuating racial segregation and discrimination (22-23). Despite this, municipalities can also generate positive outcomes by embracing justice-informed approaches to elevate the concerns and priorities of underserved residents (24-26). Instead of sitting polluting industries in underserved neighborhoods, localities can prioritize a more equitable distribution of industrial facilities, implement stricter pollution control measures, or avoid sitting high-emitting sources altogether.

Across the country, cities are beginning to acknowledge their vital role in advancing EJ. According to a study published by Diezmartínez and Gianotti (2022), 69% of the 100 largest cities in the US with climate action plans have incorporated themes of justice and equity into their policy processes (27). Other entities, including the Biden Administration, further recognize the interplay between federal EJ initiatives and municipal implementation. Both the Inflation Reduction Act of 2022 and the Infrastructure, Investment, and Jobs Act of 2021 pledged billions of dollars to local and tribal governments to expand clean drinking water, remediate polluted sites, and provide localities with financial resources to combat injustices (28-29).

Building upon the critical assessments of first-generation plans and increasing recognition of the alignment between climate action and social justice at a practical level, a new wave of literature has emerged to evaluate climate action plans and their integration with environmental justice considerations. To evaluate the prevalence of equity in local climate action plans, Caggiano et al. (2023) compared equity measures developed by the American Planning Association against indicators ranging across ten thematic areas: including transportation, air quality, energy, green space. They found that less than one third of large US cities with climate action plans include measurable progress indicators, reflecting an incomplete integration of equity into implementation apparatuses (30).

This relates to findings published by Chu and Cannon (2021), who conducted a narrative review of key planning documents from the ten largest cities in the US using equity, inclusion, and

justice indicators. The study revealed that cities exhibit variable approaches to operationalizing equity, inclusion, and justice criteria across four crucial decision-making stages: designing institutional arrangements, participatory practices, policy integration, and strategic implementation processes (31). Equity was discussed in most plans, generally in the form of income inequality rather than other inequalities (e.g., race and gender). While all surveyed plans provided evidence of inclusion in decision-making processes (e.g., collecting resident feedback), there was little evidence of socially accountable decision-making. When justice was mentioned, it was often framed as race and wealth-based vulnerabilities, whereas transformative strategies to address these underlying conditions were not as commonly discussed.

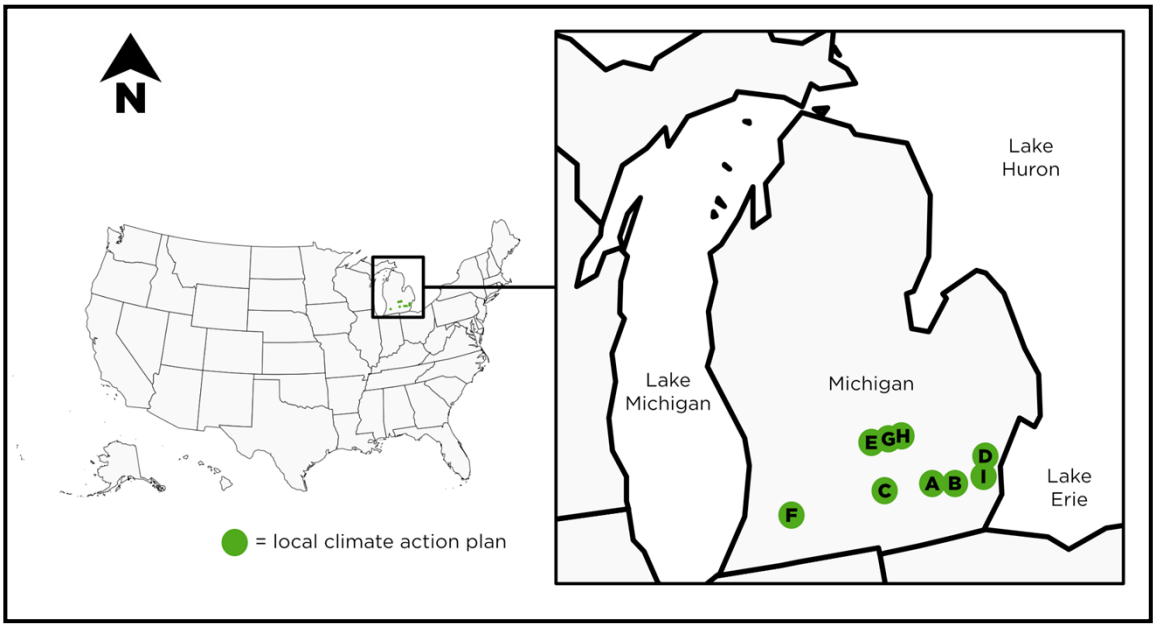
Similarly, Cannon et al. (2023) identified two distinct pathways in which equity-thinking is embedded in the climate adaptation plans of the largest twenty-five US cities (32). The first is referred to as the ideology-driven pathway, where shared beliefs within local actors and public agencies drive adaptation efforts, shaping the definition and implementation of social equity. Meanwhile, the recognition-driven pathway involves cities adopting equitable climate strategies early on, normalizing and reflecting climate equity rhetoric in their adaptation planning procedures.

While there is a growing body of literature scrutinizing the heightened focus on equity and justice in climate action plans, to the best of the authors' knowledge, there has not been an attempt to develop an evaluatory framework that seamlessly integrates well-established themes concerning adaptation and mitigation planning–such as renewable energy, water quality, and municipal solid waste–with EJ considerations. Serving as the inaugural article in a series that explores the intersection of local governance and EJ and building upon work conducted by Tang et al. (2010) and Baker et al. (2012), I outline a combined evaluatory approach which considers climate resilience and EJ. I begin by defining the regional area of interest to provide policy context for Michigan. Then, I outline the methodological components underpinning my evaluation. I conclude with my findings and assess the challenges in integrating EJ into local climate mitigation and adaptation efforts.

Regional Context

Michigan is the eleventh largest state by area, the tenth most populous, and is well-known for its automotive industry, the Great Lakes, forests, and other natural resources. Figure 1 denotes the municipalities in Michigan with community-level climate action plans as of March 2023. The names of the localities are kept anonymous.

Fig 1. Study area.



A changing climate poses severe social, environmental, and economic challenges to Michigan. Global rising temperatures are likely to contribute to rapid changes in Great Lakes water levels (33). This rise in average temperatures is expected to shorten the winter season for sporting activities, thus harming the outdoor recreation industry and adjacent local economies (34-36). Other sectors, such as agriculture and forestry, are expected to face significant stress from climate-induced heatwaves, droughts, soil erosion, and more favorable conditions for pests and pathogens (37-38). Although corn and soybean crops may experience a short-term increase in yield due to increased atmospheric carbon dioxide stimulation, productivity gains will likely decline towards the end of the century due to increased heat stress (38). Commercial fruit trees may benefit from a longer growing season but could face increased pressure from pests and higher sensitivity to cold temperatures after budbreak (38). According to Reich et al. (2022), a temperature increase of fewer than two degrees

Celsius would cause significant problems for tree species and boreal forests more generally, particularly when combined with reduced rainfall (39).

In addition to anthropogenic climate change, Michigan has a long history of environmental disasters that have culminated in injustices unevenly affecting marginalized communities. Most notably, in 2014, the City of Flint switched its water source to the Flint River, leading to the contamination of drinking water with high levels of lead and other pollutants. The crisis disproportionately affected low-income residents and people of color, who have suffered from health risks and the long-term consequences of lead exposure (40-43). Additionally, due to the state's history as an industrial powerhouse, many residents in historic manufacturing and mining areas face exposure to legacy contamination (44-46). As of 2022, there are an estimated 24,000 contaminated sites in the state, mainly due to groundwater and soil pollution (47).

In light of these events, the state government has sought to minimize climate-induced stressors and environmental injustices. In 2020, Executive Order 2020-182 was promulgated, directing the Michigan Department of Environment, Great Lakes, and Energy (EGLE) to develop a state-wide climate action plan (48). Finalized in April 2022, the MI Healthy Climate Plan presents several strategies to conserve natural resources, electrify industry and transportation infrastructure, develop clean energy systems, and commit to EJ (48). Significantly, the plan acknowledges that close cooperation with local and tribal governments is essential for implementing state-wide goals surrounding EJ. As a result, the state of Michigan has been chosen as a compelling case study to delve into the pivotal relationship between local government and the advancement of EJ.

Methodology

A report published by the Michigan Climate Action Network (MiCAN) served as a starting point to identify municipalities with local climate plans (49). According to the report, sixteen municipalities in the state had climate action policies and renewable energy goals as of 2022. This included five climate action plans, as well as numerous climate-related city council resolutions, master plans, municipal utility plans, and local ordinances. For this analysis, I defined community-level climate action plans as policy tools that outline specific actions or strategies to adapt to and

mitigate climate-induced risks at a municipal scale. It is important to note that such plans explicitly exclude actions targeting municipal operations and focus solely on broader initiatives concerning the community as a whole. Moreover, "sustainability" or "environmental action plans" were considered to be synonymous with climate action plans, unless they did not specifically focus on climate risks.

To corroborate the findings of the MiCAN report, I conducted an additional search among the 1,773 localities in Michigan, descending in order based on population. I utilized various sources, including municipal websites, online news platforms, and local ordinances to gather relevant data. This relieved four additional local climate action plans, bringing the total to nine. Upon identifying the plans, I modified the approaches developed by Tang et al. (2010) and Baker et al. (2012) to evaluate the presence of climate resiliency and EJ within the plans through qualitative content analysis.

Outcome Criteria

This study evaluated thirteen outcome criteria related to climate resilience and EJ against two evaluative categories: overall progress and plan quality (Table 1). As in Baker et al. (2012), outcome criteria reflect the ideal outcomes plans should strive to achieve through assessing issues and implementing climate policies at the local level. These criteria can be divided into eight key topics: water, air, energy, transportation, weather, ecosystems, solid waste, and EJ. They differ from the ones used by Baker et al. (2012), who curated them for different ecological, geographic, and policy contexts. Additionally, Baker et al. (2012) did not include criteria for EJ or equity considerations.

Table 1. Outcome criteria for evaluating local climate plans.

Topic	**Outcome Criteria**
Water	C1. Improved water quantity and quality.
Air	C2. Improved air quality.
	C3. Reduced GHG and other gaseous emissions.

Energy	C4. Increased utilization of clean energy.
	C5. Reduced energy use through efficiency savings.
Transportation	C6. Improved access to sustainable transportation.
	C7. Enhanced opportunities for human-powered transportation.
Weather	C8. Improved resiliency towards extreme weather events.
Ecosystems	C9. Expanded green space and urban forests.
	C10. Improved genetic, species, and ecosystem diversity.
Solid Waste	C11. Expanding recycling, reuse, and other programs leads to a decrease in municipal waste.
Environmental Justice	C12. Increased community involvement in environmental decision-making.
	C13. Establishment of an equitable distribution of environmental resources, benefits, and costs.

Evaluation Categories

Outcome criteria were evaluated against two evaluation categories: overall progress and plan quality. The awareness-analysis-action (AAA) framework proposed by Tang et al. (2010) informs the assessment of overall progress. In this case, *awareness* refers to acknowledging the causes and consequences of climate change. *Analysis* involves interrogating and synthesizing relevant information, while *action* focuses on the application of this data to develop policies.

Meanwhile, plan quality determines the ability to describe, localize, and build policy upon climate resiliency and EJ concepts. Importantly, this is not focused on actions taken after a plan is completed, but rather on how the plan is situated to set policy actions up for success. It emphasizes the need for the plan to be implementable, adaptable, and responsive to changing circumstances, with

a well-crafted plan not only outlines strategies but also anticipating potential challenges, incorporating stakeholder input, and establishing a framework that can withstand evolving conditions. The five plan quality components established by Baker et al. (2012) are utilized: information base; vision, goals, and objectives; options and priorities; actions; and implementation, monitoring, and evaluation. Table 2 describes these components in further detail.

Table 2. Plan quality components.

Plan Components	**Description**
Information base	Discussion of current and future conditions (e.g., ecological, environmental, economic, social, agricultural) influenced by climate change. Includes data and analysis of local assets and natural resources, identification of non-climate determinants of vulnerability, or vulnerability and risk assessments.
Vision, goals, and objectives	The long-term vision of how the community will adapt to and mitigate climate impacts, including the statement of quantifiable objectives and targets aimed at conserving and equitably distributing resources in a climate-stressed world.
Options and priorities	Development, consideration, assessment, and prioritization of alternative climate solutions. Includes opportunities for public engagement and stakeholder considerations.
Actions	Principles to guide land use decisions, energy investments, infrastructure projects, and more to achieve goals. Includes policies or strategies for implementation.

Implementation, monitoring, and evaluation	Resources and personnel directed to achieve successful plan implementation, monitoring, and evaluation commitments. Includes the development of a holistic, integrated climate approach aimed at connecting different policy areas (e.g., transportation, planning, parks, and recreation) and data reporting mechanisms.

Coding System

The coding system assigned values to the evaluation categories, assessing the extent of the outcome criteria present. Each criterion was compared against these categories, with the juxtaposition quantified on a five-point scale (Table 3).

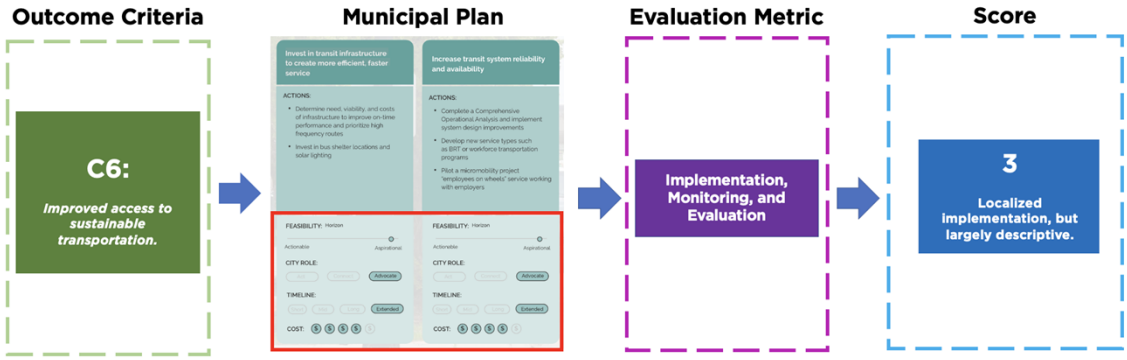
Table 3. Coding system for evaluation

Score	**Description**
0	No mention of outcome criterion in the plan.
1	Outcome criterion is mentioned, but with little to no detail.
2	Outcome criterion is mentioned and includes a description with moderate detail.
3	Outcome criterion is mentioned and includes a limited level of locally specific application. However, it is still primarily descriptive.
4	A detailed analysis of the outcome criterion is provided, and it is addressed in a locally specific manner using a variety of tools such as vulnerability, exposure or risk assessments, maps, fieldwork, GIS analysis, and local climate scenario modeling.

Figure 2 visualizes the operationalization of the coding system. In this example, sustainable transportation (C6) was selected as the outcome criteria (in green). The local climate plan pictured

was then consulted to find any elements related to achieving access to sustainable transportation systems. Once identified (in red), this was compared against a relevant evaluation component, in this case, implementation, monitoring, and evaluation (in purple). Because this plan accounted for feasibility, the role of the city, timeline, costs, and other implementation metrics in a localized fashion, yet lacked quantitative measures, a score of 3 was awarded (in blue). For each plan and outcome criteria, this process was carried out, focusing on the two evaluation categories described above.

Fig 2. Example of the coding system.



The highest possible score for each AAA category and plan quality component was 52 (i.e., thirteen outcome criteria, with a maximum score of 4). The high possible score for overall progress was 156 (i.e., 52 multiplied by the number of AAA categories), while the highest possible score for overall plan quality was 260 (i.e., 52 multiplied by the number of plan quality components). Meanwhile, the highest possible score for an individual criterion was 32 (i.e., eight evaluation metrics, with a maximum score of 4). Results are displayed as a percentage of the highest possible score. Any portion of the total possible score at or below 50% indicates that, on average, the related outcome criteria received a score of 2 or less. In this scenario, the outcome criterion has not been sufficiently localized to a municipal context for the specific evaluation category.

Limitations

There is an unavoidable level of subjectivity underpinning the coding system, as established by Baker et al. (2012). Qualitative coding involves interpretation on behalf of the coder, which can

introduce subjectivity into the analysis. To minimize bias, a rigorous approach was adopted. Each plan was reviewed twice in random order by both the primary author and an undergraduate research assistant, providing an opportunity to cross-reference initial coding decisions. This iterative process allowed for self-correction and the identification of any inconsistencies. By employing this method, the aim was to enhance the reliability and validity of the coding process and minimize potential errors or individual preferences.

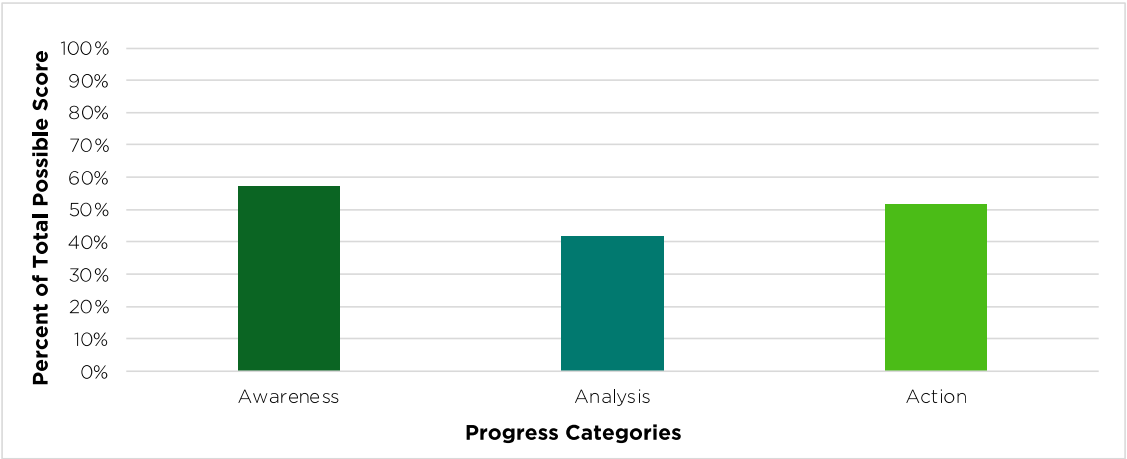
Due to a limited number of plans (n = 9), was difficult to make statistical inferences or draw general conclusions. Statistical tests, such as t-tests, require larger sample sizes to yield meaningful results and detect statistically significant differences between groups. Therefore, alternative analytical approaches, such as qualitative comparisons and descriptive analyses, were employed to explore and interpret the data. This study does not aim to be generalizable to other US states or the country as a whole. Instead, its primary objective is to showcase the practical implementation of the evaluatory framework and the specific results it yields within the context of the state of Michigan.

Results

Overall Progress

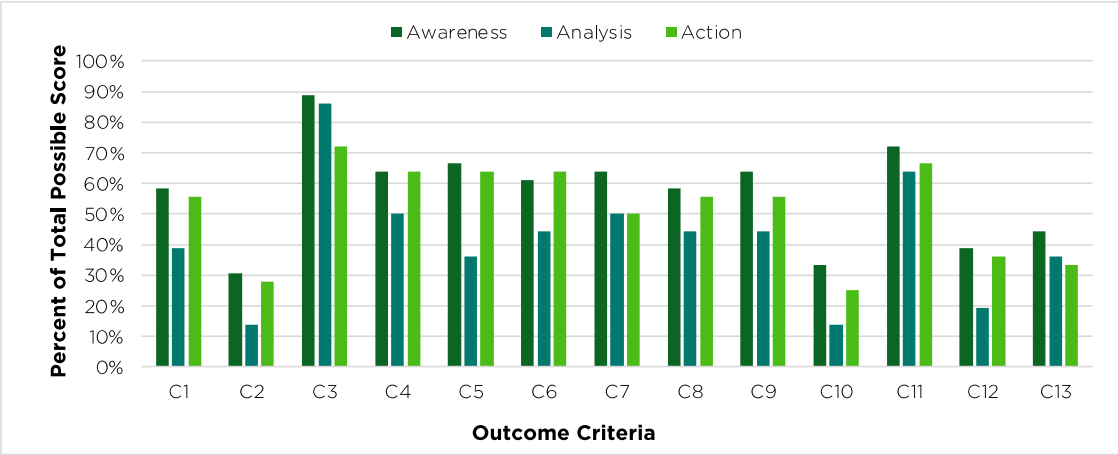
Awareness, analysis, and action categories gauged progress toward climate resiliency and EJ in localities. Among the nine plans considered, the awareness category received the highest score (57% of the total possible), while the other two categories received 42% and 51%, respectively (Fig 3).

Fig 3. Overall progress for all outcome criteria within evaluated plans.



Among all the outcome criteria, awareness scores consistently surpassed or equaled the scores for analysis or action, with the exception of sustainable transportation (C6). Emissions reductions (C3) received the highest awareness score, while procedural justice (C12), distributive justice (C13), biodiversity (C10), and clean air co-benefits (C2) ranked the lowest, underscoring a comparatively lesser degree of attention allocated to these specific topics (Fig 4).

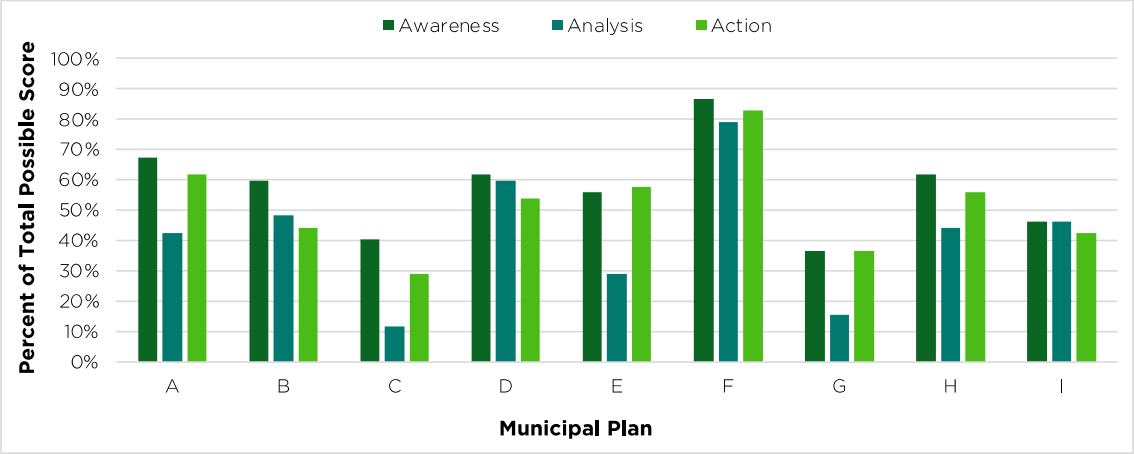
Fig 4. Overall progress in relation to outcome criteria.



In the context of this study, climate action plans that received higher rankings exhibited a notable practice of explicitly linking each addressed topic to climate-induced risks. In contrast, lower-ranking plans demonstrated a lesser degree of emphasis on establishing this explicit connection between the various topics and the risks induced by climate change. Emissions reductions (C3) and biodiversity (C10) received the worst scores within the analysis and action sections, followed by procedural (C12) and distributive justice (C13) (Fig 4). Notably, all outcome criteria received an analysis score of less than 50%, which heavily contrasts the scores given to awareness and action (Fig 4).

Among the nine municipal plans considered, Plan C had the lowest awareness score (12%) (Fig 5). In contrast, Plan G had the smallest analysis (15%) and action (37%) scores (Fig 5). Two plans, Plan D and Plan F, had scores above 50% for each progress category (Fig 5).

Fig 5. Overall progress scores per municipal plan.

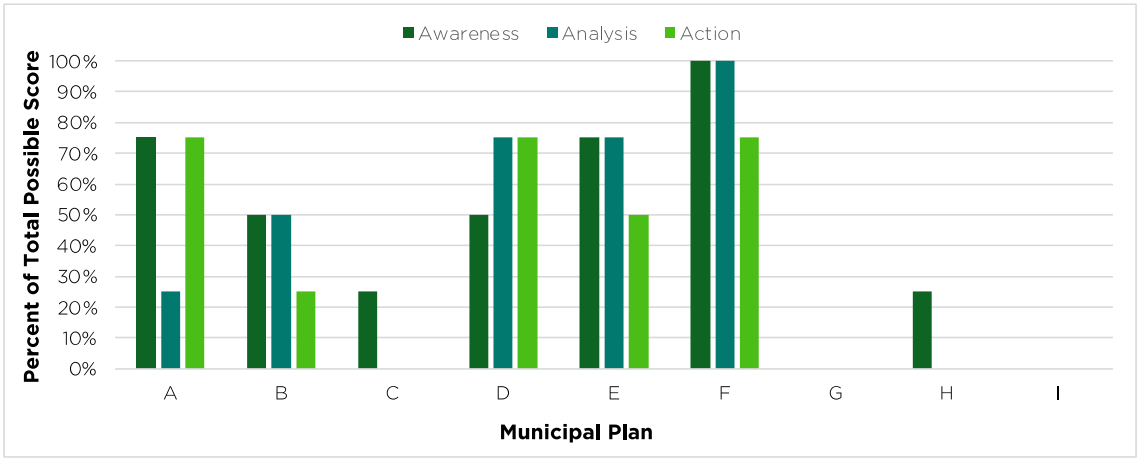


The evaluation results indicate a notable strength among the assessed plans in identifying climate-related issues. However, there appears to be a relative weakness in terms of their analytical depth and the proposal of comprehensive policies to effectively mitigate these identified issues. In essence, while the plans demonstrated proficiency in recognizing climate-induced challenges, they were comparatively less adept at formulating robust strategies for addressing and mitigating these issues. This may arise from limited technical or financial resources to conduct comprehensive analyses or develop policy recommendations. It could also reflect local governments' capabilities and perspectives toward climate action plans, as municipalities with limited analytical capacitates often frame action in terms of outlining future research. For example, Plan C listed, "investigat[ing] and evaluat[ing] alternative models for city water access" without the inclusion of policy recommendation for improving water quantity and quality (C1). On the other hand, municipalities that have already conducted analyses describe action in concrete policy terms. This is demonstrated in Plan F, which outlined "piloting micro-mobility projects' employees on wheels' service working with employers" to achieve more human-powered transportation (C7).

While a majority (56%) of municipalities included the results of GHG inventories in their plans, very few conducted other analyses (Fig 5). Notable exceptions were plans that evaluated tree canopy cover and urban heating, as well as flooding zones, walking and transportation mobility, and ease of access to green spaces.

Municipal plan scores varied widely for procedural justice (C12) and distributive justice (C13) outcomes. Figure 6 provides a visual representation of the aggregated awareness, analysis, and action scores attributed to procedural justice (C12) and distributive justice (C13) within the context of an integrated EJ framework. Plan C, Plan G, Plan H, and Plan I exhibited minimal to negligible awareness of EJ principles. Moreover, these plans demonstrated a dearth of analytical consideration concerning factors related to equity. Additionally, they were found to inadequately propose policy actions aimed at addressing community-engaged governance and equitable resource distribution. For instance, Plan C stated that the local government "recognize[d] that… we do not face environment challenges equally," but failed to expand upon this message with meaningful analysis or policy priorities. Phrases similar to the one mentioned often lack strategic language that emphasizes rigorous analysis or actionable steps, a trend that is also observed in other topics like the reduction of greenhouse gas (GHG) emissions.

Fig 6. Overall progress associated with EJ outcome criteria.



Out of the evaluated plans, a significant 78% of them made mention of either procedural justice (C12) or distributive justice (C13). However, it is noteworthy that Plan F stood apart as the sole plan that received scores above 50% for all three progress categories (Fig 6). While Plan A, Plan B, and Plan D, and Plan E acknowledged EJ, they lack descriptive analysis or action. For instance, Plan A emphasized that it "is grounded in justice and equity" and integrates an equity impact component to each policy action it proposes. Further, Plan A had a section dedicated to advancing

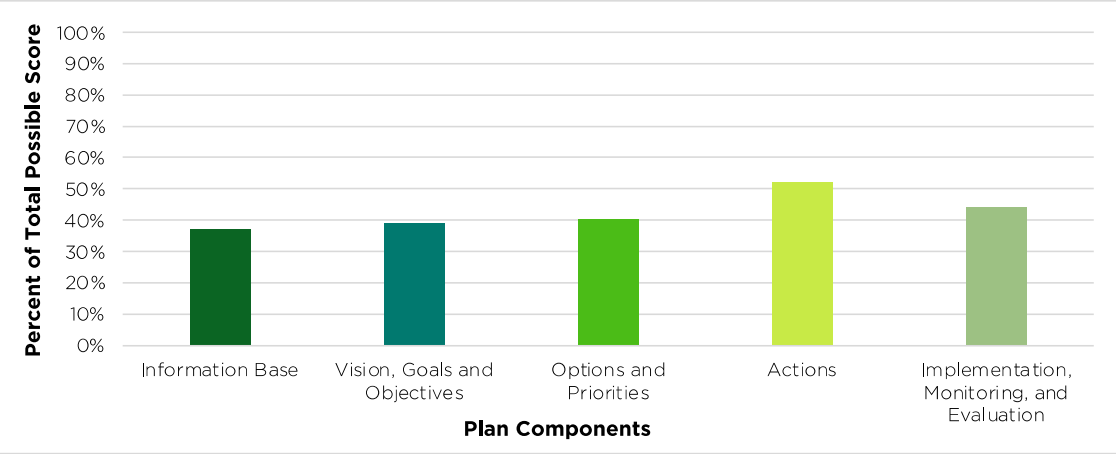
equity programming, but did not analyze equity conditions, such as access to clean drinking water among marginalized community members.

Moreover, Plan C and Plan H espoused awareness without substantive analysis of proposed policy actions. Plan C notably encompassed a well-defined account of EJ encompassing its historical context and relevance to climate change but did not include any commentary on the specific local conditions or proposed policies to effectively mitigate existing inequities. Plan H simply mentioned that equal access should be a goal when considering transportation infrastructure, without providing further detail.

Plan Quality

Plan quality was assessed based on how well outcome criteria were reflected within the five plan components. Among these, only the action component scored above 50% (Fig 7). The least-ranked component was information base (37%), followed by vision, goals, and objectives (39%), options and priorities (40%), and implementation, monitoring, and evaluation (44%) (Fig 7).

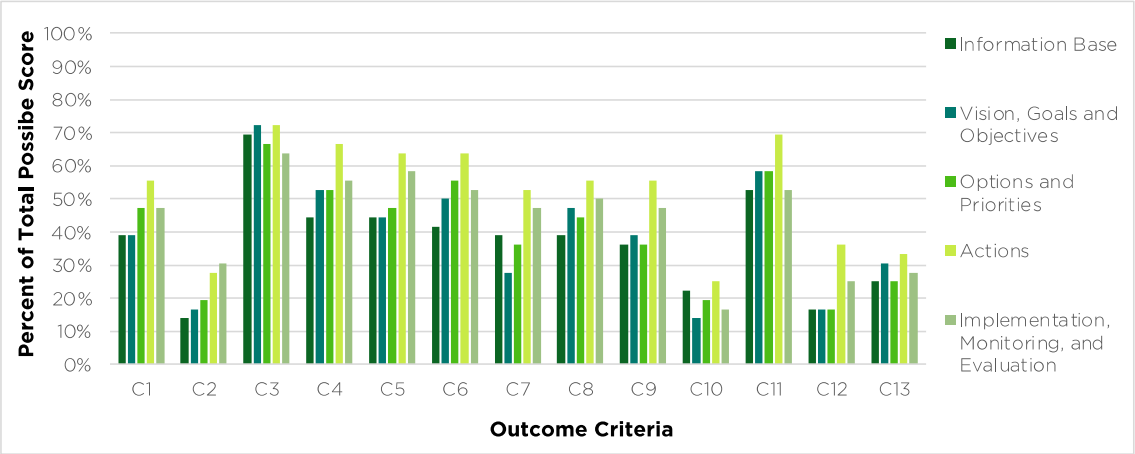
Fig 7. Plan quality for all outcome criteria within evaluated plans.



Emissions reductions (C3) ranked the highest for all five plan components (Fig 8). Meanwhile, procedural justice (C12), distributive justice (C13), biodiversity (C10), and clean air co-benefits (C2) ranked the lowest (Fig 8). Overall, outcome criteria (except for human-powered transport (C7) and biodiversity (C10)) scored the least within the information base component (Fig 8). Notably, emission reductions (C3) and municipal waste (C11) were the only outcome criteria to

365 achieve 50% among all five components, indicating that the other outcome criteria were lacking
366 sufficient localization.

367 Fig 8. Plan quality in relation to outcome criteria.



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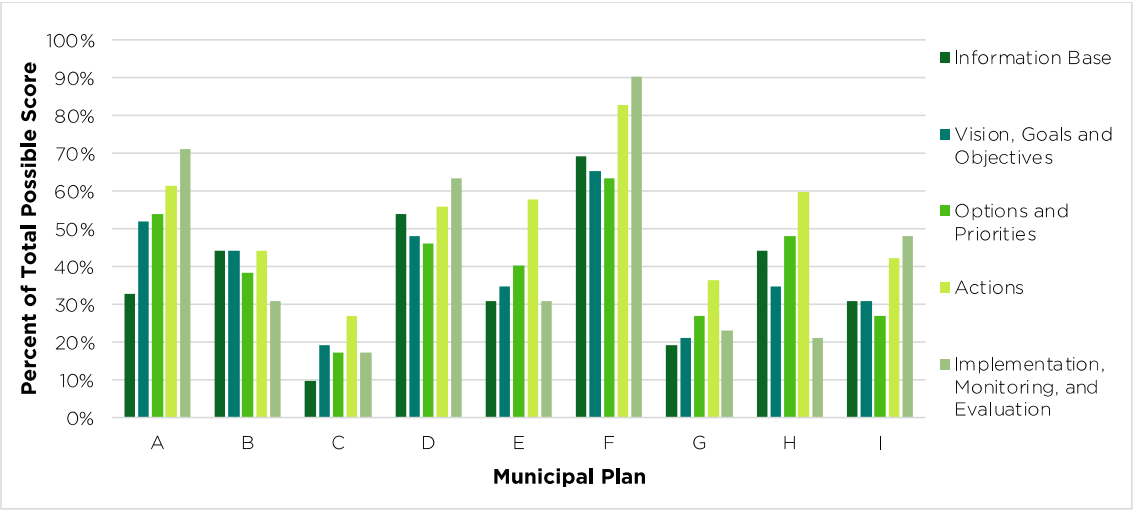
369 Among the plan quality components, the information base ranked the lowest, apart from the
370 scores for Plan D, Plan F, and Plan H (Fig 9). In most cases, the plan information base consisted of
371 descriptive statements about current conditions, rather than focusing on future implications in a
372 process guided by localized, quantitative projections. Consistently, the information base for each
373 outcome criteria relied on generic global impacts rather than specific information within the local
374 jurisdiction.

375 Fig 9. Plan quality scores per municipal plan.



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For instance, when commenting on the significance of reducing GHG emissions, Plan C stated that the "IPCC 2018 Special Report recommends that to mitigate climate change and to keep the world under 1.5 degrees Celsius, carbon dioxide emissions need to be reduced by 45% by 2030 and should reach net-zero by 2050." This is contrasted by Plan E, which included a municipal GHG inventory to identify the sources and sectors that contribute the most to emissions. Although seven out of the nine plans assessed included summary figures or referenced the results of GHG inventories, several were outdated and only reflected emissions derived from municipal actions. Leveraging localized outputs such as an up-to-date community-level GHG inventory, it is possible to aid policymakers in effectively prioritizing and targeting mitigation efforts toward the most substantial emission sources.

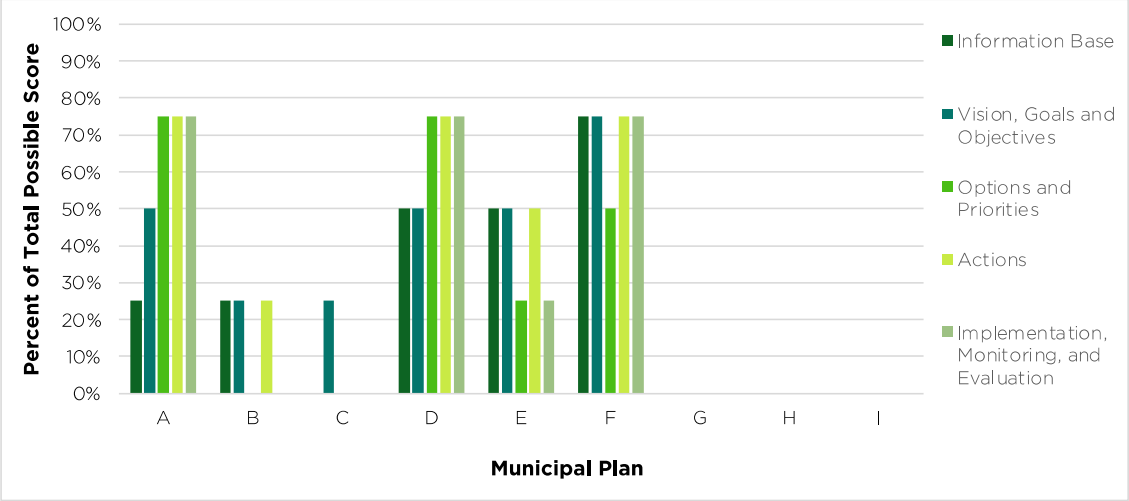
Visioning statements and objectives varied among plans, with some municipalities outlining specific visions tailored for local conditions. Plan F adeptly integrated the city's strategic vision, aligning policy proposals with core elements such as environmental responsibility and economic vitality. Conversely, several other plans merely expressed the need to "adapt to climate change" or "respond equitably" without considering the distinctive municipal context. Similarly, options and priorities were handled differently across the plans. While some local plans presented multiple alternative solutions to achieve a specific objective, others offered only one policy fix. demonstrated a comprehensive approach by proposing various options to expedite electrification, such as incentives for all-electric new construction projects, synergizing rooftop solar energy, and education campaigns. On the contrary, Plan H solely suggested an educational awareness drive as a solution to encourage residential uptake in the same topic. Because climate change is a complex and multifaceted issue, presenting alternative strategies is crucial for a flexible and adaptive approach, enhancing plan resilience in the face of potential political, economic, or technological shifts.

In the overall analysis, it was evident that the plans encompassed in this study were deficient in providing sufficient details for the implementation, monitoring, and evaluation of the proposed policies. Specifically, there was a lack of critical elements, such as the identification of key stakeholders, delineation of responsible government divisions, allocation of funding, and

404 establishment of timelines to guide the execution and assessment of the proposed initiatives. This
405 inadequacy in comprehensive planning hinders the effective operationalization and evaluation of the
406 policies outlined within the plans. When implementers are unable to act effectively, the overall impact
407 of a plan diminishes, possibly resulting in public resistance, insufficient support, or uninformed
408 decision-making. Furthermore, without identifying responsible government divisions, there may be
409 confusion about roles, responsibilities, and the allocation of resources. For plans that preclude funding
410 information and an implementation timeline, there may be a lack of accountability, indefinite delays,
411 and policy abandonment. In total, four plans outlined which divisions of local government would
412 implement given policies, while two plans went further by identifying funding measures and costs.
413 Out of these two plans, one outlined cost in relative terms (e.g., ranking scale), while the other
414 provided specific estimates in dollar amounts.

415 The plan quality scores for procedural justice (C12) and distributive justice (C13) had a range
416 of outcomes, as illustrated in Figure 10. Plan F and Plan D were the only plans with scores equal to or
417 greater than 50% for all five components (Fig 10). Plan A narrowly failed to meet this threshold, with
418 its score for information base falling below 50% (Fig 10). Conversely, the remaining plans garnered
419 limited rankings, with Plan G, Plan H, and Plan I lacking any plan quality components meeting the
420 established criteria (Fig 10). Meanwhile, Plan B had two components missing, while Plan C had four
421 absent (Fig 10).

422 Fig 10. Plan quality associated with EJ outcome criteria.



423

The information base for EJ among plans was largely generic, consistent with the broader trend observed across other outcome criteria. Plan A defined equity as "ensuing everyone gets what they need to succeed based on where they are and where they need to go," but did not go into detail about current and future conditions impacted by climate change. On the other hand, Plan F presented quantitative data on energy burdens, tree equity scores, risk of lead poising, and flood resiliency. As a result, the information base in Plan F offered a greater understanding of equity and justice issues, in turn making the plan more actionable.

Among the six plans with visioning statements for EJ, scores ranged from 25% to 75% (Fig 10). Lower ranking plans emphasized the importance of incorporating EJ into governance and municipal operations, without stressing how equity and justice conditions could be obtainable in a local setting. Plan B, which scored 25%, emphasized that the municipality "understands that its populations of people of color and low-income households are more vulnerable to both the physical and social impacts of climate change," stating that "every attempt should be made to dismantle them or to minimize actual and potential harm" through the execution of the plan. The highest-scoring plan, Plan F, demonstrated a notable commitment to equity principles by dedicating a dedicated section specifically outlining key tenets such as shared prosperity, accountability, accessibility, and interconnectedness. In a further display of comprehensive planning, Plan F proceeded to provide a detailed breakdown of how each equity theme was effectively fulfilled through the incorporation of corresponding goals, strategies, and specific actions outlined within the plan. In doing so, Plan F provided a vision for how EJ can be integrated into a governance framework and addressed with policy action at the local level.

Fewer than a majority (44%) of plans presented alternative EJ options and priorities. Among those that did, several policies were presented to address procedural (C12) and distributive justice (C13) concerns. Plan A outlined all strategies and goals from an equity impact perspective, while Plan D established alternative procedures related to equity. These included promoting diversity, equity, and inclusion initiatives, redesigning transit routes to address injustices, and promoting a livable wage.

Conversely, Plan E focused on a smaller set of initiatives to contribute to EJ, such as developing an equity toolkit and workforce training.

Out of the plans evaluated, the action component achieved the highest score for EJ plan quality. Plan A, Plan D, and Plan F scored 75%, as each presented descriptive and localized policies to address procedural (C12) and distributive justice (C13). An illustrative example is found in Plan F, where a community solar project pilot is proposed to address energy injustices and affordability concerns by employing a municipal-specific equity guide. Plan B, the lowest scoring plan, did not consider the local context when detailing how the municipal government would add an equity-focused component to street tree placement and planning.

The implementation, monitoring, and evaluation component was observed in merely four out of the nine plans assessed, thereby signifying the potential for substantive enhancements generally. Plans A, D, and F outlined critical steps such as identifying the responsible governmental unit, exploring funding options, and establishing clear implementation timelines. Meanwhile, Plan E acknowledged the necessity of a "workable funding strategy" for executing climate resiliency and EJ policies, albeit without specifying potential funding sources. Additionally, this plan lacked the incorporation of precise timelines and responsible units, thereby leaving room for further enhancement in terms of implementation clarity and accountability.

Takeaways

The findings indicate that municipalities which develop climate action plans generally possess a degree of awareness regarding the challenges presented or intensified by climate change. However, this awareness is not always adequately tailored to the specific local context, and there may be room for improvement in this regard. In Michigan, localities with climate plan have demonstrated a commitment to climate action that extends beyond others. Out of the state's 1,773 municipalities, less than 10% have plans. Further research is needed, particularly in the US context, to understand why some cities and townships choose to develop climate action plans while others do not.

Although striving to develop a climate roadmap fit for a specific community, most plans (56%) struggled to adequately localize efforts, possibly due to a lack of capacity as demonstrated by

Tang et al. (2010) and Baker et al. (2012). Instead, most relied upon global and national assessments. Additionally, this analysis relieved that most local plans only focus on a select number of issue areas. GHG emission reductions, solid waste, and energy systems received the most attention from plans, while they largely clear air, biodiversity, and EJ impacts. By neglecting to establish the connections between these topics and EJ perspectives, integrating justice and equity concerns into local plans may be challenging. Unless the individuals responsible for creating a plan are willing to actively advocate for including distributive and procedural justice principles beyond a passing mention, other topics will likely receive higher priority and attention.

Most plans lacked solid information bases to understand both present and future climate change conditions. Three plans had adequate implementation, monitoring, and evaluation metrics, with scores at or above 50%. However, a majority (66%) did not focus on these elements in detail. Even among the plans with metrics, they generally did not outline specifics, such as funding sources and costs. Among the nine municipalities subject to evaluation, a significant proportion of five exhibited minimal or negligible efforts to address crucial aspects of equity, participatory governance, and the equitable distribution of burdens. However, among those that did endeavor to tackle these considerations, merely three demonstrated substantial progress in effectively localizing EJ issues. The remaining municipalities fell short of meeting the 50% threshold, signifying the need for further advancements.

Conclusion

With the environmental, societal, economic, and political challenges posed by climate change, in combination with local governments' vital role in regulating and implementing environmental policy, local mitigation and adaptation approaches must be considered. In the US, climate action plans have become salient among pioneering municipalities. For local governments to propose, design, and implement effective policies, institutional capacity and support are required. Resources, like staffing personnel and fiscal support, will be crucial to developing plans beyond general global recognition. Without localization, it is challenging to create meaningful and actionable policy change, as the impacts of climate change vary widely across different regions and

communities. Most crucially, local governments are unique position to understand the vulnerabilities and opportunities within their communities and can tailor policies and strategies to meet their specific needs.

Thus, it is imperative for localities to go beyond their current efforts and actively engage with EJ principles while drafting climate plans. With support from state and federal partners, municipal governments are well-positioned. Relying upon their designated powers, such as zoning and planning controls, localities can pursue strategies to ensure the equitable distribution of environmental benefits and burdens across communities, preventing low-income and marginalized communities from bearing the brunt of the negative impacts of climate change.

Data Availability Statement

The data supporting the findings of this research are openly available and can be accessed through the public repository on Figshare (https://doi.org/10.6084/m9.figshare.25321282). The dataset is released under the Creative Commons Attribution 4.0 International License (CC BY 4.0), allowing for the unrestricted use, distribution, and reproduction of the data in any medium, provided the original work is properly cited. This commitment to open data aligns with the principles of transparency and reproducibility, fostering collaboration and enabling researchers, policymakers, and the public to engage with and validate the results presented in the manuscript.

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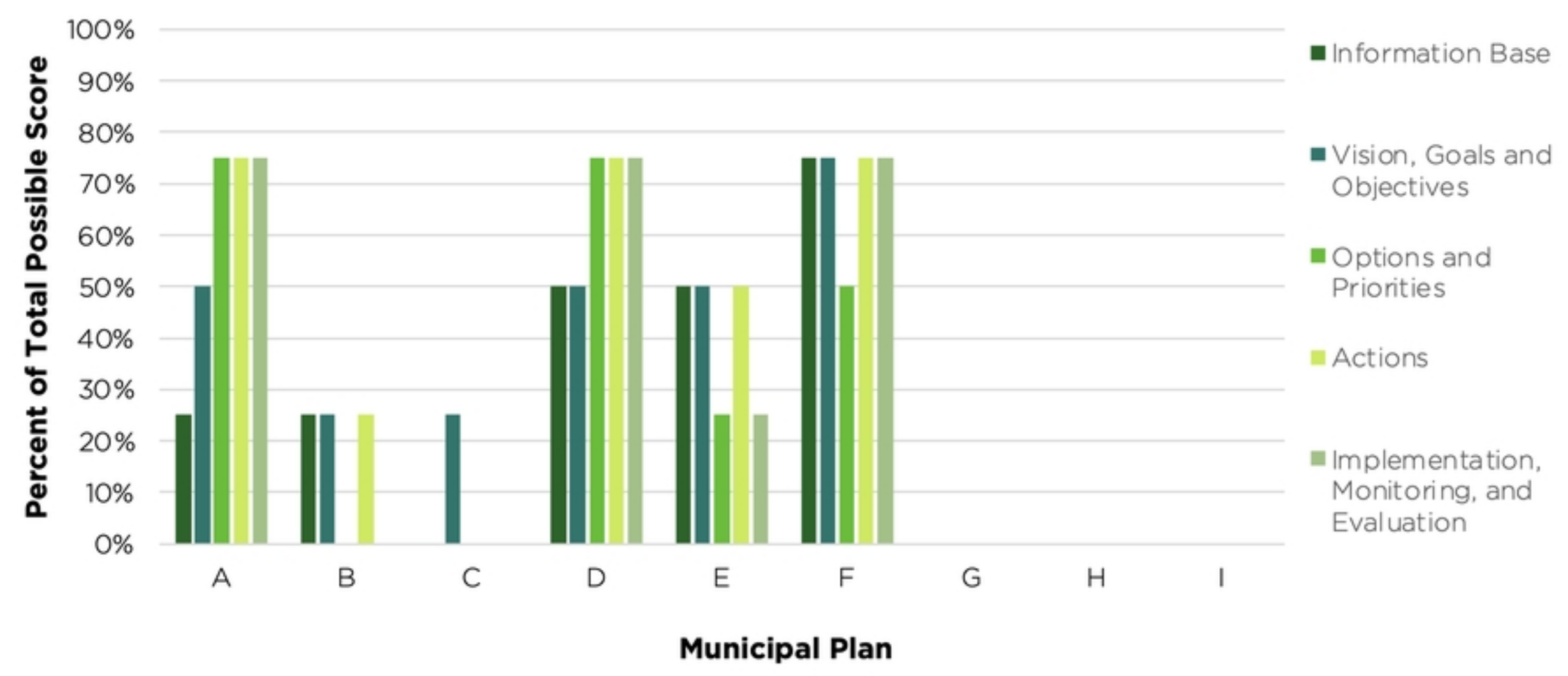
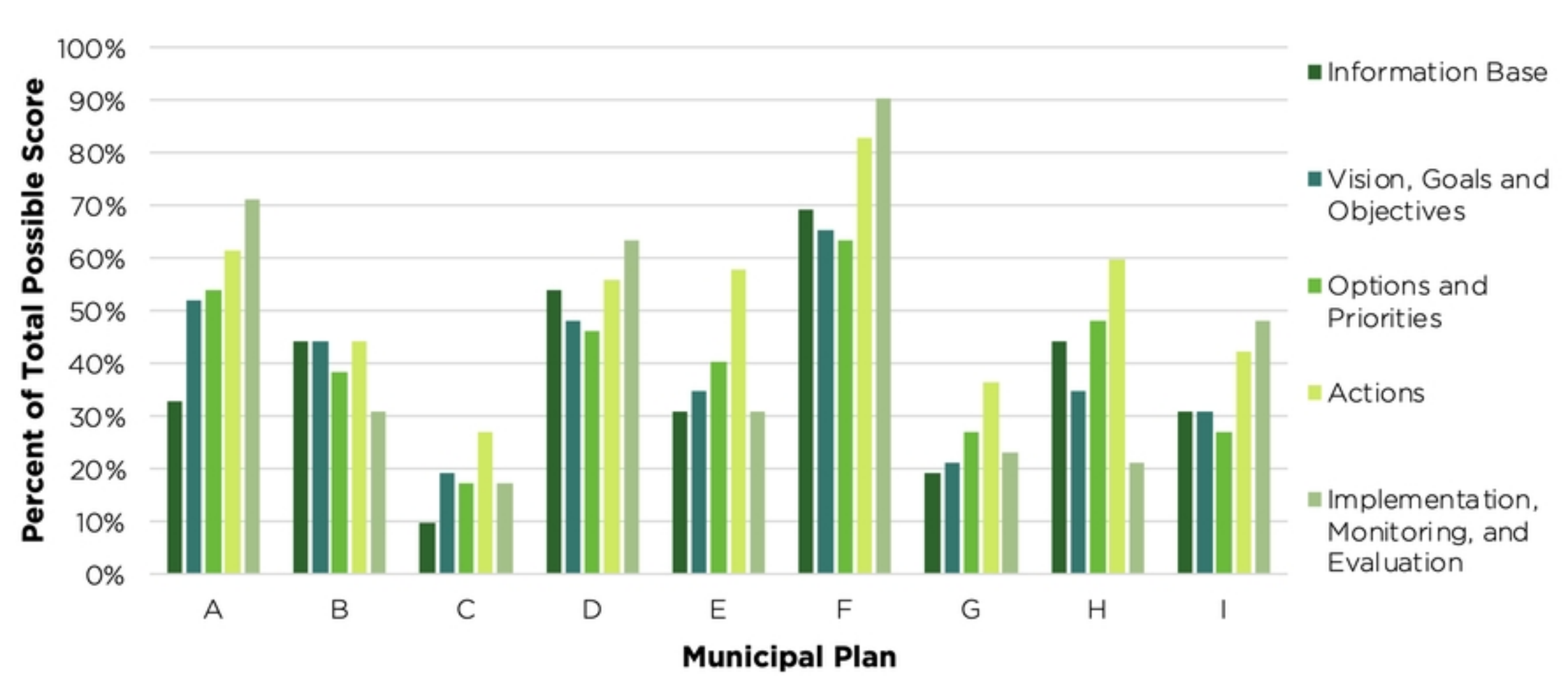
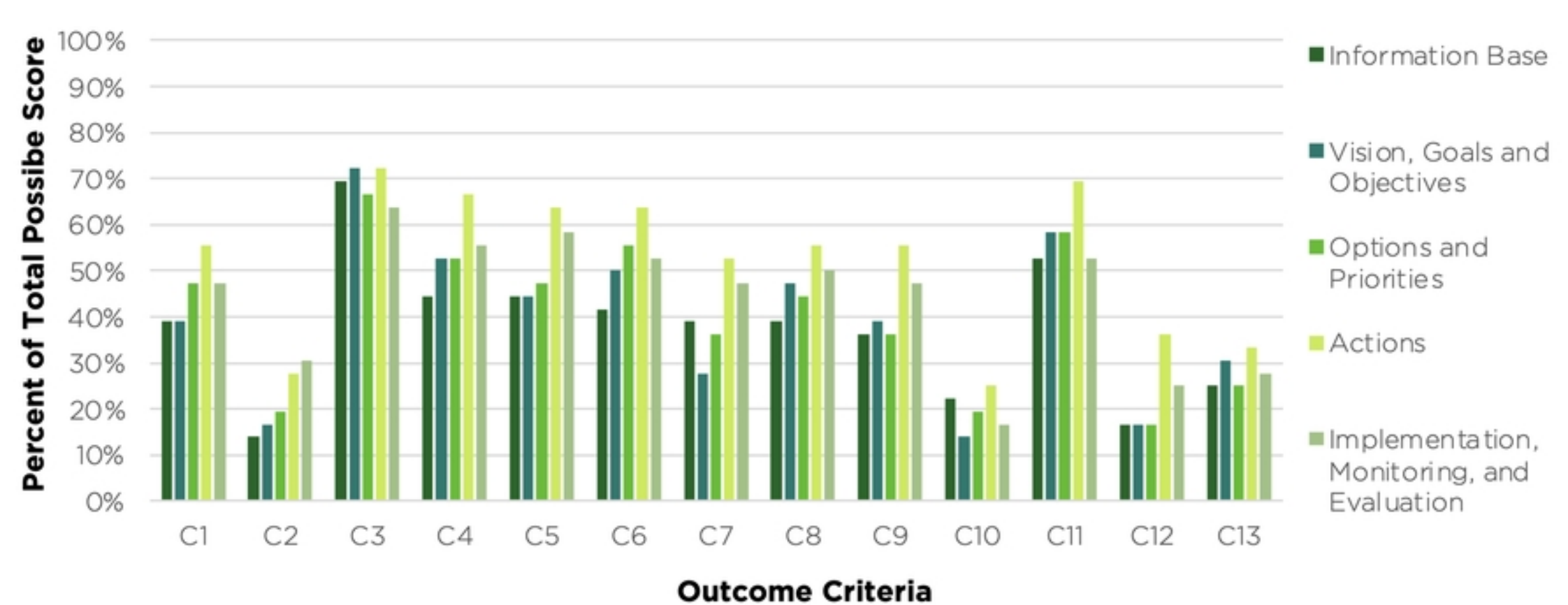


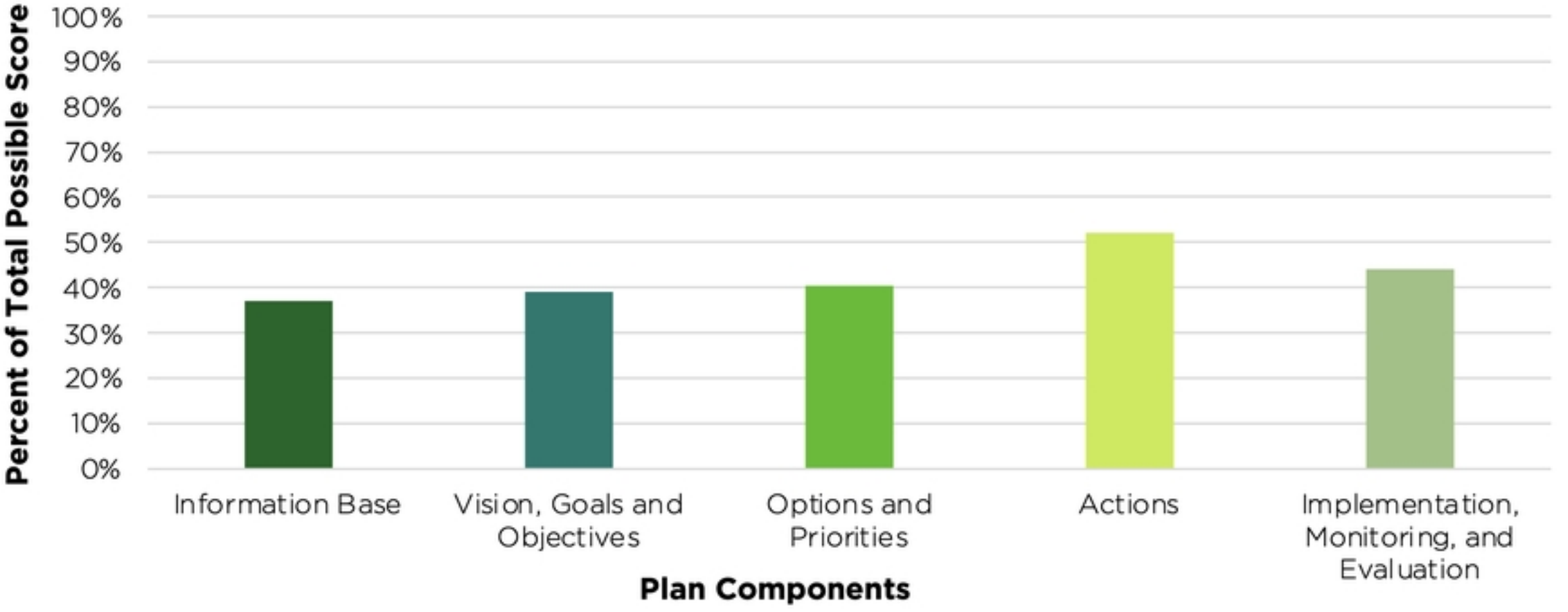
Plan quality associated with EJ outcome criteria



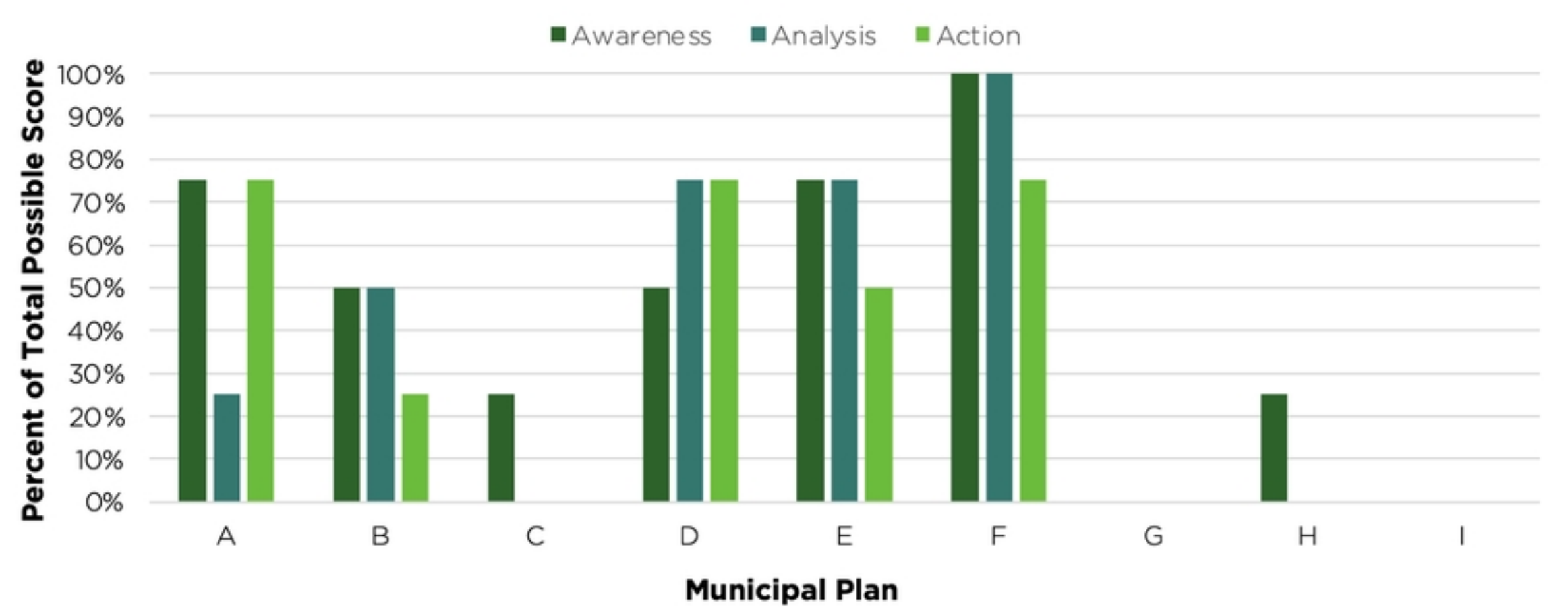
Plan quality scores per municipal plan



Plan quality in relation to outcome criteria

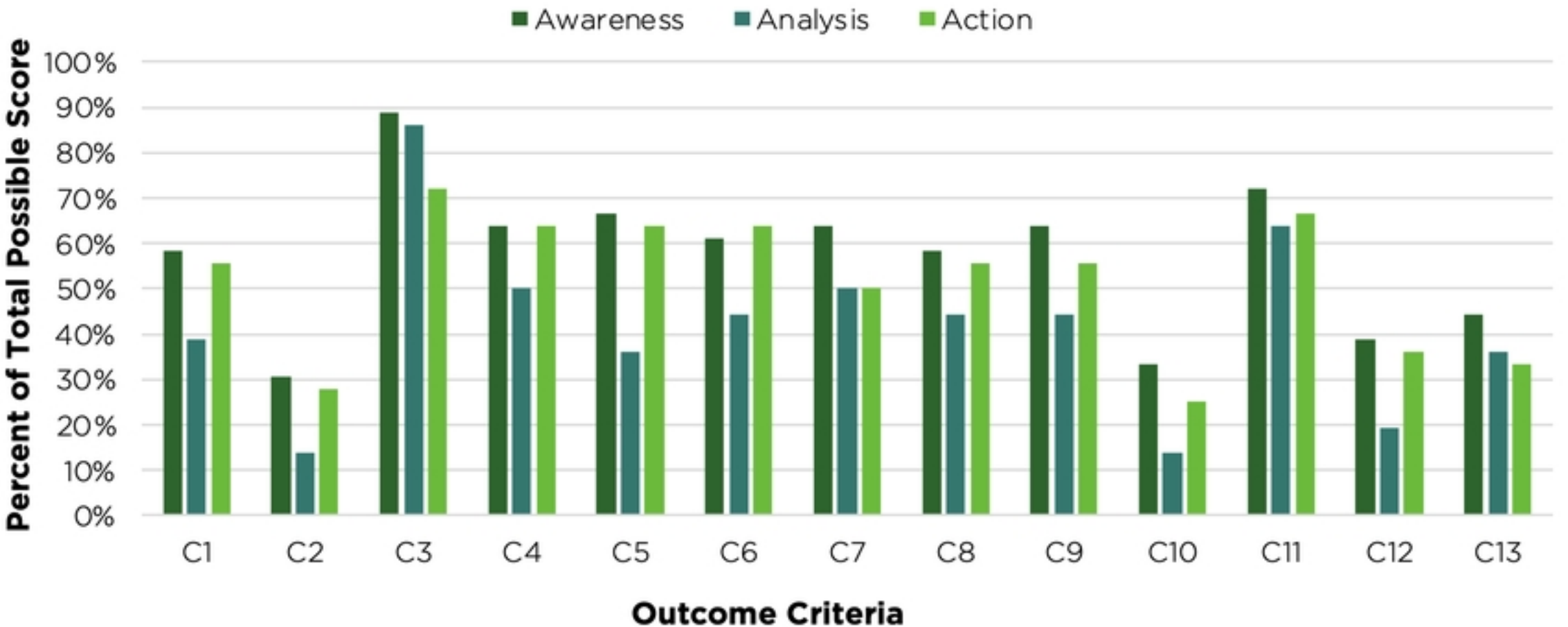


Plan quality for all outcome criteria within evaluated plans

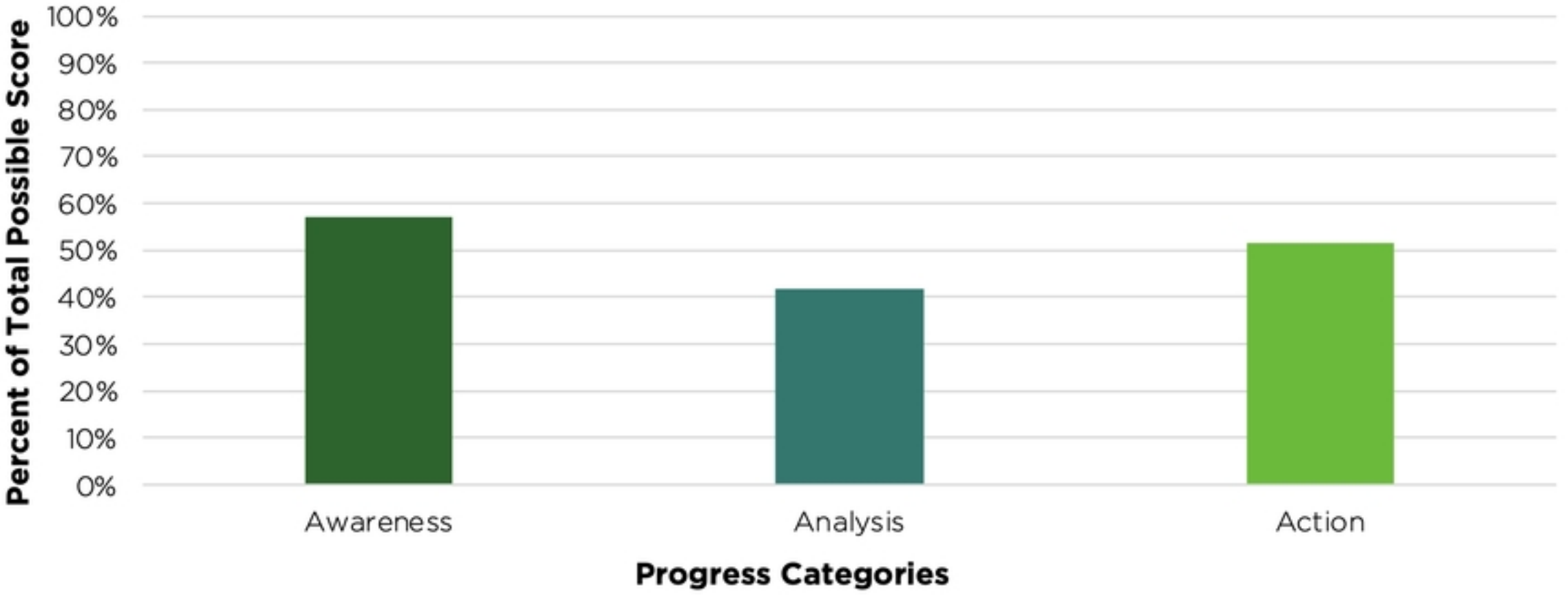


Overall progress associated with EJ outcome criteria

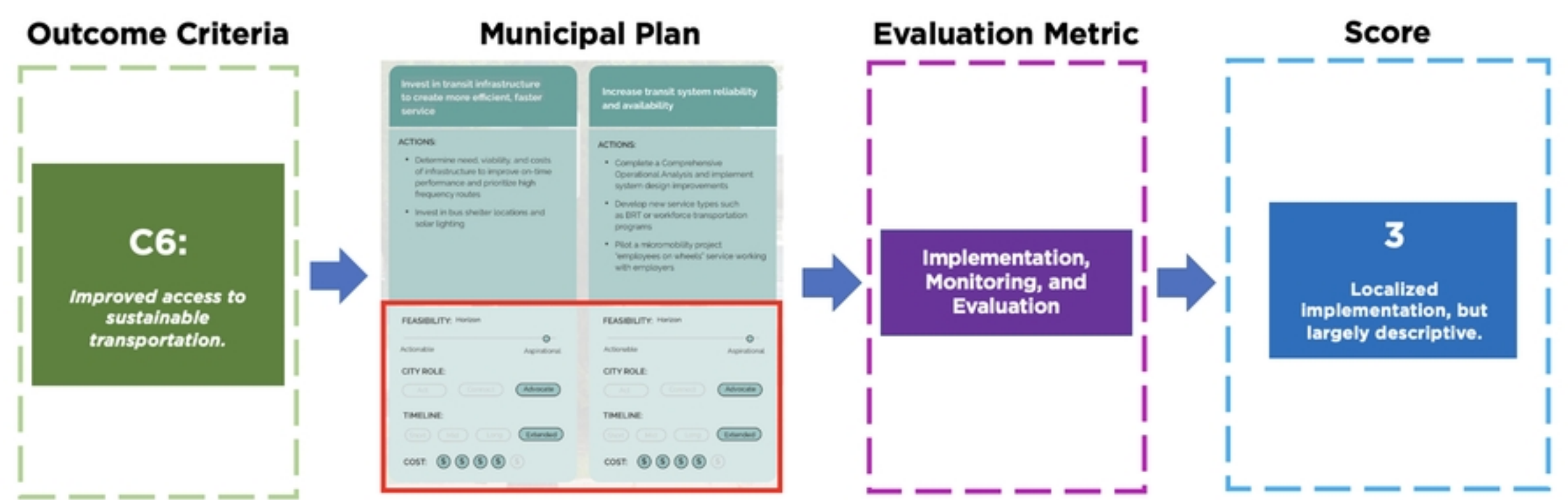
Overall progress scores per municipal plan



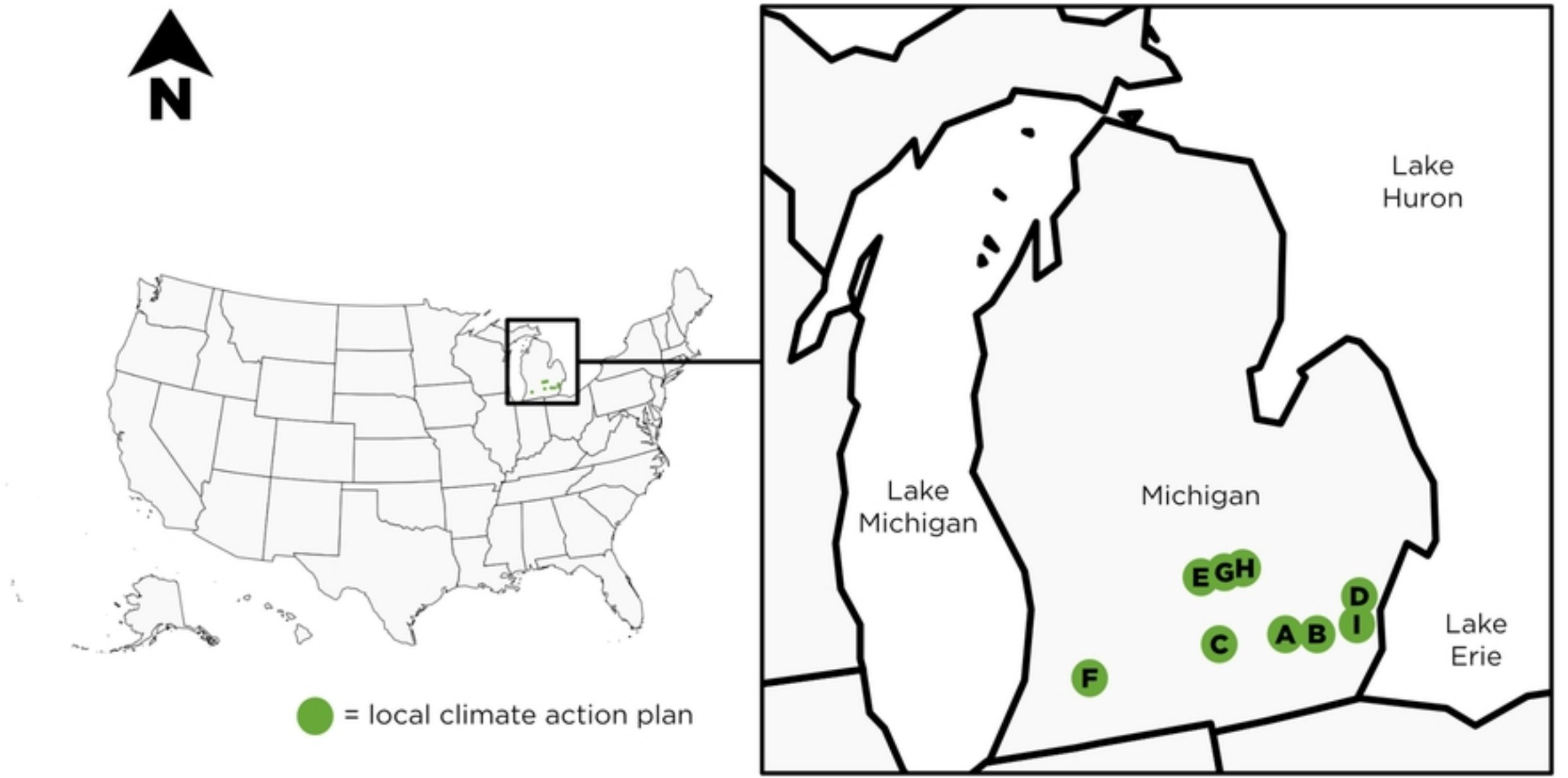
Overall progress in relation to outcome criteria



Overall progress for all outcome criteria within evaluated plans



Example of the coding system


N
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Erie
= local climate action plan

Study area