Climate Change for Cities: Mitigation and Adaptation Policies

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2022FA_MPPA_498-DL_SEC55

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November 20, 2022

Introduction

Climate change is a complex systems problem that poses special risks for cities in the United States. In 2018, 83 percent of the U.S. population lived in urban areas, and this is expected to grow to 89 percent by 2050 (*U.S. Cities Factsheet*, 2021). The threat of global warming induced climate change is especially urgent for coastal U.S. cities. A 3-degree Celsius increase in global temperature that melts the Greenland and West Antarctica Ice Sheets would raise sea levels at least 20 feet, resulting in massive permanent flooding for major cities like Miami, New Orleans, Los Angeles, New York, and Washington, D.C. (Kanter & Martinez, 2022). Farther from the coast, the likelihood of extreme weather events including droughts, wildfires, and tornadoes has increased as a result of anthropogenically-driven climate change (Stott, 2016), which threatens Midwest and inland American cities. To prepare for these challenges, cities can implement strategies of greenhouse gas emissions mitigation, and adaptation to prepare for future climate disasters. In this capstone paper, I will discuss how mitigation and adaptation policies for cities gets on the political agenda, how projects are chosen, how projects are financed and economically justified, how projects are evaluated, and what the characteristics are for successful government partnerships and policy actor networks.

Mitigation is the reduction of greenhouse gas emissions. In urban areas the majority of emissions come from energy, buildings, transportation, and waste (Kanter & Martinez, 2022). There are numerous ways cities can reduce emissions of greenhouse gases, including choosing renewable energy sources, mandating or incentivizing energy efficient building codes, and investing in mass transit (Hughes, 2017). Another mitigation tactic is the pricing and taxing of carbon emissions based on economic and climate models to determine the cost of future damages from current emissions of carbon (Mi et al., 2018). However, despite cities' best efforts to address local sources of greenhouse gas emissions, the U.S. Office of Energy Efficiency and Renewable Energy (n.d.) found that the most common climate actions taken by cities did not necessarily correspond to the largest sources of emissions in their city.

Adaptation to climate change is the “process of adjustment so that negative impacts of climate change can be reduced or avoided” (van Valkengoed & Steg, 2019, p. 158). Adaptation activities are less generalizable between cities and regions, and special attention must be given to identify the types of climate threats that could affect the city in question. Climate threats can be reduced by building systemic resilience to encourage adaptive behavior through awareness and public finance programs, and hazard-specific actions to reduce the impact of major climate events (Kanter & Martinez, 2022). Some examples of hazard-specific actions include drought management policies in the southwest, construction of dikes and pumps to manage storm surge in New Orleans, and heat relief centers for heatwaves in areas that have historically never dealt with extreme heat in the pacific northwest states.

When a city decides to pursue mitigation and adaptation policies, it must form a coalition of support to get policies enacted and projects funded. To accomplish this, local politicians and administrators must analyze and understand the policy domain and the policy environment so they can operate strategically and effectively to get climate policies on the policy agenda (Birkland, 2020). It is crucial that policy actors pushing climate mitigation and adaptation clearly define the problem and possible solutions. Schattschneider (1975) described the power of a clear policy agenda by stating that the group that successfully describes a problem will also be the one that defines solutions to it and will be more likely to win the policy debate. Birkland (2020) describes aspects of problem definition that include focusing events and numbers as indicators of problems. In the climate change debate, extreme storms can act as focusing events to draw attention to a necessary policy, and tracking metrics such as global temperature change and CO_2 emissions can help policy makers to keep their finger on the pulse of how likely an extreme weather event is to occur.

When a climate policy has found its place on the policy agenda, it must be financed and included in the city's budget. For construction projects and capital expenditures, cost objects and cost behavior must be determined according to fixed and variable costs, and the time horizon and range of outputs must be calculated (Mikesell, 2016). This paper will explore how mitigation and adaptation policies are typically financed and how they are described in different types of budgets. It is also important to account for the economic impact of the policy, or the damages from doing nothing. Adverse climate conditions are an externality of rising global temperature and how the taxpayers fund mitigation and adaptation policies must be optimally designed to account for different economic perspectives and who should carry the weight of correcting the externality. One way to account for this externality is through the pricing of carbon emissions using a statistical economic model, such as the EPA's Social Cost of Carbon (Pindyck, 2019).

When the policy has been funded and implemented, it must be evaluated on a regular basis to ensure it is successful. For climate policies it is important to establish a causal link between the policy's implementation and desired impact (Rossi, et al., 2019). Azevedo and Leal (2017) developed a framework that uses descriptive, causal, and normative questions to connect mitigation activities to observable outcomes. However, the definition of a successful adaptation is often subjective. Singh et al. (2022) identified eleven different viewpoints, including economic impact, improved wellbeing, reduced vulnerability or increased adaptive capacity, enhanced resilience to climate shocks, sustainability, avoiding maladaptation, ecosystem conservation, community-based adaptation, adaptive governance, social justice, and transformation.

Finally, this paper will discuss the characteristics of the networks of policy actors that push and implement climate policies in cities by analyzing literature to determine the level of collaboration seen in these networks. Agranoff (2012) describes a conductive agency as one who uses the power of collaboration to enhance their strategic advantage, typically seen in a network setting. Cities must often contract with firms to perform evaluations and perform construction work for climate adaptation projects, and the central authority at the city level must manage these relationships with care to ensure success. This paper will also discuss aspects of the monitoring and program evaluation stages of climate mitigation and adaptation projects for cities.

Getting Climate Policy on the Policy Agenda

John Kingdon (2011) visualized the way policies and projects become reality is when elements of three “streams” come together to elevate a policy from the ephemeral policy universe to the policy agenda. These streams include the Problem stream, which for this paper includes the situation of a warming climate and increased probability of adverse and catastrophic weather events. The Policy stream is all the potential ideas that could be implemented for climate change mitigation and adaptation. The third stream is the politics stream, which symbolizes the state of politics and public opinion around the topic of climate change. These three streams do not cross until they reach a “window of opportunity”, typically during or after a focusing event that brings attention to the issue and stakeholders are motivated to enact policy (Kingdon, 2011). For cities adapting to climate change, a focusing event could be the repetitive catastrophic flooding of certain neighborhoods, or the experience of extreme heat that puts pressure on basic utilities such as water and electricity.

Climate mitigation and adaptation projects will generally fall into Brewer’s policy cycle, which includes agenda setting, estimation, selection, implementation, and termination or renewal

(Brewer & deLeon, 1983). After issue emergence, advocacy coalitions push actors to debate different policies that ultimately set the policy agenda. For a climate mitigation policy, this debate would center on how, and if, the city needs to reduce carbon emissions. For an adaptation policy or project, the agenda setting debate would center on the effectiveness and feasibility of capital projects that improve resilience or reduce damage. Estimation would include conducting cost-benefit analysis to determine if the mitigation measures impose a regressive tax or have negative economic externalities, or in the case of an adaptation project, if it can be funded in the budget or financed. The selection stage is where the city's elected leaders decide upon a course of action. Implementation is the physical activities generated by the policy. Finally, the evaluation stage is crucial for determining the impact of the mitigation or adaptation policy, which can supply information on whether the project can be improved, renewed, or terminated.

However, these six stages of Brewer's policy cycle are multidimensional and subject to the four aspects of the policy environment: structural, social, economic, and political (Birkland, 2020). The structural environment describes how climate policy moves through the legislative process and receives funding and implementation (Birkland, 2020). For grassroots actors in a city that desires climate mitigation or adaptation, it is vital to accurately understand the mechanics of how issues surface at city and county meetings, and what the procedures are for advancing policies. The social environment describes the demographics relevant to the policy issue (Birkland, 2020). Is the proposed policy more favored by one demographic or political party over another? This type of question can help to understand the mood of different social groups that are competing in the policy space. The political environment comprises the desires of politicians and realpolitik of policy debate (Birkland, 2020). Public approval data can help politicians to justify a certain climate policy or to help understand the actual list of feasible policies that voters will support. Finally, the economic environment places the climate policy within the context of what the current economic conditions will allow for in terms of spending and appetite for debt. During economic downturns, voters may be less likely to support funding for climate actions over economic stimulus or social spending.

These four aspects of the policy environment help us to understand why certain policies were chosen over others. Climate change presents wicked problems that cannot be fully understood or solved by a single person or political body, and the choices that voters and politicians make can be better understood using decision-making frameworks like rational-comprehensive decision making, bounded rationality, and incrementalism (Birkland, 2020). Rational comprehensive decision-making assumes that people are rational actors with all the knowledge and understanding needed to select the best decision (Birkland, 2020). For climate mitigation and adaptation projects, it is unlikely that all the city council members will have complete understanding of the climate models that determine how much carbon should be taxed for mitigation, or what the risk assessments for damage to different public utilities are with perfect accuracy in the case of adaptation. However, the city council members likely have some sense of what is possible given the political climate and personal expertise, and by using experts can make decisions using a bounded rationality framework. With bounded rationality, actors recognize their limitations and may not seek a perfectly optimal policy outcome, but instead aim for one that "satisfices" (Storing, 1962). For a climate mitigation project, a satisficing outcome might be the construction of solar panels for a few, instead of all, public buildings in the city. For climate adaptation, a satisficing outcome might be the selection of a less effective but more cost-efficient floodwater drainage system. However, these decisions are not usually made without any sort of history. This is where the incrementalism framework helps to understand how small steps build towards larger policy outcomes over time. In the context of climate policy, it is likely you will see studies, commissions, and resolutions by political bodies about climate change that signal mitigation or adaptation policies may be in the future.

Public Finance Considerations for Climate Mitigation and Adaptation Policies

An important consideration of climate change mitigation and adaptation projects is how the projects are going to be financed. Mikesell (2016) identified four phases of public budgets that include executive preparation, legislative consideration, execution, and audit and evaluation. During the executive preparation stage of crafting a climate policy item in a budget, forecasting should be done to analyze the cost of future damages as well as future income streams that may be tied to the project and expected future costs of implementation and maintenance (Mikesell, 2016). During cost analysis and estimation, the project will be summarized as a series of cost objects with cost behavior that can be fixed or variable depending on the time horizon, specific cost object, and range of output provided by the expenditure (Mikesell, 2016). The budget analysis should be able to justify the chosen project by presenting cost comparisons for alternatives, such as privatization of different parts of the project, if revenue will come from taxes or fees, and if the project will enhance economic development (Mikesell, 2016).

When crafting a carbon tax and estimating its revenue to the city, there is the assumption that when carbon taxes are instituted to discourage carbon emissions, the revenue from these taxes will decrease over time as society cuts back carbon-emitting behaviors to avoid the tax (de Mello & Martinez-Vazquez, 2022). It is important to remember that carbon taxes are not a long-term source of funding, and their forecasted discounted income value should be used for long-term public budget planning. When forecasting the revenue from carbon taxes the estimator should model the elasticity of the market response to the carbon taxes. Certain sections of society and certain geographic areas will be more able to reduce carbon consumption than others. In a public policy catch-22, it is possible that climate change will drive up consumption of carbon in the form of electric and natural gas heating and cooling systems. Policy makers studying a carbon tax to mitigate climate change should consider if the tax is regressive (de Mello & Martinez-Vazquez, 2022). If the carbon tax results in a tax burden that is disproportionately shouldered by lower-income taxpayers, the tax may not socially equitable or politically feasible.

Adaptation can be more costly than mitigation as it requires funding for capital investments in infrastructure (de Mello & Martinez-Vazquez, 2022). Capital investments are accounted for in a capital budget that is separate from the annual public budget. A key difference between the capital budget and annual budget is that the capital budget is financed with payments over the course of its lifetime, compared to the annual public budget which is balanced yearly (Mikesell, 2013). This distinction is important for how cost-benefit analysis is conducted on the adaptation project. For capital projects, cost-benefit analysis should categorize the project objectives, estimate the project's impact on those objectives, estimate the project's costs, discount cost and benefit streams at a calculated discount rate, and summarize the findings in a format that aids decision making (Mikesell, 2013). For adaptation projects, it is important to categorize the objectives so that different projects or policy options can be studied for cost-effectiveness. This can be difficult to do if metrics are not consistent between analyses of the multiple projects being evaluated for funding.

Reguero et al. (2018) examined the cost-effectiveness of three types of adaptation interventions that coastal cities that are at risk of flooding could take by analyzing storm damage to counties on the gulf coast. These adaptations include nature-based, such as restoring oyster reefs; structure or "grey" investments into construction projects like seawalls; and policy measures like requiring home elevation in flood-prone areas. Reguero et al.'s (2018) analysis started by assessing baseline or current risk, estimating future risk using CLIMADA software, and then comparing the costs and benefits of adaptation measures. This analysis found that nature-based projects are the most cost-effective and contribute the most to overall damage reduction and include positive externalities (Reguero et al., 2018). Grey structure investments and policy measures deliver the greatest damage reduction from a single type of event, but are expensive and overall not very cost-effective (Reguero et al., 2018). Cities that are considering adaptation investments should take a multi-prong approach and identify the greatest threats posed by climate change, what natural or ecosystem investments are cost-effective, what types of structures they can build to directly prevent damage, and what kind of policies help citizens to avoid damage. When crafting policy measures it is important to consider unforeseen outcomes and avoid moral hazards, such as government insurance policies that encourage building in flood-prone areas (de Mello & Martinez-Vazquez, 2022).

Cities can better estimate the total costs of an adaptation project by using Activity Based Costing. Activity Based Costing can help avoid the cost distortion caused by substantial indirect costs by turning indirect costs into direct costs by assigning them to narrowly defined activities rather than allocate them from a broadly defined cost pool (Michel, 2004). A city can implement Activity Based Costing for a mitigation or adaptation project by allocating direct costs to cost objects and allocating indirect costs to cost activities. In this example a direct cost might be the salaries of workers, and the cost object would be seawall being constructed as part of a grey infrastructure adaptation strategy. An indirect cost would be the meetings and administrative overhead necessary for managing and monitoring the project, and the cost activities would be labeled collaboration and management. These cost activities that include meetings and administration are then calculated and applied toward the cost object construction project, which including cost activities represents a more accurate description of costs. Activity Based Costing can also be applied in stages when different direct costs and cost activities arise at different times of the project life cycle (Michel, 2004). For a climate change adaptation project, this can be useful as there are many indirect costs that come from activities related to researching the climate change threats to the city and possible routes for damage avoidance and resilience during the early stages of planning. Once the project has been selected, direct costs can be applied to the cost objects that represent the physical aspects of the project, and indirect costs, such as overseeing the construction process and financial draws, will be relatively smaller. At the end stages of the project when monitoring and evaluation come into play, indirect costs bundled into activities will again become important to capture the full costs of long-term monitoring and measuring the impact of the project.

How do you Economically Justify a Climate Project?

Investment in climate mitigation and adaptation policies requires stakeholders to invest in projects with the understanding that the long-term payoff of the investment will outweigh the short-term benefit of not spending the money or spending the money in other ways. To determine the future value of money you could potentially invest, you must convert the future value to present value using discounting. Discounting creates a comparable future value of money by determining what the value of that investment would be when accounting for inflation (Rossi, et al., 2019). Investments into climate mitigation and adaptation are typically large capital investments that must provide a net positive value over time. To determine if the investment is feasible, the city must calculate its probability that it will experience an adverse climate event, its discounted cost in damages, and its discounted cost to avert or mitigate the damages.

With the understanding that global climate change is a negative externality of rising carbon dioxide levels generated through consumption of fossil fuels, cities should want to reduce the impact of this externality to its citizens. However, there is a gap between the amount of funding given to climate mitigation policies and the funding level necessary to avert climate damages that Gillingham and Palmer (2014) refer to as the energy efficiency gap. In discounting terms, individuals tend to heavily discount future energy savings when presented with options related to the energy efficiency of a durable good (Train, 1985). This means that individuals place a low value on the return on energy efficiency investments rather than having the funds in hand now. This behavior can result in a market failure when climate damages could have been avoided had stakeholders sufficiently valued investments in climate mitigation or adaptation. Gillingham and Palmer (2014) studied the literature of economic underpinnings of this behavior and found that imperfect information, principal-agent issues, and credit constraints often resulted in undervaluing investments in energy efficiency.

Gillingham and Palmer (2014) also explored behavioral functions related to undervaluing energy efficiency investments and found that nonstandard preferences in consumers can distort perceptions of value. These behaviors include self-control problems, reference-dependent preferences, nonstandard beliefs, and nonstandard decision making (Gillingham & Palmer, 2014). Reference-dependent preferences refers to consumers' tendency to value an investment according to a particular point of reference. Loss aversion is an example where consumers tend to exaggerate the decline of utility from a relative loss compared to the increase of utility from a relative gain (Tversky & Kahneman, 1981). Nonstandard beliefs about climate change are also an important behavioral aspect to consider alongside loss aversion. Due to its politicized nature, climate change mitigation and adaptation policies may run up against nonstandard beliefs that systematically incorrect about the future (DellaVigna, 2009). These unsupported beliefs can range from downplaying the cost of climate change, to beliefs that exaggerate the cost of climate change. For cities considering climate mitigation or adaptation investments, it is important to consider loss aversion and nonstandard beliefs when framing the choices presented to stakeholders (Gillingham & Palmer, 2014).

From both an economic and behavioral perspective, Gillingham and Palmer (2014) recommend correcting information asymmetry as a critical step in determining first-best approaches to help stakeholders correctly value investments and make decisions. Also, Gillingham and Palmer (2014) recommend policies that are matched and tailored to specific situations, as opposed to general policies or blanket statements. An example of a tailored policy to build disaster resilience is the Federal Emergency Management Agency's Swift Current Initiative, which is focused on making flood mitigation assistance available through annual grants for communities that are repetitively flooded and receive substantial damage to buildings. In addition to tailored policies, cities can address principal-agent problems by contracting out government services with clearly defined inputs and outputs.

Public Private Partnerships for Climate Mitigation and Adaptation

When undertaking climate mitigation and adaptation projects, cities will likely need help from the private sector through Public-Private Partnerships, or PPPs. PPPs in the energy sector are "industry-government alliances that involve joint technology road mapping, collaborative priorities for the development of advanced energy-efficient and low-carbon technologies and cost sharing" (Brown, 2001, p. 1204). PPP collaboration can come from hiring private firms to research climate threats to the city and suggest policies to mitigate emissions and adapt to the threat, and in the later stages by hiring private firms for the construction and maintenance of capital projects. Buso and Stenger (2018) found that compared to public subsidies, PPPs can lead to higher outcomes and performance when there is fair allocation of bargaining power between public and private contractors, when private and social returns are similar, and when bargaining procedures are not perceived as being too lengthy or costly.

Some of the main advantages of PPPs are that they bring private capital to public infrastructure, can be a risk-sharing device, can help to pool financing, and can increase efficiency by bringing cost discipline from the private sector (Ahmad & Xiao, 2018). Ahmad and Xiao (2018) also found critiques of PPPs included government use of off balance-sheet investments to avoid budget restraints, questionably excessive private sector profits, and increased administrative costs. Information asymmetry is important for constructing contracts so that public managers are made fully aware of the liabilities and costs generated (Ahmad & Xiao, 2018). The acceptance of risk is a key part of contracts for capital investments. Private contractors are less attracted to the risker parts of projects, such as preparation and construction in the early stages, but can be more willing to take on elements of operations once the project is complete, such as maintenance and daily operations (Ahmad & Xiao, 2018).

PPPs are constrained by the contracting framework they are negotiated in, which can be dynamic depending on the type of project and the legal and informational challenges that arise. Governments should always pursue complete contracts with every contingency accounted for, but in a loosely linked network of public and private partners, incomplete contracts will likely be drawn. Ahmad and Xiao (2018) shared insights into how to achieve optimal results from a PPP in an incomplete contracting environment which include sharing information, allow the private sector manager to be responsible for cost innovation, and the public sector manager to be responsible for quality assurance. PPP contracts may be too complex for local governments to optimally design and should seek support from a central PPP-management body (Ahmad & Xiao, 2018). As with any business negotiation, incentives should be aligned with outcomes so that principal-agent outcomes are avoided.

Decentralized networks for PPP Management

When undertaking a PPP for a climate mitigation or adaptation initiative, managing that partnership will require savvy public managers who can operate in decentralized networks with both formal and informal relationships. Maraña and Sarriegi (2020) embrace the idea of informal relationships to boost resilience for critical infrastructure with their concept of a People Public Private Partnership. The People aspect of this partnership symbolizes the importance of involving the public in decisions and the need for citizens to consider themselves relevant stakeholders (Maraña & Sarriegi, 2020). Maraña and Sarriegi (2020) conducted a literature review and surveyed experts to find what network characteristics were important, and at what stage of a project these characteristics were considered important and found that the characteristics for information flow were highly valued in the beginning and middle stages. The qualities Maraña and Sarriegi (2020) identified include information quality, information sharing, participation, information accessibility, information transparency, and user friendliness.

describe modern critical infrastructure as an interdependent network that is only as resilient as the other critical infrastructure it relies on. For example, a pump system for dispersing floodwater should have multiple power systems and internet connectivity options so that it can continue to function during an extreme weather event. We should also not forget the human resources who must operate critical infrastructure during extreme weather events and prioritize training and contingency plans to reduce the likelihood of human error compounding difficulties in an emergency situation.

When public agencies that work for cities are accomplishing goals using a decentralized and distributed network of cooperation and collaboration and loosely linked partners, that public agency is acting as a conductive agency (Agranoff, 2012). These networks can be horizontal, where the conductive agency deals with counterparts in other agencies and the private sector, and vertical when it works with teams at higher and lower levels of its organizational structure. Agranoff (2012) describes networks as non-hierarchical collaborarchies that mix bureaucratic principles with ideals from volunteer organizations to create a leadership structure that is flexible and based on champions, advocates, and work groups. Pinske and Kolk (2012) found that in the context of addressing climate change, partnerships help each party achieve more than either could have on their own by filling in gaps based on their relative strengths and weaknesses. These gaps include regulatory gaps, where public governance falls short of a needed goal, participation gaps that lack inclusiveness and representation, resource gaps that can be addressed by pooling resources, and a learning gap that is addressed by sharing information (Pinske & Kolk, 2012). Sharing information is critical for building a successful network as knowledge management is a key role of a conductive agency that is expected to provide guidance and leadership through the process of selecting and implementing a climate mitigation or adaptation project.

Roggero and Thiel (2018) studied collaborative and isolated institution styles and found that collaborative agencies will adjust their existing coordination structures to adapt to the new event, and isolated institutions will create collaborative structures if the climate threat is perceived to be serious enough. This is important for building climate change coalitions in a collaborative network. If there is an isolated agency that is uncooperative with your network, perhaps there is a better way to communicate how serious the problem is and how working together to mitigate or adapt to this threat is in both agency's best interests.

How do you Evaluate a Climate Project's Impact?

Any climate project undertaken by a city should be properly monitored so that its outcome and impact can be judged, and changes to the program can be made if needed. Different types of evaluations can be used for climate mitigation and adaptation projects, including needs assessments, assessments of program theory and design, assessments of program process, impact evaluations, and cost and efficiency assessments (Rossi et al., 2019). When assessing program impact, it is key to create a causal design that can be described with a logic model (Rossi et al., 2019). For climate mitigation projects that seek to reduce the release of carbon dioxide, establishing causality will require reliance on climate science and economics to determine how much carbon dioxide release has been reduced and what that metric means specifically for the city. It will be easier to study the impact and causality of adaptation projects that can be tested or observed during extreme weather events to determine if the adaptation project provided the expected level of resilience. The goal of a causal evaluation design is to isolate the effects of the program on outcomes of interest to stakeholders and give unbiased estimates of the magnitude of the effects (Rossi et al., 2019). Establishing causality is a rigorous task but it can give extra legitimacy to projects where outcomes are easily linked to adaptation activities.

One of the first steps in program evaluation is to identify the program outcome and the proper way to measure it. Outcome measurement properties that are relevant to program impact are reliability, validity, and sensitivity (Rossi et al., 2019). For climate mitigation, the Social Cost of Carbon is a widely accepted calculation that meets inspection for these three properties. Owen (2020) found that some good adaptation practices include strengthening institutional partnerships, engaging local individuals and communities, promoting strong leadership, and facilitating social learning. Even in the evaluation stage, network management is key for ensuring quality and keeping stakeholders engaged so that the policy has the best result possible.

A good example of a logic model that could be applied to climate mitigation or adaptation policies is the Center for Disease Control's logic model developed by their Program Performance and Evaluation Office. The CDC model uses a circular flow chart with six steps that includes engaging stakeholders, describing the program, focusing the evaluation design, gathering credible evidence, justifying conclusions, and ensuring use and sharing lessons learned (CDC, 2021). It is important to note the CDC model is circular and starts and ends by engaging stakeholders and sharing lessons. This is important for climate policies so that successes and failures can be shared and evidence-based practices are implemented and tested so that more effective policies can be determined in the future. For gathering evidence and justifying conclusions, a policy analyst could create cost-benefit estimates to compare what the project costed versus savings from mitigation and adaptation. However, this may be difficult to certify as the counterfactual to implementing the project is not doing the project while still experiencing the same weather event, so there is no control group for projects such as seawall or drainage construction. In these cases, the analysis may need to compare different areas that did or did not receive treatment and reconcile their differences such that a comparison can be made. One method of comparing two groups is with covariate-adjusted, regression-based estimates (Rossi, et al., 2019). This method first measures baseline characteristics for both groups and calculates the predictability of these covariates towards target outcome. To compare the groups, it is assumed that whatever differences in program outcome that cannot be accounted for by the covariates is the actual program effect. This method is also effective as it gives a quantitative estimate of program effect that can be compared to the program's cost to determine cost effectiveness and the unit cost of project outcome, which is helpful for activity based costing.

One framework that a city could use to evaluate its overall risk and readiness is the Urban Adaptation Assessment created by the University of Notre Dame (n.d.). This study provides scores and calculations for assessing different climate threats and preparedness levels for 278 cities in the United States. A city could create a scorecard for itself based on these metrics and measure its progress toward climate goals in relation to other cities with a comparable metric. Figure A1 shows Urban Adaptation Assessment averages by region, with the highest average overall risk going to the Northeast region, which is at high risk of flooding from sea level rise, and the highest overall readiness going to the upper Midwest. The Urban Adaptation Assessment (University of Notre Dame, n.d.) includes policy factors such as the existence of drought management plans and the number of corruption convictions to build a metric that is robust to political policy environment and could be highly useful for tracking cities with similar demographics and political, social, and economic environments.

Conclusion

Climate change poses an existential threat to certain cities that are not prepared to mitigate their contributions to the climate crisis and adapt to an uncertain future. This paper discussed policy streams and the budget process at the initial stages of implementation, the economics of mitigation and adaptation activities, contracting and organizational theory considerations, and elements of program evaluation for climate change projects for cities. Between these dimensions there is a common theme of stakeholder engagement and collaboration. For a policy to make it on the agenda, it must appeal to a broad enough section of society that it is politically feasible. This means that political organizations must be in contact with citizens and interest groups to gather stakeholder feelings on a particular climate threat, and what appropriate actions should be taken. It should not be forgotten that machines do not move policies between the stages of the policy cycle, people do, and their interactions govern the types of actions that a political body can take. Different decision-making frameworks can estimate what a political body of semi-rational individuals is capable of, but there is a need for more research into the behavioral and organizational psychology of groups tackling climate change projects. Also, more research is needed on the efficacy of different tax policies for mitigation and their real contributions toward reducing emissions. Ultimately, mitigation and adaptation policies should complement each other to build a city that is sustainable and resilient to threats from climate change.

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Appendix A

Figure A1. Average Risk and Readiness of Cities by Region (University of Notre Dame, n.d.)

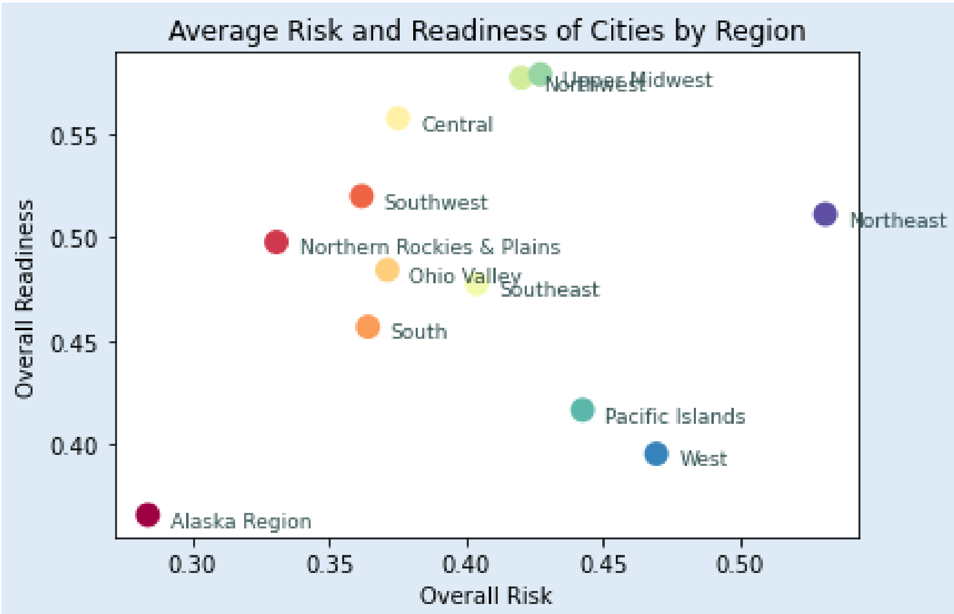

Figure A2. Boxplot of Overall Risk grouped by Region (University of Notre Dame, n.d.)

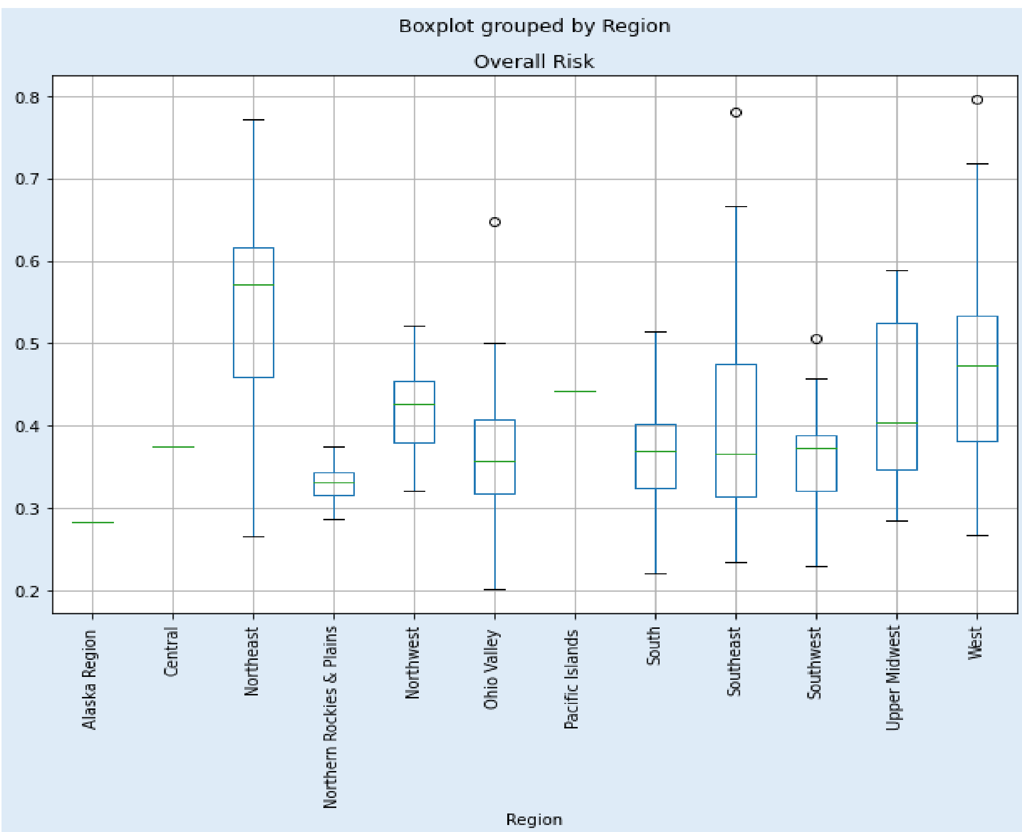

Figure A3. Boxplot of Overall Readiness grouped by Region (University of Notre Dame, n.d.)