

## RESEARCH ARTICLE

# Evaluating local climate policy: Municipal action plans through the lens of resilience and environmental justice

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## Abstract

In the US, local governments are increasingly crucial in driving climate action. Drawing upon previous scholarly work, 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 efforts as a result of 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 limitations, local governments lack the tools to effectively implement justice-oriented climate policies.

## 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 [2,3]. Moreover, upwards of 750 municipalities have signed onto the Climate

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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Mayors Network, which aims to fulfill the commitments agreed upon in the Paris Climate Agreement [4].

To facilitate policy action, pioneering municipalities have begun developing climate action plans, also referred to as sustainability or environmental action 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.

According to scholars of the policy cycle, evaluation is core to the development and implementation of policies [5–11]. While there is dispute in some academic communities over the extent to which analytics should contribute to this process, the growing emphasis on “evidence-based policymaking” among governments and civil society demands a thorough examination of policy effectiveness and direction through rigorous evaluation frameworks [12–18]. In regards to environmental policies, some studies have shown that evaluation can result in enhanced reflexive learning and adaptability [19–22]. Given the complexity of the social, economic, cultural, and ecological contexts surrounding climate change, multifaceted methods are essential in providing a holistic representation of real-world problems and solutions.

Several studies have evaluated municipal climate action plans in the US. Historically, plans have tended to focus on climactic and ecological processes related to climate resiliency, rather than socio-economic factors. Many conceptualizations of climate resiliency exist, with it functioning primarily as a normative goal promoted in policy, development, economics, and other related fields [23–27]. In the context of this paper, climate resiliency refers to the ability of individuals from all generations to maintain and enhance their livelihoods and well-being in spite of environmental, economic, social, or political disruptions [26]. Another commonality amongst municipal climate action plans is the type of operating environment they are situated in. According to Wheeler [28], first-generation climate plans enacted by cities lacked institutional support, long-term planning direction, and adequate progress measures. Others emphasize that first-generation plans were often isolated from other policy areas, limiting their impact on governance [29]. In order to quantify how plans influence local policymaking, Tang et al. [30] outlined a framework conceptualizing plan quality, focusing on local awareness, analysis, and actions (AAA) to mitigate and adapt to climate impacts. 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. [31] supported this claim through an assessment of local plans against a multi-criteria framework, evaluating the content and quality of the plans against measures of climate resiliency. 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.

In addition to the quality of plans themselves, successfully mitigating and adapting to climate change relies upon financial and technical resources. In an analysis of Copenhagen’s climate plan, Damsø et al. [32] determined that the city government was an essential incubator for coordinating efforts between the municipal administration and the local utility provider. Consequently, Copenhagen’s 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 [33] 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 in relatively lower emissions. Additionally, researchers have conducted comparative analyses measuring the emissions impact of policy interventions in cities against business-as-usual (BAU) conditions. Morlet and Keirstead [34] evaluated the carbon abatement costs of London, Berlin, Copenhagen, and Paris, comparing them against a set of urban and energy governance metrics. 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 growing relevance of environmental justice (EJ). Considered to be a wide-ranging discipline that encompasses the fair distribution of environmental burdens and benefits, EJ has become a key climate priority for campaigners, academic researchers, non-profit organizations, and policymakers in recent decades [35–38]. 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 [39–41]. Many believe addressing environmental injustice is essential to achieving an equitable and robust transition to a decarbonized economy [42–45]. Indeed, focusing climate action at all levels of government is essential to uprooting the inequities brought upon by structural and systemic racism [46–48]. As a result, the scope of EJ has evolved to recognize that access to clean water, sanitation, green spaces, housing conditions, and exposure to noise and toxins impact human health greatly [49–52]. This establishes the two key components of EJ, environments and people, with equity as a central tenant [53]. Procedural justice, another crucial aspect, emphasizes the importance of providing minority groups with a voice and legal protection within political and legal systems [54–56]. Meanwhile, distributive justice stresses the need for what is deemed a socially-just allocation of resources, goods, opportunity in a society [57,58].

Under federalism, municipalities have a significant role to play in determining 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 [59]. 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 [60,61]. Despite this, municipalities can also generate positive outcomes by embracing justice-informed approaches to elevate the concerns and priorities of underserved residents [62–64]. 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 [65], 69% of the 100 largest cities in the US with climate action plans have incorporated themes of justice and equity into their policy processes. Other entities, including the Biden-Harris 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 [66,67].

Building upon the critical assessments of first-generation plans and 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 EJ considerations. To evaluate the

prevalence of equity in local climate action plans, Caggiano et al. [68] compared equity measures developed by the American Planning Association against indicators ranging across ten thematic areas including transportation, air quality, energy, and 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 [68].

This relates to findings published by Chu and Cannon [69], 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 these criteria across four crucial decision-making stages: designing institutional arrangements, participatory practices, policy integration, and strategic implementation processes [69]. 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 [69]. 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. [70] identified two distinct pathways in which equity-thinking is embedded in the climate adaptation plans of the largest twenty-five US cities. 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 [70]. 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 examining equity and justice in climate action plans, to the best of the authors' knowledge there has not been an attempt to develop a framework that blends well-established themes concerning adaptation and mitigation planning—such as renewable energy, water quality, and municipal solid waste—with EJ considerations. In doing so, it is possible to engage with more holistic and effective strategies that minimize the disparate effects of climate change on marginalized populations [71,72]. From an evaluatory perspective, a joint framework is essential for assessing the effectiveness and fairness of strategies employed by local governments, allowing for a comprehensive assessment of how well climate action plans address the needs and vulnerabilities of marginalized communities. This should enable decision-makers to identify areas for improvement and prioritize interventions that promote equity and resilience. Moreover, evaluating the integration of equity into climate planning helps ensure accountability and transparency in decision-making, facilitating ongoing learning and improvement in addressing the intersecting challenges of climate change and social injustice [73–75].

Serving as the inaugural article in a series that explores the intersection of local environmental governance and EJ, I outline a combined evaluatory approach which considers climate resilience and EJ indicators. I aim to bridge the gap between traditional climate action plans and EJ, thereby fostering more inclusive mechanisms for addressing climate change at the municipal level. Local governments often grapple with limited resources, expertise, and capacity, which can hinder their ability to effectively incorporate equity considerations into their climate policies and programs. Additionally, competing priorities and bureaucratic constraints may further complicate efforts to prioritize EJ in decision-making processes. By providing an evaluatory framework that integrates EJ considerations with resiliency planning, this research offers a valuable resource for localities seeking to navigate these challenges. I begin by defining the regional area of interest to contextualize the state of Michigan and its policy environment.

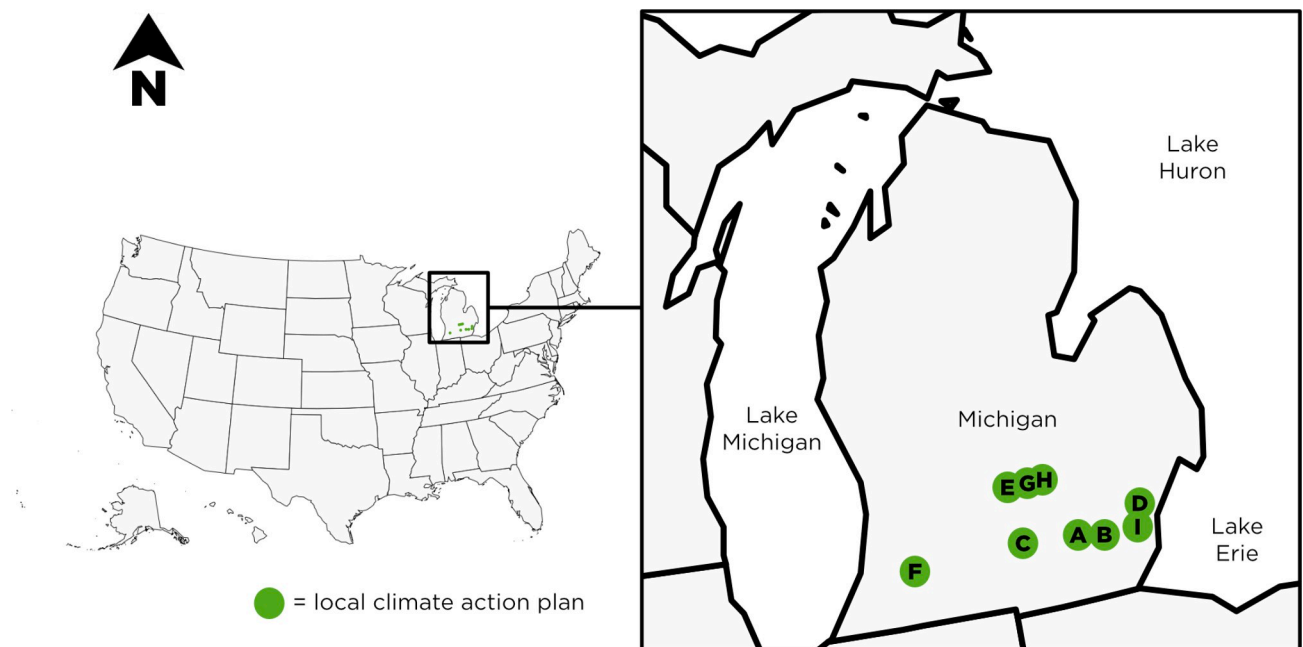
Then, I outline the data collection and methodological components underpinning my evaluation. I conclude with my findings and assess the challenges in integrating EJ into local climate mitigation and adaptation efforts.

## Background and methods

### 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. Fig 1 denotes the municipalities in Michigan with community-level climate action plans as of March 2023. The names of the localities are kept anonymous to preserve the privacy of authors and co-authors, as many local plans included support from volunteers and other private citizens.

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 [76]. 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 [77–79]. 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 [80,81]. 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 [81]. Likewise, 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 [81]. According to Reich et al. [82], 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.



**Fig 1. Study area.** Source: Base map layer from SimpleMaps.com (<https://simplemaps.com/resources/svg-us>), licensed under CC BY 4.0 (<https://simplemaps.com/data/license>).

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In addition to anthropogenic climate change, Michigan has a long history of environmental disasters that have culminated in harm to 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 hurt low-income residents and BIPOC communities, who have suffered from health risks and the long-term consequences of lead exposure [83–86]. Additionally, due to the state's history as an industrial powerhouse, many residents in historic manufacturing and mining areas face exposure to legacy contamination [87–89]. As of 2022, there are an estimated 24,000 contaminated sites in the state, mainly due to groundwater and soil pollution [90].

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 [91]. 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 [91]. 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.

### Plan identification

A report published by the Michigan Climate Action Network (MiCAN) served as a starting point to identify municipalities with local climate plans [92]. According to the report, sixteen municipalities in the state had climate action policies and renewable energy goals as of 2022 [92]. 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 change.

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 revealed four additional local climate action plans, bringing the total to nine. Upon identifying these plans, I modified the approaches developed by Tang et al. [30] and Baker et al. [31] to conduct a qualitative content analysis, which entailed systematically examining and interpreting textual data to derive meaningful insights on climate resilience and EJ topics [93].

### Content analysis

The methods employed in this study mirror those conducted by Tang et al. [30], Baker et al. [31], Diezmartínez and Gianotti [65], Caggiano et al. [68], and Cannon et al. [70], who utilized qualitative content analysis and scoring mechanisms to enhance the understanding of local climate action plans. Through systematic examination of policy documents, this type of analysis enables researchers to uncover nuanced insights into how climate resilience and EJ concerns are addressed within local planning frameworks.

The nine municipal action plans were assessed using MAXQDA, a qualitative data analysis software, and relied on a deductive approach. This process was guided by predetermined outcome criteria, evaluation categories, and a scoring system discussed below. Within this framework, the coding system—also outlined below—meticulously evaluated thirteen outcome criteria against two overarching evaluation categories: overall progress and plan quality.

**Outcome criteria.** The outcome criteria used in this study 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 (Table 1). They differ from the ones used by Baker et al. [31], who curated them for different ecological, geographic, and policy contexts. Additionally, Baker et al. [31] did not include criteria for EJ or equity considerations.

Similar to Baker et al. [31], the outcome criteria reflect important threats to climate resiliency in Michigan and the US more broadly. For instance, improved water quantity and quality is crucial for ensuring an adequate water supply in light of droughts or increased rainfall intensity [94,95]. Local governments play a leading role in managing water resources through local ordinances, regulatory enforcement, and infrastructure investment [96]. Additionally, considering air quality and GHG emissions is essential for climate resiliency. This is because GHG mitigation and improved air quality jointly minimize the direct driver of climate change and the public health risks associated with air pollution [97,98]. Local governments can implement measures such as emissions controls, promoting clean transportation options, and enforcing environmental regulations to improve air quality and reduce emissions within their jurisdiction [99].

Increasing the utilization of clean energy in concert with improving efficiency further contributes to climate resiliency by lowering GHG emissions and enhancing energy security [100]. Both of these outcomes are influenced by local decision-making, as local governments can adopt policies like renewable energy incentives, building codes for energy efficiency, and public awareness campaigns to encourage sustainable energy practices and reduce reliance on fossil fuels [101,102]. In a similar regard, improving access to sustainable transportation options and promoting human-powered transportation modes such as walking and cycling can also reduce GHG emissions, traffic congestion, and fossil fuel dependence, with local governments empowered to invest in public transit, biking lanes, and pedestrian-friendly streets [103,104].

**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.

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Building resilience towards extreme weather events is critical, with preparedness and adaptation measures seeking to minimize the impacts of extreme weather events [105]. Expanding green spaces, urban forests, and biodiversity can play a role in this as well, in addition to enhancing ecosystem services such as carbon sequestration and air and water purification to contribute to climate resilience [106,107]. Additionally, expanding recycling, reuse, and waste reduction programs can reduce the environmental impact of waste disposal, conserve resources, and limit GHGs resulting from landfills [108].

Furthermore, increased community involvement in decision-making reflects an inclusive and participatory processes that centers individual and group concerns to foster equitable approaches to climate change [109,110]. Establishing equitable conditions relates to distributive justice and the fair allocation of environmental resources, benefits, and burdens across communities. This reflects the attempt to rectify historical injustices and ensure that marginalized populations have access to essential environmental amenities and protections, thus increasing climate resiliency across communities [111].

**Evaluation categories.** Outcome criteria were evaluated against two evaluation categories: overall progress and plan quality. The awareness-analysis-action (AAA) framework used by Tang et al. [30] informs the assessment of overall progress. In this case, *awareness* refers to acknowledging the causes and consequences of climate change [30]. *Analysis* involves interrogating and synthesizing relevant information, while *action* focuses on the application of this data to develop policies [30].

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 ensure policy successes in the medium and long-term. It emphasizes the need for the plan to be implementable, adaptable, and responsive to changing circumstances, with a well-crafted plan not only outlining 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. [31] 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.

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**Table 3. Scoring system for evaluation.**

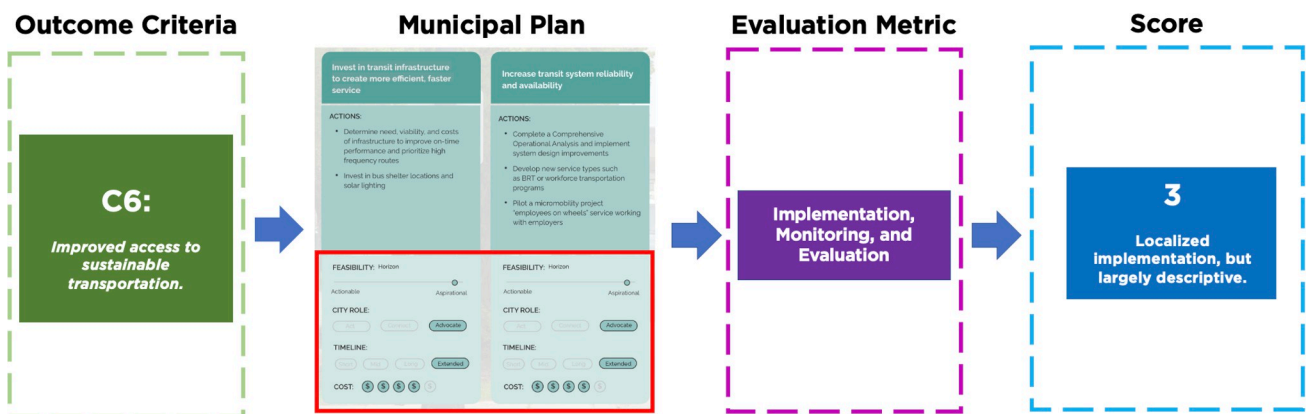
Score	Description
0	No mention of outcome criterion in the plan.
1	Outcome criterion is mentioned, but with little to no detail.
2	Outcome criterion is mentioned and includes a description with moderate detail.
3	Outcome criterion is mentioned and includes a limited level of locally specific application. 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.

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**Scoring system.** The scoring 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).

Fig 2 visualizes the operationalization of the scoring 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). This process was carried out for each plan and outcome criteria, focusing on the two evaluation categories described above.

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.



**Fig 2. Example of the coding system.**

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**Limitations.** There is an unavoidable level of subjectivity underpinning the scoring system, as noted by Baker et al. [31]. 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 ( $n = 9$ ), it 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 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.

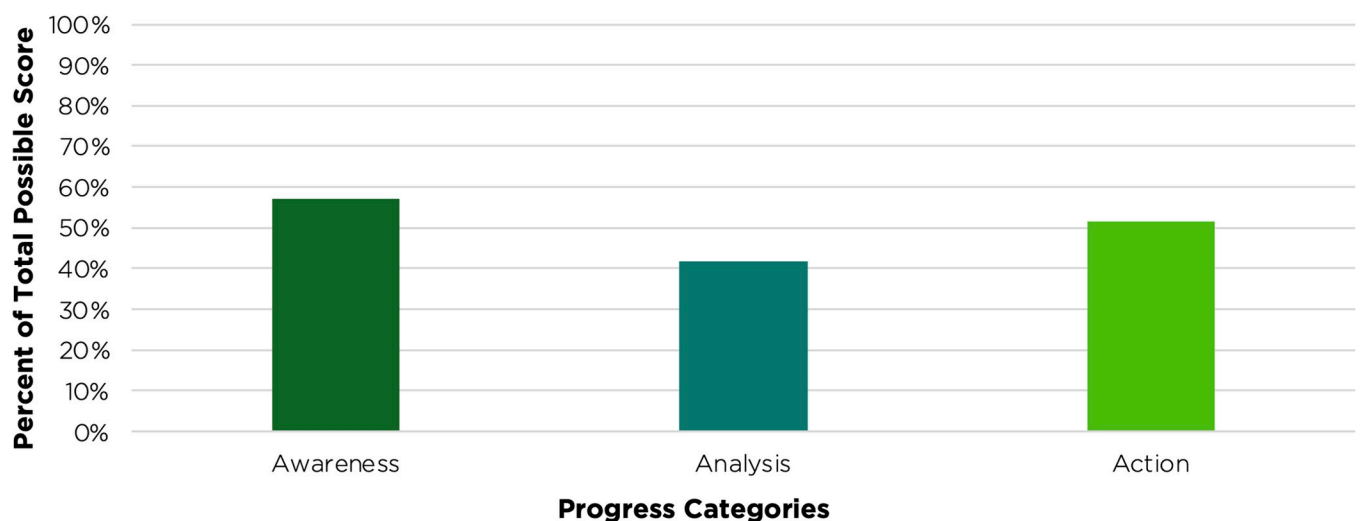
## Results

### Overall progress

Awareness, analysis, and action categories gauged progress toward climate resiliency and EJ outcomes 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).

Among all the outcome criteria, awareness scores consistently surpassed or equalled 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 topics (Fig 4).

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,



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

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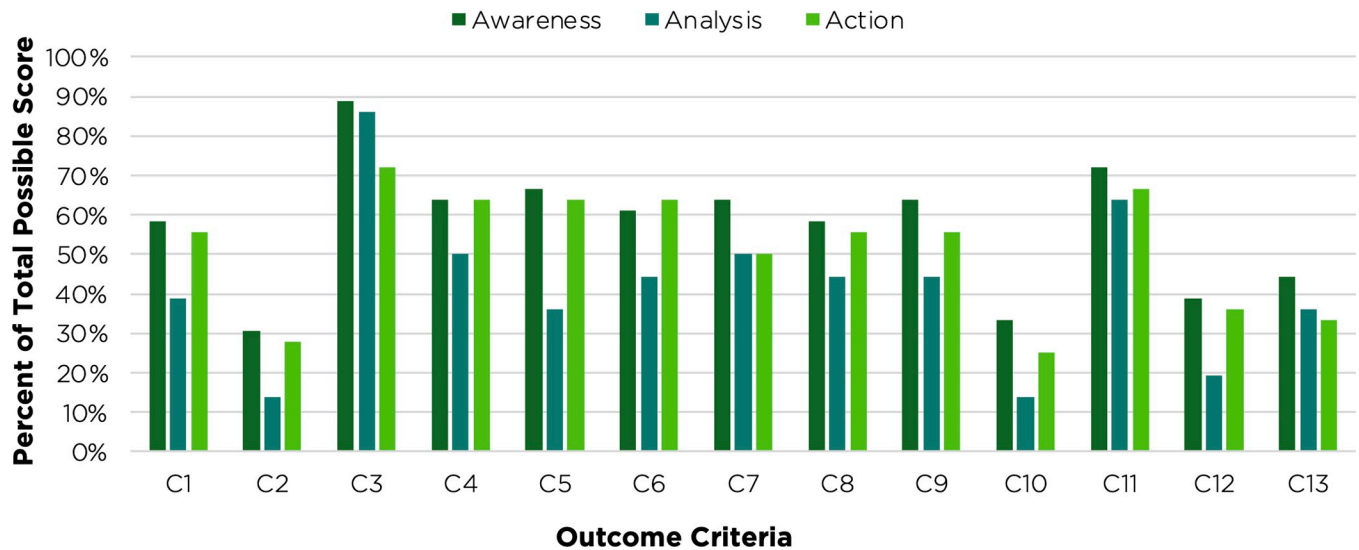


Fig 4. Overall progress in relation to outcome criteria.

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lower-ranking plans demonstrated a lesser degree of emphasis on establishing this explicit connection between the various criteria 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).

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

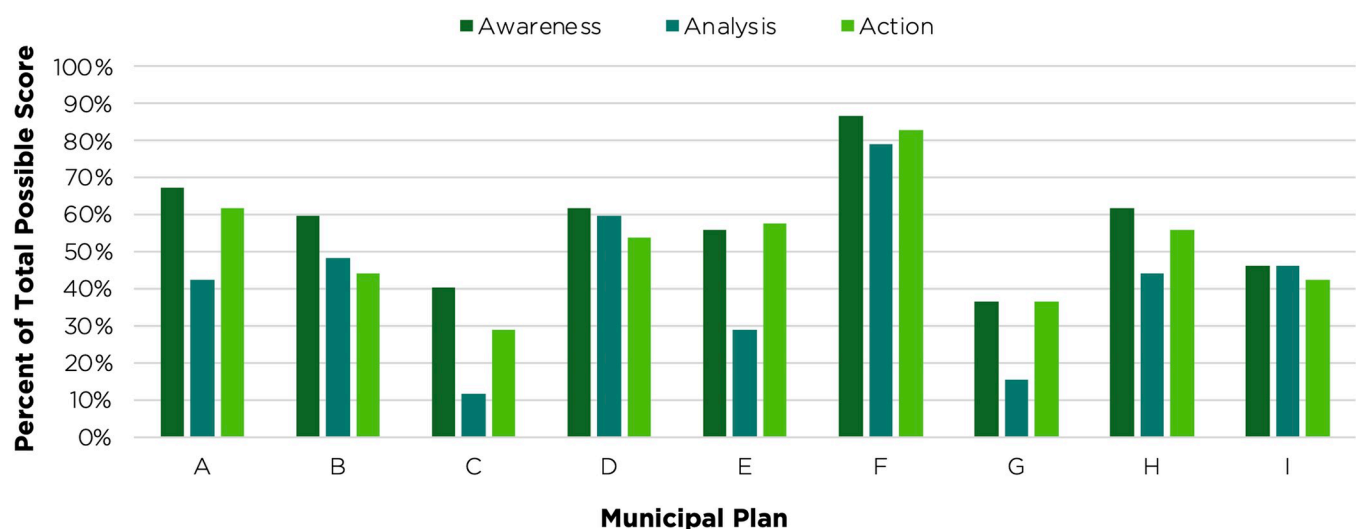
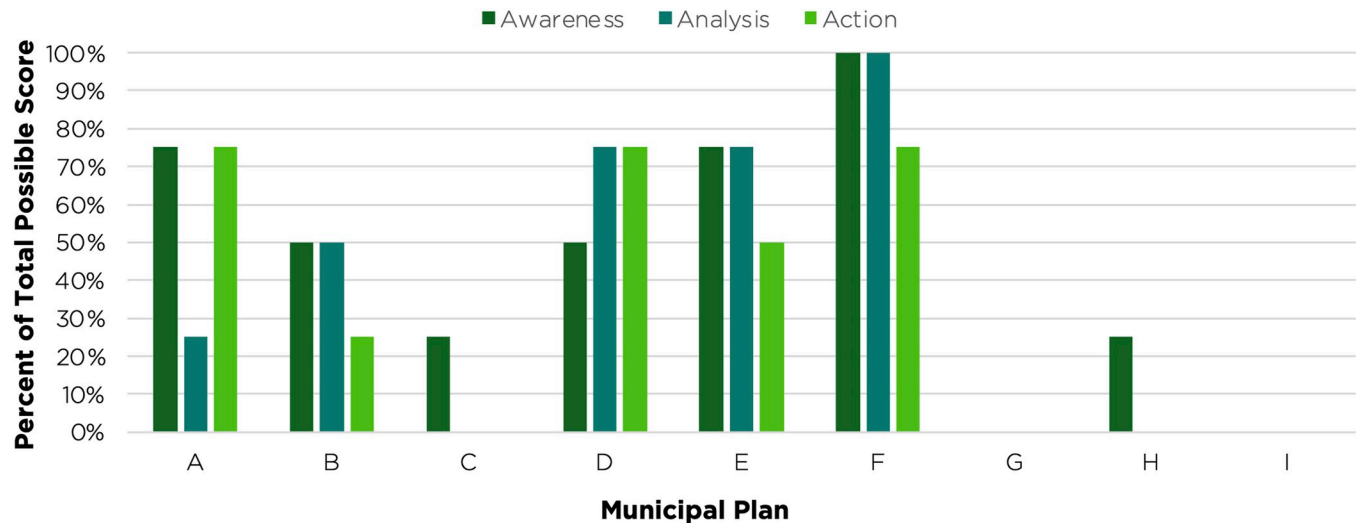


Fig 5. Overall progress scores per municipal plan.

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**Fig 6. Overall progress associated with EJ outcome criteria.**

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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 climate change impacts. This may arise from limited technical or financial resources to conduct rigorous analyses or develop policy recommendations. It could also reflect local governments' capabilities and perspectives toward climate action plans, as municipalities with relatively smaller analytical capacities 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 recommendations for improving water quantity and quality (C1). On the other hand, municipalities that have already conducted analyses describe action in more 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. Fig 6 provides a visual representation of the aggregated awareness, analysis, and action scores attributed to procedural justice (C12) and distributive justice (C13). Plan C, Plan G, Plan H, and Plan I exhibited minimal to negligible awareness of these EJ principles. Moreover, most 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.

Out of the evaluated plans, a significant 78% of them mentioned 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 emphasizes that it "is grounded in justice and equity" and integrates an equity impact component to each policy action it proposes. Plan A also 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.

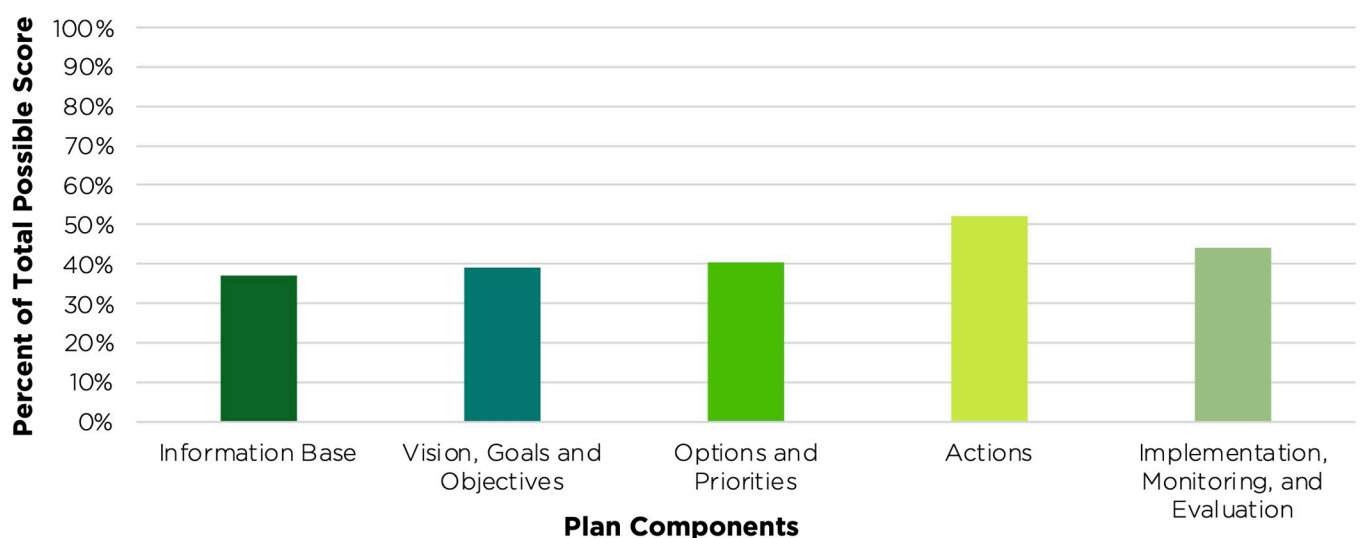
Moreover, Plan C and Plan H espoused awareness without substantive analysis of existing conditions or proposed policy actions. Plan C notably encompassed a well-defined account of EJ encompassing its historical context and relevance to climate change but did not include any commentary on the specific 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).

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

Among the plan quality components, the information base ranked the lowest, apart from the scores for Plan D, Plan F, and Plan H (Fig 9). In most cases, the plan information base



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

<https://doi.org/10.1371/journal.pclm.0000395.g007>

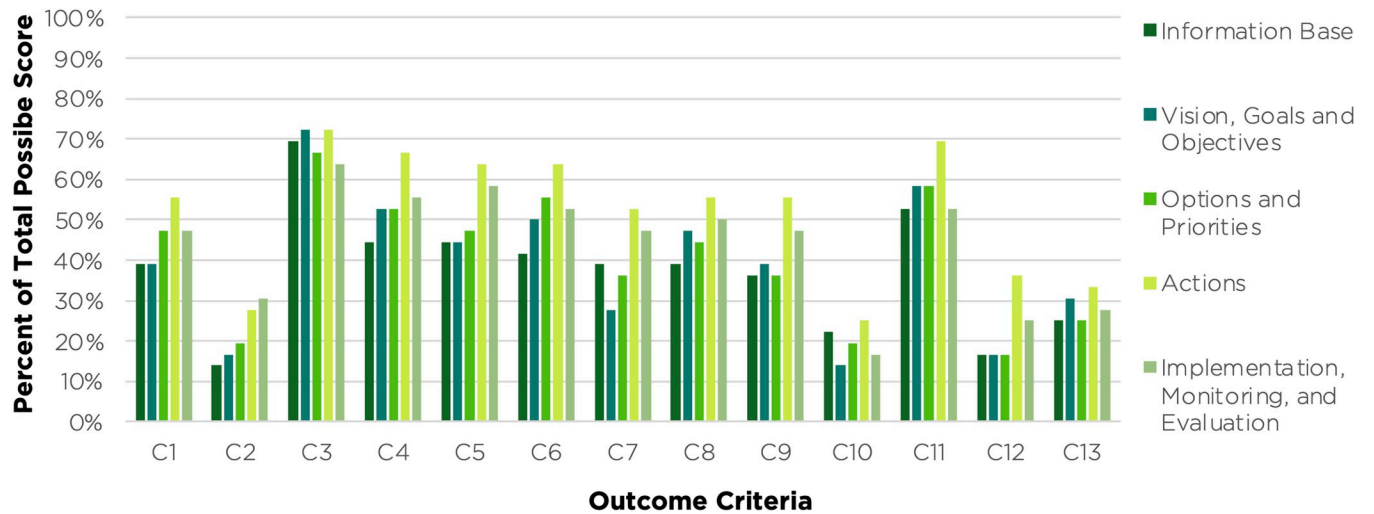


Fig 8. Plan quality in relation to outcome criteria.

<https://doi.org/10.1371/journal.pclm.0000395.g008>

consisted of descriptive statements about current conditions, rather than focusing on future implications in a process guided by localized, quantitative projections. Consistently, the information base for each outcome criteria relied on generic global impacts rather than specific information within the local jurisdiction.

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

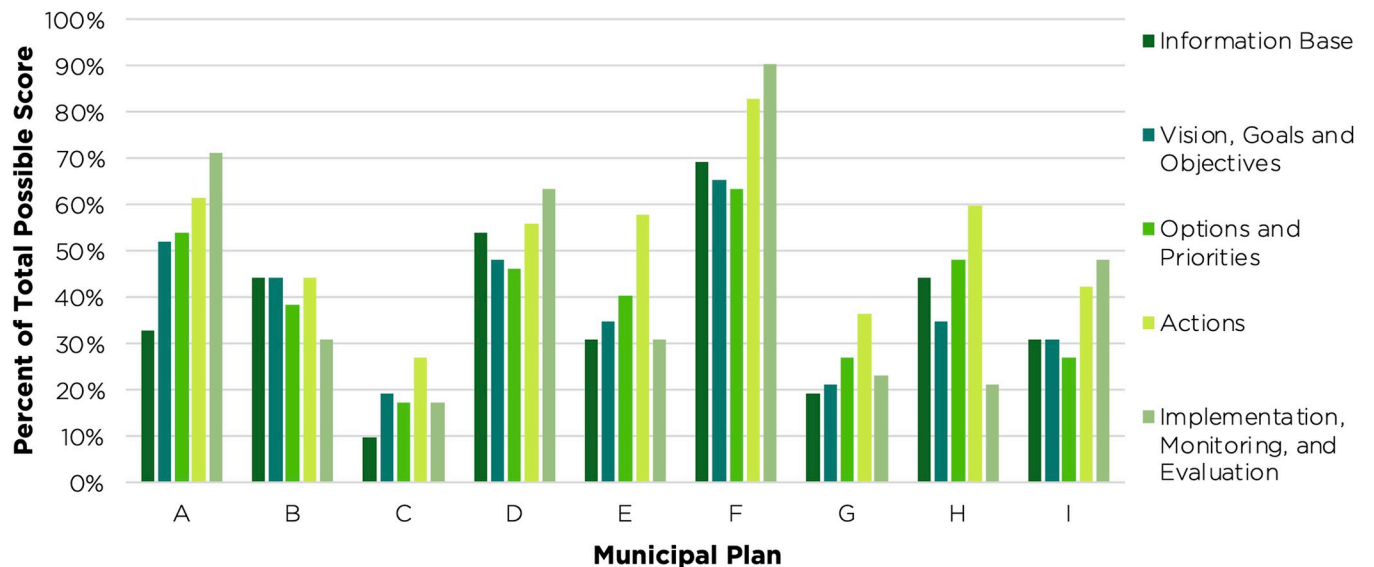


Fig 9. Plan quality scores per municipal plan.

<https://doi.org/10.1371/journal.pclm.0000395.g009>

derived from municipal actions, rather than the community overall. By leveraging localized outputs, such as an up-to-date community-level GHG inventory, it is possible to aid policy-makers in effectively prioritizing and targeting mitigation efforts toward the most substantial emission sources. However, most plans were not informed by this level of detail.

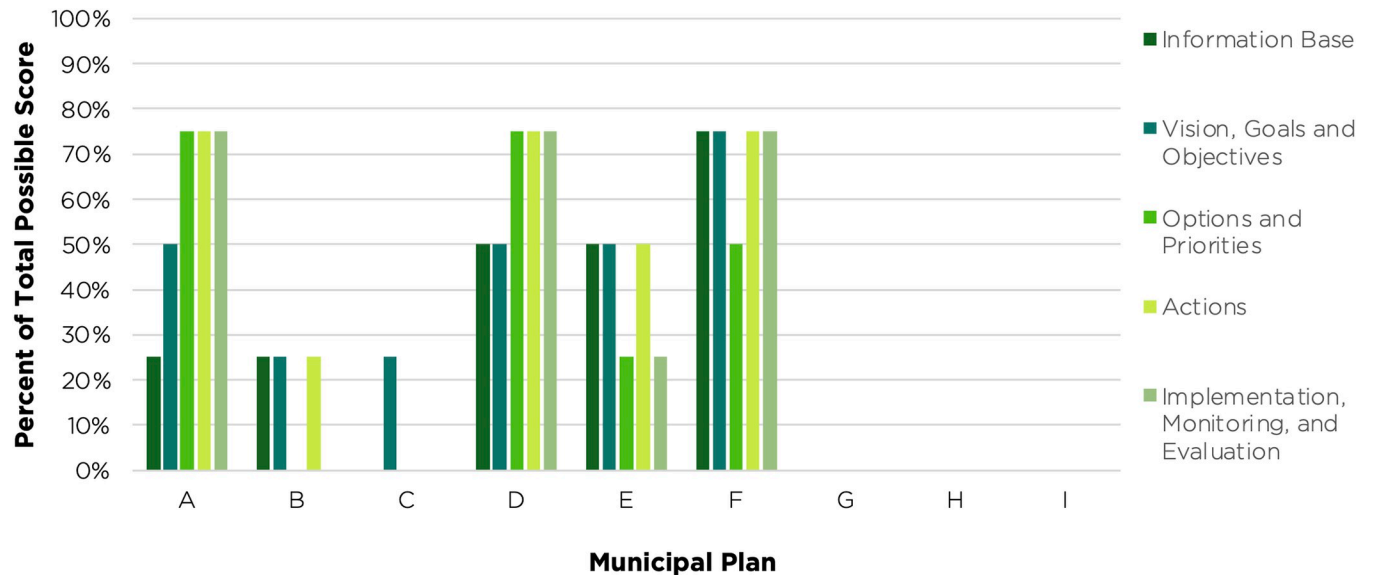
Visioning statements and objectives varied among plans, with some municipalities outlining specific visions tailored for local conditions. Plan F adeptly integrated the city's strategic vision, aligning policy proposals with core elements such as environmental responsibility and economic vitality. Conversely, several other plans merely expressed the need to "adapt to climate change" or "respond equitably" without considering their distinctive local 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. Plan F 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 educational campaigns. On the contrary, Plan H solely suggested an educational awareness drive as a solution to encourage residential uptake of electric appliances. 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 is evident that most plans are unable to provide sufficient details for the implementation, monitoring, and evaluation of 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 establishment of timelines to guide the execution and assessment of the proposed initiatives. This lack of information hinders the effective operationalization and evaluation of the policies outlined within the plans. When implementers are unable to act effectively, the overall impact of a plan diminishes, possibly resulting in public resistance, insufficient support, or uninformed decision-making. Furthermore, without identifying responsible government divisions, there may be confusion about roles, responsibilities, and the allocation of resources. For plans that preclude funding information and an implementation timeline, there may be a lack of accountability, indefinite delays, and policy abandonment. In total, four plans outlined which divisions of local government would implement given policies, while two plans went further by identifying funding measures and costs. Out of these two plans, one outlined cost in relative terms (e.g., ranking scale), while the other provided specific estimates in dollar amounts.

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

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 poisoning, 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



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

<https://doi.org/10.1371/journal.pclm.0000395.g010>

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 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 in the plan from an equity impact perspective, while Plan D established alternative routes to achieving 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 its 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 need for substantive improvement more generally. Plans A, D, and F outlined critical steps such as identifying responsible

governmental units, 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 strengthening clarity and accountability.

## Discussion

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 is likely a need for improvement. Despite, this it is important to recognize that 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. [30] and Baker et al. [31]. Instead, most relied upon global and national assessments. Additionally, this analysis revealed 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 ignore or minimize clear air, biodiversity, and EJ. 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 conditions. Three plans had adequate implementation, monitoring, and evaluation content, with scores at or above 50%. However, a majority (66%) did not focus on these elements in detail. Even among the plans with this information present, they generally did not outline specifics, such as funding sources and costs. Among the nine municipal plans, 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, only three demonstrated an ability to comprehensively plan for EJ issues. The remaining municipalities fell short of meeting the 50% threshold, signifying the need for focusing on EJ conditions within their local context.

Overall, plan progress and quality results are similar to the findings presented in existing literature. When analyzing local plans, Tang et al. [30] found that awareness of climate-related issues scored the highest, with limited analysis and action capabilities. Baker et al. [31] concluded that local governments have minimal information bases in need of long-term investment to adequately plan for the impacts of climate change. Findings in this paper further echo Caggiano et al. [68] and Chu and Cannon [69], who pointed to the increasing prevalence of equity principles in local climate action plans over the last decade. Cannon et al. [70] work on decision and thought pathways, which noted there is no one-size-fits-all approach to equity and justice in local climate planning, is also exemplified in this study.

My central contribution is performing an assessment which considers how EJ and climate resiliency measures input into local climate planning. Rather than focusing exclusively on whether plans engage with equity and justice, my work evaluates the progress and quality of

these plans, thereby seeking to illustrating their effectiveness in guiding real-world decision making. Results underscore the role of information and knowledge generation, data collection and monitoring, and institutional and external (e.g., community and specialist) support in facilitating or impeding EJ integration. While many municipalities acknowledge the link between climate change and social inequities such as race and income, few provide specific local data on these dynamics, their unique manifestations, and available policy mechanisms for local governments to address them within a climate context. Consequently, I add to the scholarly debate surrounding EJ and local governance by highlighting implementation challenges, such as limited information bases and uncertainty in policy options and alternatives to achieve equitable outcomes for communities.

This paper sets the stage for future analysis focused on several key areas: exploring EJ integration in mitigation plans versus adaptation plans, analyzing key resource constraints faced by local governments, examining the role of community engagement in the planning and implementation process, assessing the integration of climate action plans with other policy frameworks (e.g., master plans), and focusing on the longitudinal differences in equity outcomes across communities with equity infused climate plans. Subsequent research should also strive to address the limitations of this study, particularly its exclusive focus on Michigan municipalities and its reliance on a single time period. These factors may restrict its capacity to fully capture the dynamic nature of climate action planning and policy evolution in a more broadly applicable context.

## Conclusions

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 positioned 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 existing efforts and actively engage with EJ principles while drafting climate plans. With support from state and federal partners, municipal governments are well-positioned to do so. Relying upon their designated powers, such as zoning and planning controls, local governments 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.

## Author Contributions

**Conceptualization:** Graham Diedrich.

**Data curation:** Graham Diedrich.

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**Funding acquisition:** Graham Diedrich.

**Investigation:** Graham Diedrich.

**Methodology:** Graham Diedrich.

**Project administration:** Graham Diedrich.

**Resources:** Graham Diedrich.

**Software:** Graham Diedrich.

**Supervision:** Graham Diedrich.

**Validation:** Graham Diedrich.

**Visualization:** Graham Diedrich.

**Writing – original draft:** Graham Diedrich.

**Writing – review & editing:** Graham Diedrich.

## References

1. Intergovernmental Panel on Climate Change. Sixth Assessment Report. 2023. [cited 2024 May 10]. Available from: <https://www.ipcc.ch/assessment-report/ar6/>.
2. United Nations Framework Convention on Climate Change. Kyoto Protocol to the United Nations Framework Convention on Climate Change. 1997. [cited 2024 May 10]. Available from: <https://unfccc.int/documents/2409>.
3. United Nations Framework Convention on Climate Change. Paris Agreement under the United Nations Framework Convention on Climate Change. 2016. [cited 2024 May 10]. Available from: [https://unfccc.int/sites/default/files/resource/parisagreement\\_publication.pdf](https://unfccc.int/sites/default/files/resource/parisagreement_publication.pdf).
4. Climate Mayors Network. Demonstrating leadership on climate change through meaningful actions in our communities. 2020. [cited 2024 May 10]. Available from: <https://climatemayors.org/>.
5. Lasswell HD. Power and Personality. United Kingdom: Taylor & Francis Limited (Sales); 2017.
6. Lasswell HD. The Decision Process: Seven Categories of Functional Analysis. United States: Bureau of Governmental Research, College of Business and Public Administration, University of Maryland; 1956.
7. Brewer GD. The policy sciences emerge: To nurture and structure a discipline. *Policy sciences*. 1974 Sep 1:239–44.
8. Brewer GD, DeLeon P. The Foundations of Policy Analysis. United States: Brooks/Cole Publishing Company; 1983.
9. DeLeon P. The stages approach to the policy process: What has it done? Where is it going. *Theories of the policy process*. 1999; 1(19):19–32.
10. Weible CM, editor. *Theories of the Policy Process*. United Kingdom: Routledge; 2023.
11. Hill M, Varone F. *The Public Policy Process*. United Kingdom: Taylor & Francis; 2021.
12. Schattschneider EE. *The semisovereign people: a realist's view of democracy in America*. Austria: Dryden Press; 1988.
13. Kuhn T. *The nature of scientific revolutions*. Chicago: University of Chicago; 1970.
14. Jasanoff S. *The Fifth Branch: Science Advisers as Policymakers*. United States: Harvard University Press; 2009.
15. Norton BG. *Sustainability: A philosophy of adaptive ecosystem management*. United States: University of Chicago Press; 2005.
16. Cohen S. *Understanding environmental policy*. United States: Columbia University Press; 2014.
17. Ostrom E, Schroeder L, Wynne S. *Institutional incentives and sustainable development: Infrastructure policies perspective*. United States: Westview Press; 1993.
18. Cairney P. *The Politics of Evidence-Based Policy Making*. United Kingdom: Palgrave Macmillan UK; 2016.
19. Hildén M. The evolution of climate policies—the role of learning and evaluations. *J Clean Prod*. 2011; 19(16):1798–1811. <https://doi.org/10.1016/j.jclepro.2011.05.004>

20. Hildén M, Jordan A, Rayner T. Climate policy innovation: developing an evaluation perspective. *Environ Polit*. 2014; 23(5):884–905. <https://doi.org/10.1080/09644016.2014.924205>
21. Kariuki P, Reddy P. Operationalising an effective monitoring and evaluation system for local government: considerations for best practice. *African Evaluation Journal*. 2017; 5(2). [cited 2024 May 10]. Available from: <https://hdl.handle.net/10520/EJC-ca88a9ab0>.
22. Crabb A, Leroy P. *The Handbook of Environmental Policy Evaluation*. 1st ed. Routledge; 2008. <https://doi.org/10.4324/9781849773072>
23. Resilience Brown K., *Development and Global Change*. United Kingdom: Taylor & Francis; 2015.
24. Béné C, Wood RG, Newsham A, Davies M. Resilience: New Utopia or New Tyranny? Reflection about the Potentials and Limits of the Concept of Resilience in Relation to Vulnerability Reduction Programmes. Working Paper No. 405. IDS, Brighton; 2012.
25. Barrett CB, Conostas MA. Toward a theory of resilience for international development applications. *Proc Natl Acad Sci USA*. 2014; 111(40):14625–30. <https://doi.org/10.1073/pnas.1320880111> PMID: 25246580
26. Tanner T, Lewis D, Wrathall D, et al. Livelihood resilience in the face of climate change. *Nature Climate Change*. 2015; 5:23–26. <https://doi.org/10.1038/nclimate2431>
27. Schleussner CF, Pfliegerer P, Andrijevic M, Vogel MM, Otto FE, Seneviratne SI. Pathways of climate resilience over the 21st century. *Environmental Research Letters*. 2021; 16(5):054058. <https://doi.org/10.1088/1748-9326/abed79>
28. Wheeler SM. State and Municipal Climate Change Plans: The First Generation. *Journal of the American Planning Association*. 2008; 74(4):481–496. <https://doi.org/10.1080/01944360802377973>
29. Urwin K, Jordan A. Does public policy support or undermine climate change adaptation? Exploring policy interplay across different scales of governance. *Global Environmental Change*. 2008; 18(12):180.
30. Tang Z, Brody SD, Quinn C, Chang L, Wei T. Moving from Agenda to Action: Evaluating Local Climate Change Action Plans. *Journal of Environmental Planning and Management*. 2010; 53(1):41–62. <https://doi.org/10.1080/09640560903399772>
31. Baker I, Peterson A, Brown G, McAlpine C. Local Government Response to the Impacts of Climate Change: An Evaluation of Local Climate Adaptation Plans. *Landscape and Urban Planning*. 2012; 107(2):127–136. <https://doi.org/10.1016/j.landurbplan.2012.05.009>
32. Damsø T, Kjær T, Christensen TB. Implementation of Local Climate Action Plans: Copenhagen—Towards a Carbon-Neutral Capital. *Journal of Cleaner Production*. 2017; 167:406–415. <https://doi.org/10.1016/j.jclepro.2017.08.156>
33. Millard-Ball A. Do City Climate Plans Reduce Emissions? *Journal of Urban Economics*. 2012; 71(3):289–311. <https://doi.org/10.1016/j.jue.2011.12.004>
34. Morlet C, Keirstead J. A Comparative Analysis of Urban Energy Governance in Four European Cities. *Energy Policy*. 2013; 61:852–863. <https://doi.org/10.1016/j.enpol.2013.06.085>
35. Laurent É. Issues in environmental justice within the European Union. *Ecological Economics*. 2011; 70(11):1846–1853. [cited 2024 May 10]. Available from: <https://EconPapers.repec.org/RePEc:eee:ecolec:v:70:y:2011:i:11:p:1846-1853>.
36. Schlosberg D. *Defining Environmental Justice: Theories, Movements, and Nature*. United Kingdom: OUP Oxford; 2007.
37. Walker G. *Environmental Justice: Concepts, Evidence and Politics*. United Kingdom: Taylor & Francis; 2012.
38. Martinez-Alier J, Temper L, Del Bene D, Scheidel A. Is There a Global Environmental Justice Movement? *The Journal of Peasant Studies*. 2016; 43(3):731–55. <https://doi.org/10.1080/03066150.2016.1141198>
39. Bryant B, Mohai P. *Race And The Incidence Of Environmental Hazards: A Time For Discourse*. 1st ed. Routledge; 1992.
40. Lester J, Allen D, Hill K. *Environmental Injustice In The US: Myths And Realities*. 1st ed. Routledge; 2001.
41. Ringquist EJ. Assessing evidence of environmental inequities: A meta-analysis. *Journal of Policy Analysis and Management*. 2005; 24(2):223–247. <https://doi.org/10.1002/pam.20088>
42. McCauley D, Raphael H. Just Transition: Integrating Climate, Energy and Environmental Justice. *Energy Policy*. 2018; 119:1–7. <https://doi.org/10.1016/j.enpol.2018.04.014>
43. McCauley D, Ramasar V, Heffron RJ, Sovacool BK, Mebratu D, Mundaca L. Energy Justice in the Transition to Low Carbon Energy Systems: Exploring Key Themes in Interdisciplinary Research. *Applied Energy*. 2019; 233–234:916–921. <https://doi.org/10.1016/j.apenergy.2018.10.005>

44. Schlosberg D, Collins L. From Environmental to Climate Justice: Climate Change and the Discourse of Environmental Justice. *WIREs Climate Change*. 2014; 5(3):359–374. <https://doi.org/10.1002/wcc.275>
45. Wang X, Lo K. Just Transition: A Conceptual Review. *Energy Research and Social Science*. 2021; 82:102291. <https://doi.org/10.1016/j.erss.2021.102291>
46. Schlosberg D. Reconceiving Environmental Justice: Global Movements And Political Theories. *Environmental Politics*. 2004; 13(3):517.
47. Schlosberg D. Theorising Environmental Justice: The Expanding Sphere of a Discourse. *Environmental Politics*. 2013; 22(1):37–55. <https://doi.org/10.1080/09644016.2013.755387>
48. Givens JE, Huang X, Jorgenson AK. Ecologically unequal exchange: A theory of global environmental injustice. *Sociology Compass*. 2019; 13:e12693. <https://doi.org/10.1111/soc4.12693>
49. Foy KC. Home is Where the Health Is: The Convergence of Environmental Justice, Affordable Housing, and Green Building. *Pace Environ Law Rev*. 2012; 30(1). [cited 2024 May 10]. Available from: <https://heinonline.org/HOL/LandingPage?handle=hein.journals/penv30&div=4&id=&page=>.
50. Wolch JR, Byrne J, Newell JP. Urban green space, public health, and environmental justice: The challenge of making cities 'just green enough'. *Landscape and Urban Planning*. 2014; 125:234–244. <https://doi.org/10.1016/j.landurbplan.2014.01.017>
51. Sobotta RR, Campbell HE, Owens BJ. Aviation noise and environmental justice: The barrio barrier. *Journal of Regional Science*. 2007; 47:125–154. <https://doi.org/10.1111/j.1467-9787.2007.00503.x>
52. Collins MB, Munoz I, JaJa J. Linking 'toxic outliers' to environmental justice communities. *Environmental Research Letters*. 2016; 11(1):015004. <https://doi.org/10.1088/1748-9326/11/1/015004>
53. Agyeman J, Bullard RD, Evans B. Exploring the Nexus: Bringing Together Sustainability, Environmental Justice and Equity. *Space and Polity*. 2002; 6(1):77–90. <https://doi.org/10.1080/13562570220137907>
54. Suiseeya KR. Procedural justice matters: Power, representation, and participation in environmental governance. In: *Environmental Justice*. 1st ed. Routledge; 2020.
55. Bell D, Carrick J. Procedural environmental justice. In: *The Routledge Handbook of Environmental Justice*. 1st ed. Routledge; 2017.
56. Holland B. Procedural Justice in Local Climate Adaptation: Political Capabilities and Transformational Change. *Environmental Politics*. 2017; 26(3):391–412. <https://doi.org/10.1080/09644016.2017.1287625>
57. Dobson A. *Justice and the Environment: Conceptions of Environmental Sustainability and Theories of Distributive Justice*. United Kingdom: Oxford University Press; 1998.
58. Levenda AM, Behrsin I, Disano F. Renewable energy for whom? A global systematic review of the environmental justice implications of renewable energy technologies. *Energy Research & Social Science*. 2021; 71:101837. <https://doi.org/10.1016/j.erss.2020.101837>
59. Fox S. Localizing Environmental Federalism. *UC Davis Law Review*. 2020; 54:133–180.
60. Ware L. Plessy's Legacy: The Government's Role in the Development and Perpetuation of Segregated Neighborhoods. *RSF: The Russell Sage Foundation Journal of the Social Sciences*. 2021; 7(1):92–109. <https://doi.org/10.7758/RSF.2021.7.1.06>
61. Seitles M. The Perpetuation of Residential Racial Segregation in America: Historical Discrimination, Modern Forms of Exclusion, and Inclusionary Remedies. *Journal of Land Use & Environmental Law*. 1999; 14:89.
62. Brinkley C, Wagner J. Who Is Planning for Environmental Justice—and How? *Journal of the American Planning Association*. 2022. <https://doi.org/10.1080/01944363.2022.2118155> PMID: 39228964
63. Liotta C, Kervinio Y, Levrel H, Tardieu L. Planning for Environmental Justice—Reducing Well-Being Inequalities through Urban Greening. *Environmental Science & Policy*. 2020; 112:47–60. <https://doi.org/10.1016/j.envsci.2020.03.017>
64. Kato-Huerta J, Geneletti D. A Distributive Environmental Justice Index to Support Green Space Planning in Cities. *Landscape and Urban Planning*. 2023; 229:104592. <https://doi.org/10.1016/j.landurbplan.2022.104592>
65. Diezmartínez CV, Short Gianotti AG. US cities increasingly integrate justice into climate planning and create policy tools for climate justice. *Nature Communications*. 2022; 13(1):5763. <https://doi.org/10.1038/s41467-022-33392-9> PMID: 36180440
66. The White House. Fact Sheet: Inflation Reduction Act Advances Environmental Justice. 2022. [cited 2024 May 10]. Available from: <https://www.whitehouse.gov/briefing-room/statements-releases/2022/08/17/fact-sheet-inflation-reduction-act-advances-environmental-justice/>.

67. The White House. Fact Sheet: The Bipartisan Infrastructure Law Advances Environmental Justice. 2021. [cited 2024 May 10]. Available from: <https://www.whitehouse.gov/briefing-room/statements-releases/2021/11/16/the-bipartisan-infrastructure-law-advances-environmental-justice/>.
68. Caggiano H, Kocakuşak D, Kumar P, et al. U.S. cities' integration and evaluation of equity considerations into climate action plans. *NPJ Urban Sustain.* 2023; 3:50. <https://doi.org/10.1038/s42949-023-00129-6>
69. Chu EK, Cannon CE. Equity, inclusion, and justice as criteria for decision-making on climate adaptation in cities. *Current Opinion in Environmental Sustainability.* 2021; 51:85–94. <https://doi.org/10.1016/j.cosust.2021.02.009>
70. Cannon C, Chu EK, Natekal A, et al. Translating and embedding equity-thinking into climate adaptation: an analysis of US cities. *Regional Environmental Change.* 2023; 23:30. <https://doi.org/10.1007/s10113-023-02025-2>
71. Bose P. Climate Adaptation: Marginal Populations in the Vulnerable Regions. *Climate and Development.* 2017; 9(s1):575–578. <https://doi.org/10.1080/17565529.2017.1318747>
72. Barnett J. Climate Change, Insecurity, and Injustice. In: Adger WN, Paavola J, Huq S, Mace MJ, editors. *Fairness in Adaptation to Climate Change.* The MIT Press; 2006. <https://doi.org/10.7551/mitpress/2957.003.0011>
73. *The Oxford Handbook of Environmental Political Theory.* United Kingdom: OUP Oxford; 2015.
74. Heyward C. Climate Change as Cultural Injustice. In: Brooks T, editor. *New Waves in Global Justice.* New Waves in Philosophy. Palgrave Macmillan, London; 2014. [https://doi.org/10.1057/9781137286406\\_8](https://doi.org/10.1057/9781137286406_8)
75. Vinyeta K, Powys Whyte K, Lynn K. Climate change through an intersectional lens: gendered vulnerability and resilience in indigenous communities in the United States. Gen. Tech. Rep. PNW-GTR-923. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest; 2015.
76. Wuebbles D, Cardinale B, Cherkauer K, Davidson-Arnott R, et al. An Assessment of the Impacts of Climate Change on the Great Lakes. Environmental Law and Policy Center. 2019. [cited 2024 May 10]. Available from <https://elpc.org/wp-content/uploads/2020/04/2019-ELPCPublication-Great-Lakes-Climate-Change-Report.pdf>.
77. US Environmental Protection Agency. What Climate Change Means for Michigan. 2016. [cited 2024 May 10]. Available from <https://19january2017snapshot.epa.gov/sites/production/files/2016-09/documents/climate-change-mi.pdf>.
78. Shih C, Nicholls S. How Do Weather Conditions Influence Leisure Traffic? Evidence from Michigan and Implications for Climate Change. *Tourism Analysis.* 2012; 17(4):431–443. <https://doi.org/10.3727/108354212X13473157390641>
79. Sigmann C. Perceptions of Climate Risk and Efforts to Adapt to Climate Change: An Example for Tourism Industries in Northwest Michigan USA. Michigan State University ProQuest Dissertations Publishing. 2023. [cited 2024 May 10]. Available from <https://www.proquest.com/docview/2822647162?pq-origsite=gscholar&fromopenview=true>.
80. The Office of Debbie Stabenow. The Climate Crisis and Michigan. 2019. [cited 2024 May 10]. Available from [https://www.stabenow.senate.gov/imo/media/doc/Climate Crisis Report.pdf](https://www.stabenow.senate.gov/imo/media/doc/Climate%20Crisis%20Report.pdf).
81. Great Lakes Integrated Sciences and Assessments. Agriculture Summary. [cited 2024 May 10]. Available from <https://glisa.umich.edu/resources-tools/climate-impacts/agriculture/>.
82. Reich PB, Bermudez R, Montgomery RA, et al. Even modest climate change may lead to major transitions in boreal forests. *Nature.* 2022; 608:540–545. <https://doi.org/10.1038/s41586-022-05076-3> PMID: 35948640
83. Carrera JS, Key K. Troubling Heroes: Reframing the Environmental Justice Contributions of the Flint Water Crisis. *WIREs Water.* 2021; 8(4):e1524. <https://doi.org/10.1002/wat2.1524> PMID: 36694813
84. Pauli BJ. The Flint Water Crisis. *WIREs Water.* 2020; 7(3):e1420. <https://doi.org/10.1002/wat2.1420>
85. Grossman DS, Slusky DJG. The Impact of the Flint Water Crisis on Fertility. *Demography.* 2019; 56(6):2005–2031. <https://doi.org/10.1007/s13524-019-00831-0> PMID: 31808102
86. Brooks SK, Patel SS. Psychological Consequences of the Flint Water Crisis: A Scoping Review. *Disaster Medicine and Public Health Preparedness.* 2022; 16(3):1259–1269. <https://doi.org/10.1017/dmp.2021.41> PMID: 33958025
87. Murray K, Peterman C. Soil Contamination as a Legacy of the US Auto Industry, Southwest Detroit, Michigan USA. EGU General Assembly 2012. 2012. [cited 2024 May 10]. Available from <https://ui.adsabs.harvard.edu/abs/2012EGUGA..14...45M/abstract>.
88. Revord E. Legacies of Industrial Contamination: Voices of Resistance in White Lake, Michigan. Cal Poly Humboldt Theses and Projects. 2018. [cited 2024 May 10]. Available from <https://digitalcommons.humboldt.edu/etd/178>.

89. Shaw E. Polychlorinated Biphenyls (PCBS): A Legacy of Contamination in Michigan's Rivers. Michigan Technological University, United States; 2018. ProQuest. [cited 2024 May 10]. Available from: <https://ezproxy.msu.edu/login?url=https://www.proquest.com/dissertations-theses/polychlorinated-biphenyls-pcbs-legacy/docview/2184766922/se-2>.
90. Michigan Department of Environment, Great Lakes, and Energy [EGLE]. Contaminated Sites. 2022. [cited 2024 May 10]. Available from [https://www.house.mi.gov/hfa/PDF/EnvironmentalQuality/EGLE\\_Subcmte\\_Testimony\\_Contaminated\\_Sites\\_Presentation\\_3-1-22.pdf](https://www.house.mi.gov/hfa/PDF/EnvironmentalQuality/EGLE_Subcmte_Testimony_Contaminated_Sites_Presentation_3-1-22.pdf).
91. Michigan Department of Environment, Great Lakes, and Energy [EGLE]. MI Healthy Climate Plan. 2022. [cited 2024 May 10]. Available from <https://www.michigan.gov/egle/-/media/Project/Websites/egle/Documents/Offices/OCE/MI-Healthy-Climate-Plan.pdf?rev=d13f4adc2b1d45909bd708cafccbfffa&hash=99437BF2709B9B3471D16FC1EC692588>.
92. Madigan K, Stille G. Michigan Communities Leading on Climate. Michigan Climate Action Network. 2022. [cited 2024 May 10]. Available from <https://assets.nationbuilder.com/miclimatereaction/pages/1006/attachments/original/1647885013/MichiganCitiesClimateReportWEB.pdf?1647885013>.
93. Selvi AF. Qualitative content analysis. In: The Routledge Handbook of Research Methods in Applied Linguistics. 1st ed. 2019.
94. Alamdari N, Sample DJ, Steinberg P, Ross AC, Easton ZM. Assessing the Effects of Climate Change on Water Quantity and Quality in an Urban Watershed Using a Calibrated Stormwater Model. *Water*. 2017; 9:464. <https://doi.org/10.3390/w9070464>
95. Duran-Encalada JA, Paucar-Caceres A, Bandala ER, Wright GH. The impact of global climate change on water quantity and quality: A system dynamics approach to the US–Mexican transborder region. *European Journal of Operational Research*. 2017; 256(2):567–581. <https://doi.org/10.1016/j.ejor.2016.06.016>
96. Gerber BJ. Local Governments and Climate Change in the United States: Assessing Administrators' Perspectives on Hazard Management Challenges and Responses. *State and Local Government Review*. 2015; 47(1):48–56. <https://doi.org/10.1177/0160323X15575077>
97. Borrego C, Rafael S, Rodrigues V, Monteiro A, Sorte S, Coelho S, et al. Air quality, urban fluxes and cities resilience under climate change—a brief overview. *International Journal of Environmental Impacts*. 2018; 1(1):14–27. <https://doi.org/10.2495/EI-V1-N1-14-27>
98. Feng M, Ren J, He J, Chan FKS, Wu C. Potency of the pandemic on air quality: An urban resilience perspective. *Science of The Total Environment*. 2022; 805:150248. <https://doi.org/10.1016/j.scitotenv.2021.150248> PMID: 34536865
99. Walker MS. The Place of Local Government in air pollution control. *Natural Resources Lawyer*. 1972; 5(Nat. Resources Law). [cited 2024 May 10]. Available from: <https://heinonline.org/HOL/P?h=hein.journals/narl5&i=190>.
100. Cox SL, Hotchkiss EL, Bilello DE, Watson AC, Holm A. Bridging Climate Change Resilience and Mitigation in the Electricity Sector Through Renewable Energy and Energy Efficiency: Emerging Climate Change and Development Topics for Energy Sector Transformation. United States; 2017. <https://doi.org/10.2172/1411521>
101. Wang X, Liu C, Hawkins CV. Local Government Strategies for Financing Energy Efficiency Initiatives. *The American Review of Public Administration*. 2017; 47(6):672–686. <https://doi.org/10.1177/0275074015619483>
102. Armstrong JH. Modeling effective local government climate policies that exceed state targets. *Energy Policy*. 2019; 132:15–26. <https://doi.org/10.1016/j.enpol.2019.05.018>
103. Hresko Pearl T. Racing to defeat climate change on reluctant roads: autonomous vehicles, urban climate resilience, and legal reform. In: *Urban Climate Resilience*. Cheltenham, UK: Edward Elgar Publishing; 2022. <https://doi.org/10.4337/9781803922508.00017>
104. Górka K, Szyja P. Cooperation of local governments and enterprises to support the provision of sustainable transport infrastructure. *Management of Environmental Quality*. 2015; 26(5):739–751. <https://doi.org/10.1108/MEQ-08-2014-0128>
105. Panteli M, Mancarella P. Influence of extreme weather and climate change on the resilience of power systems: Impacts and possible mitigation strategies. *Electric Power Systems Research*. 2015; 127:259–270. <https://doi.org/10.1016/j.epsr.2015.06.012>
106. Tan PY, Zhang J, Masoudi M, Alemu JB, Edwards PJ, Grêt-Regamey A, et al. A conceptual framework to untangle the concept of urban ecosystem services. *Landscape and Urban Planning*. 2020; 200:103837. <https://doi.org/10.1016/j.landurbplan.2020.103837> PMID: 32341614
107. Vilhar U. Water Regulation and Purification. In: Pearlmutter D, et al., editors. *The Urban Forest*. Future City, vol 7. Springer, Cham; 2017. [https://doi.org/10.1007/978-3-319-50280-9\\_5](https://doi.org/10.1007/978-3-319-50280-9_5)

108. Maria FD, Sisani F. Greenhouse Gas Emissions and Environmental Impact from Recycling the Organic Fraction of Solid Waste: Comparison of Different Treatment Schemes from a Life Cycle Perspective. *Recycling*. 2017; 2(3):13. <https://doi.org/10.3390/recycling2030013>
109. Corburn J. Bringing Local Knowledge into Environmental Decision Making: Improving Urban Planning for Communities at Risk. *Journal of Planning Education and Research*. 2003; 22(4):420–433. <https://doi.org/10.1177/0739456X03022004008>
110. McComas KA, Arvai J, Besley JC. Linking Public Participation and Decision Making through Risk Communication. In: *Handbook of Risk and Crisis Communication*. Routledge; 2010.
111. Allam MZ. Urban resilience and economic equity in an era of global climate crisis. 2019. [cited 2024 May 10]. Available from: <https://hdl.handle.net/2123/21380>.