ISSN 1946-7664. MCFNS 2018
Vol. 10, Issue 2, pp. 33–45
Mathematical and Computational Forestry & Natural-Resource Sciences

AVAILABLE ONLINE AT HTTP://MCFNS.COM

Submitted: Mar. 20, 2018
Accepted: Sep. 28, 2018
Published: Oct. 30, 2018
Last Correction: Oct. 10, 2018

THE ROLE OF THE U.S. MAYORS AND URBAN FORESTS IN ADDRESSING CLIMATE CHANGE MITIGATION AND ADAPTATION

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Abstract. Leadership at cities and municipalities can be instrumental in beginning local conversation regarding climate change and urban forest policies. Much research has been devoted to national climate change actions, but little is currently known about initiatives and actions at the local level. This study presents results of a survey of U.S. Conference of Mayors Climate Protection Agreement (MCPA) members, representing 1,054 cities and 93.6 million people, conducted to improve the understanding of how mayors view urban forest policies related to climate change. The goals of the study were to examine local government initiatives for climate change and urban forests and how mayors prioritize these investments. The results indicated that a variety of local climate change mitigation and adaptation actions were being pursued by member MCPA cities. This is important as the international climate change regime rarely acknowledges the role of cities tackling climate change, though they are vulnerable settlements and at the same time important emitters. Since MCPA represents the most heavily populated states as well as the majority of the state capitals in the United States, policymakers should seriously consider integrating the roles of these local institutions in the national climate change policy process, and emphasize adaptation and urban forests' role in these efforts.

Keywords: Municipal; governments; cities; greening; networks

1 Introduction

Addressing climate change remains one of the challenging public policy issues in the United States and beyond. Thus far, most climate change strategies are focused on the mitigation of emissions, primarily driven by international initiatives and agreements, such as the Kyoto Protocol. Some countries' governments have examined different mechanisms to facilitate collective action, with the most popular being cap-and-trade and carbon tax approaches (Stern 2006, Congressional Budget Office 2003). While mitigation has dominated the international agenda, addressing the issues of vulnerability and adaptation to climate change has received growing recognition (United Nations Habitat 2011, Bulkeley and Tuts 2013).

Because researchers estimate that more than three-fourths of global carbon emissions come from urban areas (Satterthwaite 2008, Stern 2006), cities become a natural place to start a discussion concerning climate change. People tend to choose to live and cluster in urban areas, but because of the concentrated nature of their pollution and increased consumption of resources, urban areas tend to heavily contribute to environmental problems. Local governments have been found to lead the majority of climate change interventions to try out new ideas and methods in the context of future uncertainties (Broto and Bulkeley 2013).

Cities can respond to climate change concerns through emissions mitigation but also by taking or promoting adaptive strategies (United Nations Habitat 2011). Stone (2012a) suggested that rather than focusing purely on emission reductions, adaptive strategies such as innovative land use planning, should also be employed. According to previous research, the most effective ways to adapt to rising heat effect of climate change could be planting trees and expanding natural vegetation in ur-

ban areas (Lynn et al. 2009, Zhou and Shepherd 2009, Stone 2012a, Stone 2012b, Stone et al. 2013). Similar strategies of adaptation can include increasing options for water retention and infiltration, reducing the heat island effect, and reducing vulnerability to natural hazards such as storms and hurricanes. Nevertheless, relatively few cities have developed and implemented coherent adaptation strategies. Instead, they have focused on mitigation strategies, partly as a result of existing incentives for mitigation activities (United Nations Habitat 2011, Jabareen 2013).

It is unwise and often impossible to separate mitigation actions from adaptation measures (Bulkeley and Tuts 2013) because of the inherent synergy between the two agendas. For instance, urban forests have been known to provide ecosystem benefits that address both mitigation and adaptation strategies such as sequestering carbon, reducing air pollution, providing shade thereby decreasing energy demands, decreasing the urban heat island effect, and intercepting water runoff thus controlling stormwater overflow problems (Thomas and Geller 2013, United Nations Habitat 2011, Walton et al. 2016). The creation, maintenance, and functionality of urban forestry is proposed as a key environmental resource that bridges these two positions (Benedict and McMahon 2006) and may also engage citizens in environmental stewardship (Fisher et al. 2015). Investments in urban forests have increased in many cities and studies generally assert that any increase in urban forests is desirable and will mitigate pollution problems (Manning 2008, McPherson et al. 2013, Roy et al. 2012).

In this study, we investigated local government networks in climate change efforts. Specifically, we sought answers to the following questions: 1) What are the characteristics that predict climate change implementation within the MCPA network? 2) What is the willingness of mayors to prioritize urban forests and climate change adaptation? and 3) What actions have mayors taken on urban forests and what role do they play in climate change?

1.1 Emergence of Local Institutional Networks of Climate Protection

Governance networks are believed to be important conduits of information and collective actions while addressing public problems (Granovetter 1985) and playing a key role in urban responses to climate change (Bulkeley 2010). Climate change networks in particular have been shown to increase commitment and actions regarding climate change (Hakelberg 2014). Lee and Koski (2015) suggest that signing a climate change protection agreement places the mayor in a network of like-minded actors, offering opportunities to develop solutions to climate change. Furthermore, Hakelberg (2014) showed that network membership had a positive impact on European cities' propensity to adopt climate change strategies.

There are two primary climate change networks in the United States: the U.S. Conference of Mayors' Climate Protection Agreement (MCPA) and the International Council for Local Environmental Initiatives' (ICLEI) Cities for Climate Protection (CCP). The CCP program has members worldwide and performance is tied to five municipal mitigation milestones. MCPA is U.S.-based and although has overarching objectives aimed at climate change policy and emission mitigation, performance is not tied to milestones. Krause (2012) showed that CCP membership had a small to moderate effect on local climate change activity, whereas no such discernable effect with MCPA membership. The MCPA has been viewed as a symbolic agreement because of its nonbinding nature (Krause 2011). However, the role of local leadership within networks is important to addressing climate change and agreements like MCPA can indirectly influence climate action because the network creates a mechanism for cities to influence each other (Lee and Koski 2015).

1.2 Climate Networks' Role in Climate Adaptation

Research is limited in the role of climate networks in climate adaptation efforts. Adaptation initiatives may be less presented because they have less visibility than those concerned with mitigation (Broto and Bulkeley 2013) and they also may not have been taken purposefully in the name of climate change. Another challenge is the uncertainty associated with climate predictions and understanding the nature of future climate change risks as well as identifying the main drivers of urban vulnerability. Most adaptation analyses investigate the physical vulnerability of cities to the direct impacts of weather and climate events only; even though it is understood that vulnerabilities depend not only on physical parameters but also socioeconomic factors (Hallegatte and Corfee-Morlot 2011).

To date, mitigation approaches have more readily-quantifiable targets and actions, which have led to more funding opportunities than adaptation approaches. A report by the ICLEI found that 95 percent of CCP U.S.-member cities reported that securing adaptation funding was a challenge (Carmin et al. 2012). However, research on cities' adaptation actions have been problematic. Based on a study in California, Wang (2012) suggested that factors predicting a city's adoption of climate change mitigation were different from a city's adoption of climate change adaptation and that the usual sociode-

mographic predictors of cities' climate change mitigation actions have little power in explaining a city's prioritization of climate change adaptation actions.

2 Methodology

Since our study involved examining the MCPA members' climate change initiatives and actions, required data were collected via survey. MCPA members consist of more than 1,000 local governments in the United States, representing cities in every state, including the District of Columbia, the Northern Mariana Islands, and Puerto Rico, encompassing about 30 percent of the total U.S. population and 36.9 percent of the U.S. metropolitan population. Membership to MCPA represent an appeal to a more liberal urban demographic and real commitments to purchasing, energy consumption, and land use (Lee and Koski 2012).

An electronic survey instrument was developed and pre-tested on 50 randomly selected MCPA members and yielded a response rate of 20 percent. The final survey was implemented during the winter of 2013–2014 with an invitational email including a link to the survey sent to each MCPA member. The survey questions covered the topics of: (1) the perceived effectiveness of MCPA goals, (2) opinions and actions on climate change, (3) the prioritization of environmental investments, and (4) opinions and actions on urban forests. The identity and contact information for each mayor was obtained by reviewing the MCPA list, municipal websites, or by contacting city hall. A follow up reminder was sent one week later. Nonrespondents received two additional follow up emails. Data on each city's land area in square miles, population, racial demographics, education attainment level of residents, median household income, and median home values were obtained from 2010 U.S. Census datasets. Demographic data were also requested of the respondents. Information on the percent local votes cast for Democrat candidate in 2012 presidential election was obtained from the Congressional Quarterly Voting and Elections Collection (2003). The survey and its corresponding research protocols were reviewed and approved by the Institutional Review Board at the University of Georgia to ensure the protection of rights and welfare of human subjects of the research.

2.1 Model 1

We first applied the "political market" framework to examine the supply and demand factors for MCPA cities within their climate change initiatives. These results serve to examine the effects of MCPA networks on overall climate change efforts, which addresses the first research question. The "political market" theory of policy change is a combination of the Tiebout theory, the theory that household mobility will induce jurisdictions to provide efficient mixes of local public goods and taxes (Tiebout 1956), and an "interest group" framework, a theory that political forces and interests are mediated by local institutions, such as local nonprofits (Lubell et al. 2005, Feiock et al. 2010).

The number of climate change actions a city took is the dependent variable for this analysis. Participants were asked to select climate change issues being addressed in their city, whether through regulations or policies and aimed government-wide or community-at-large. Ten climate change issues were presented for selection: carbon emissions inventory, carbon offset programs, disaster preparedness planning, educational/awareness programs, increase of urban green spaces, land use planning, retrofitting buildings with energy efficient materials, storm drain and water-absorbing capacity improvements, transportation improvements, or others specified in text by the participant (Figure 1). Policy actions were summed to generate the dependent variable. Weights were not applied because the accuracy of weighting each action is debatable (Kwon et al. 2014), since some policy actions are harder than others to achieve (Krause 2011) and the problem depends on the scope and scale of problems to be addressed as well as on the extent that the issues overlap other policy areas (Feiock and Coutts 2013).

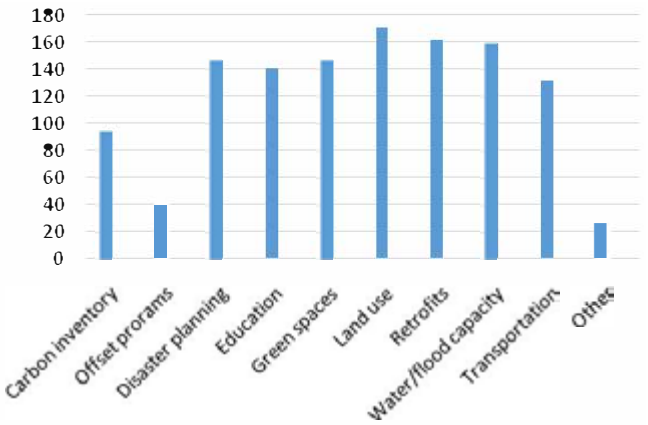

Figure 1: Climate change actions adopted.

A standard approach for addressing summed integer variables, or count data, is a Poisson regression model (King 1988). This model has been used in previous research examining climate actions taken by cities (Bae and Feiock 2013; Kwon et al. 2014). A random variable Y is said to have a Poisson distribution with parameter μ if it takes integer values $y = 0, 1, 2,$ with probability

$$Pr\{Y = y\} = \frac{e^{-\mu}\mu^{y}}{y!} \quad (1)$$

for $\mu>0$. The mean of this distribution is equal to the variance. Two tests were run to test the applicability of the Poisson model: 1) the goodness of fit test, which yielded an insignificant ($p<0.05$) test statistic, indicating that the Poisson model was appropriate and 2) the likelihood ratio test of overdispersion parameter alpha after running the analysis using a negative binomial regression, which showed that alpha is not significantly different from zero, thus reinforcing the Poisson distribution as appropriate.

The likelihood function for n independent Poisson observations is a product of the probabilities given in equation (1). The log likelihood equation is:

$$\log L(\beta) = \sum \{y_i \log(\mu_i) - \mu_i\} \tag{2}$$

where μ_i depends on the covariates $x_i$and a vector of parameters β. Using the link function to transform y:

$$G(y) = \log(y) \tag{3}$$

and adding (3) to a regression equation yields the Poisson regression:

$$\log(Y_i) = \beta_0 + \beta_1 X_1 + \ldots + \beta_{13} X_{13} \tag{4}$$

where Y represented the number of climate change actions taken by a given city.

The supply-side independent variables in the Poisson regression included government form, climate change staff, per capita general funds, and climate change salience. The *government form* was found by looking up the charter for each city. The variable was coded 1 for council-manager and 0 for mayor-council or other structure. Scholars argue that the council-manager form of government produces greater efficiency in local government policy and operations than the traditional mayor-council form of government (Bae and Feiock 2013, Clingermayer and Feiock 1993). The form of the municipal government may shape the choice to pursue climate change actions. The mayor-council form of government was expected to be related to the number of climate change actions, since it has been shown the mayor-council structure tends to focus on the community-at-large and the council-manager form tends to focus more on administrative organization (Bae and Feiock 2013).

The presence of *climate change staff* may be an indicator of the ability for a city to undertake climate change activities, since advancing such activities would be difficult without staff developing and implementing plans. Resources and fiscal health of a city can be represented by *per capita general fund*; therefore, the size of a city's general fund may be an indicator of the ability to increase climate change actions and also urban forests (Krause 2011). The amount of importance a city official places on taking action on climate change activities would also be an indicator of how many climate change activities are undertaken, as measured by *climate change salience*. City officials' beliefs in climate protection could generate more leadership and motivation in increasing climate change activities. To control for the effect of differences in respondent (mayor versus designated representative), the variable *mayor* was added, which was coded 1 for a mayor and 0 for a designated representative responding on behalf of the mayor.

The demand-side independent variables in the Poisson regression included environmental awards, median income, population, percent white population, percent Democratic voters, and population density. Zahran et al. (2008) found that community involvement in environmental causes in addition to nonprofit environmental organization activity increased the likelihood that cities would participate in ICLEI's CCP campaign. However, Lee and Koski (2015) found that environmental groups were not significant drivers of climate change mitigation action in cities. Thus as a proxy, *environmental awards* may be an indicator of support from local stakeholder groups, influencing local policy choices (Bae and Feiock 2013, Feiock and West 1993). Certain city characteristics can be viewed as motivation for officials to address environmental issues (Krause 2010). The community characteristics of *median income* of city residents (Cottrell, 2003), *population* (Lubell et al. 2005, Zhu and Zhang 2008), *percent white population* (Kalof et al. 2002), *percent Democratic voters* (Krause 2010), and *population density* (Bae and Feiock 2013, Poudyal et al. 2010) have all been linked to demand for environmental protection in previous research.

2.2 Model 2

We used the variables in the previous model with additional variables potentially related specifically to climate change adaptation to test what variables contribute to city officials' prioritization of adaptation as a method to address climate change, which answers the second research question. The probit model is commonly used to analyze discrete choices (Wooldridge 2010) and was used in this study the association between city officials' selection of climate change adaptation as the preferred method to address climate change and their commitments, beliefs, and city characteristics. The climate change priority method selected by the respondent, "climate change adaptation projects" was a binary variable (1 for the respondent's preference for adaption to be the primary method to address climate change and 0 otherwise). This result was extracted from a survey question requesting respondents to select one method to ad-

dress climate change from a list that included emissions trading, performance- or cost-based credit, carbon tax, adaptation projects, or other (Figure 2).

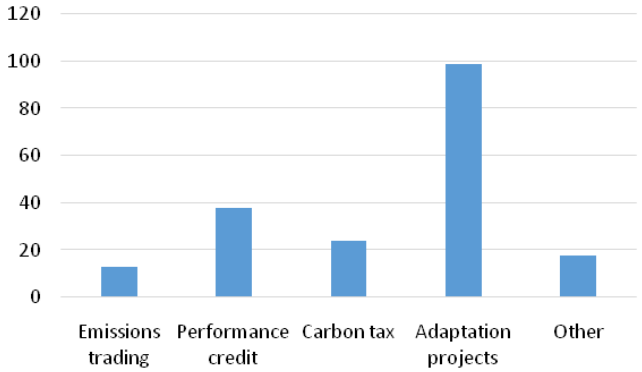

Figure 2: Top priority method to address climate change.

The latent variable model, with the latent variable, y^* (Wooldridge 2010), was:

$$y_i^* = \beta x_i + e_i \tag{5}$$

where β was a vector of parameters, $e_i \sim$ Normal (0,1), and y^* was not observed, but observed was the binary variable y, which represented a discrete choice variable, 0 or 1:

$$y_i = \begin{cases} 0 \; if \; y_i^* \leq 0 \\ 1 \; if \; y_i^* > 0 \end{cases} \tag{6}$$

The likelihood probabilities were:

$$P\left(Y_i = 1\right) = \Phi(\beta x_i) \tag{7}$$

$$P\left(Y_i = 0\right) = 1 - \Phi(\beta x_i) \tag{8}$$

where P represented the probability that the respondent selected yes or no to the climate change activity of the increase of green spaces and Φ represented the standard normal cumulative distribution function.

The independent variables in the probit regression included all variables from the Poisson regression and additional variables that may be factors in prioritizing climate change adaptation: green infrastructure, urban forests, urban forest plan, and prioritization of urban forests. The *green infrastructure* variable was based on whether a city had taken action on installing green infrastructure. The *urban forests* variable was measured based on the level of importance the mayor assigned to urban forests being included in climate change strategies (Tab. 1). The *urban forest plan* variable was based on whether the city had an urban forest plan in place or not. The *prioritization of urban forests* was based on the ranking assigned when compared to other environmental priorities. These variables have been cited as important to climate adaptation (Gill et al. 2007). To understand how the independent variables affect the unobserved latent variable y^*, the marginal effects of the corresponding variables, which are a function of both the estimated parameters and the values of the explanatory variables, can be calculated using:

$$\frac{\partial y_i}{\partial x_k} \frac{\partial P(y_i = 1|z)}{\partial x_k} = \phi(\beta' x_i)\beta_k \tag{9}$$

where ϕ is the probability density function of the standard normal cumulative distribution function and z represents $x_1, x_2 \ldots x_{15}$. Thus the marginal effect of increasing x_k resulted in a change in y of the magnitude $\phi(x_i\beta)\beta_k$ which varies according to values of x which are selected. Most software use a default value of the sample means for the x vector.

Table 1: Preferred environmental priority actions (1=least preferred; 5=most preferred)

Environmental Action	Mean (n=184)
Green building	3.0652
Energy conservation	3.0489
Transportation	2.9457
Urban forests/green spaces	3.1848
Alternative energy	2.9783

2.3 Urban Forests' Role in Climate Change Strategies

For the third research question regarding what role urban forests played in climate change strategies, we analyzed responses to urban forest survey questions and additional text provided by respondents. Questions included whether the city already had an urban forest plan, how strongly the respondent felt urban forests should be part of climate change strategies, and if the city planned to increase urban forests within the next five years.

3 Results

The cities used for this study were reduced to 1,001 because contact information could not be found for 52 mayors and Princeton Township and Princeton Borough in New Jersey merged in 2013. There were 244 survey respondents, representing a 24.4 percent response rate. Out of the 244 respondents, 13 declined survey participation and 29 surveys did not have a sufficient amount of responses to be deemed as usable for the study (Tab. 2). The final number of surveys used for the study was 202.

Table 2: Survey respondents and nonrespondents compared to all U.S. MCPA cities

Characteristics	All cities receiving survey (n=1,001)	Responding cities (n=244)	Nonresponding cities (757)
Population	91,481,412.0	29,213,566.0	622,667,846.0
Average population	91,390.0	119,727.7	82,256.1
Median household income (dollars)	61,880.6	65,205.0	60,809.1
Education (% bachelor's or higher)	36.4	40.5	35.1
Political leaning (% Democrat)	55.5	56.6	55.1
Population density (population per square mile)	3,309.2	3,481.9	3,254.8

Table 3: Survey respondents compared to total urban U.S. and Puerto Rico populations, 2010

Description	Population represented	Percentage of total urban population
Population—United States & Puerto Rico	312,471,327	n/a
Urban population—United States & Puerto Rico, n=3,592	252,746,527	n/a
Population—U.S. Conference of Mayors, n=1,054	93,150,685	36.9
Population—No contact information, n = 52	1,669,273	0.7
Population—Revised, n=1,001	91,481,412	36.2
Population—Unfinished surveys, n=29	2,519,345	1.0
Population—Refusals, n=13	462,556	0.2
Final survey respondents, n=202	26,830,180	10.6

The responding mayors' (or their designated representatives') cities represented 38 states and one territory covering 26.2 million people or about 28.7 percent of the revised sample population (Tab. 3). The population of Puerto Rico was included in this study because there were several mayors from Puerto Rico who signed onto the Climate Protection Agreement, with one mayor from Puerto Rico participating in this study.

In comparison to the surveys performed by the U.S. Conference of Mayors, the 24.4 percent response rate was on par with previous studies. The first survey conducted by the U.S. Conference of Mayors in 2007 to benchmark the efforts of all the signatories yielded a 25.3 percent response rate (U.S. Council of Mayors 2007). The second survey was performed in 2008 to assess resource constraints on climate protection strategies yielded a 15.5 percent response rate (U.S. Council of Mayors 2008). A third survey was performed in 2014 to assess the climate change mitigation and adaptation actions of mayors yielded a 26.9 percent response rate (U.S. Council of Mayors 2014). We contributed to these studies by extending quantitative analysis to examine what factors may affect mayors' decision-making.

The representativeness of respondents was assessed with the revised MCPA cities surveyed. The average population size of the responding cities was 129,860, which was about 41 percent larger than the revised MCPA average of 92,124. The median household income for the responding cities was $64,789, which was only 5.2 percent larger than the revised MCPA average of $61,583. The percent of residents with education attainment of a bachelor's degree or higher was 40.6 percent for responding cities, or 4.3 percent higher than the MCPA cities. The political leaning of residents in the responding cities was 57.1 percent Democrat, which is only 1.6 percent higher than the overall MCPA average. The population density of the responding cities was about 3,500 residents per square mile, a 5.8 percent difference from the MCPA average of 3,314 residents per square mile. A Kruskal-Wallis test confirmed these differences. At $\alpha = 0.05$, the test returned p-values of 0.03 for Democratic voters, 0.0002 for educational attainment, 0.75 for median income, and 0.34 for population density, which means the null was rejected based on two of the variables (Democratic voters and educational attainment) that the responding cities and non-responding cities were not from identical populations and that there was a significant difference between the two groups. It was concluded that nonresponse bias may exist; however, weights were not applied to study results. Other studies examining municipal officials also did not apply weighting strategies (Krause 2012, Bae and Feiock 2013). In addition, Van Goor and Stuiver (1998) found that the most and least successful municipalities respond the least, while intermediately successful ones respond the most. Their results indicated that the "curvilinear" relationship between performance and response can be interpreted as an interaction effect between interest in the

Table 4: Descriptive statistics for independent variables

Variables	Description	Obs	Mean	Std Dev	Min	Max
govt_form	1=council-manager form, 0=mayor-council form	202	0.663	0.474	0.00	1.00
cc_staff	1=has climate change staff, 0=otherwise	194	0.696	0.461	0.00	1.00
lgfund_per	Log of per capital general fund available in 2013	199	6.932	0.741	4.26	9.87
cc_imp	Importance to respondent for city to address climate change (-2=least important, 2=most important)	202	1.040	0.935	-2.00	2.00
mayor	1=mayor responded, 0=otherwise	200	0.430	0.496	0.00	1.00
award	1= received environmental award(s), 0=otherwise	200	0.770	0.422	0.00	1.00
lnmedinc	Log of median income	202	10.949	0.472	9.79	13.21
lnpop	Log of population	202	10.438	1.441	6.19	15.93
pct_white	Percent white population	202	0.755	0.162	0.11	0.98
dem	Percent Democrat voters	202	0.571	0.121	0.20	0.84
sqmi_pers	Population density ($population \div citylandarea$)	202	3515.435	2923.965	11.60	27012.50
cc_green	1=action taken to increase green infrastructure, 0 otherwise	202	0.723	0.449	0.00	1.00
cc_uf	Importance of urban forests to be included in climate change strategies (1=least important, 5=most important)	200	4.235	0.880	1.00	5.00
budg_uf	Importance of urban forests to be addressed if funding available (1=least important, 5=most important)	184	3.185	1.398	1.00	5.00

survey topic and evaluation apprehension; and therefore, weighting did not lead to better results (Van Goor and Stuiver 1998).

3.1 Differences in Perception between Mayors and Designated Officials

To compare the attitudes of respondents who were mayors and those who were designated representatives, a Kruskal-Wallis test was performed to determine if any significant differences between the two groups existed. The null was that the two groups were from identical populations. Differences were found for the following variables (p-values): Increase Urban Green Spaces, p-value = 0.016; Land Use Planning, p-value = 0.001; Storm Drain and Water-Absorbing Improvements, p-value = 0.002; and Change in Environmental Budget, p-value = 0.002, suggesting that there could be a small difference between the responses of mayors and designated representatives. Thus the dummy variable *mayors*, where 1 = mayor and 0 = designated representative, was added to regression models.

3.2 Factors Contributing to Climate Change Actions

Table 4 reports descriptive statistics of the variables used in the Poisson estimation for the number of climate change actions taken. The estimation of Poisson regression model resulted in significant supply-side factors for the mayor-council government form, climate change staff, and climate change salience (Tab. 5). *Government form* was negative and significant, suggesting that the mayor-council form contributes to the increase in the number of climate change actions taken. This also suggests that climate change actions taken during the last five years may be more likely aimed at community-wide measures rather than government operations. Bae and Feiock (2013) found that the mayor-council form of government more likely addressed climate change policies at the community-at-large level and that the council-manager form tended to focus more on government operations. These so-called "strong mayors," elected at large in the mayor-council system, may be more interested in taking climate change actions to attract or retain political resources and electoral support in their community, as indicated by the positive and significant variable *climate change salience*. Having *climate change staff* increased the probability of increased climate change actions, indicating a higher level of capacity and/or the punctuated emphasis of climate change policy. The demand-side policy variables of *environmental awards* and *population density* resulted in significant coefficients. Support from environmental stakeholders and higher population density has been shown to be important to the number of climate change activities (Bae and Feiock 2013).

The pseudo R^2 measure of 0.03 at first glance seems low (Tab. 5). This measure represents the proportional reduction in deviance due to the inclusion of the predictors (Heinzl and Mittlböck 2003). It does not represent

Table 5: Poisson regression for number of climate change actions taken in respondent's city (n=187)

Independent variables	Coefficient estimates
Intercept	1.829^{c}
	(0.611)
Supply-Side Factors	
Council-manager goverment (govt_form)	-0.099^{b}
	(0.047)
Climate change staff (cc_staff)	0.168^{c}
	(0.058)
General fund (lngfund_per)	-0.027
	(0.028)
Mayor (mayor)	-0.009
	(0.044)
Climate change salience (cc_imp)	0.072^{c}
	(0.025)
Demand-Side Factors	
Environmental awards (award)	0.127^{b}
	(0.060)
Median income (lnmedinc)	-0.018
	(0.052)
Population (lnpop)	-0.020
	(0.017)
Population density (sqmi_pers)	1.3e-05^{a}
	(7.0e-06)
Percent white population (pct_white)	0.062
	(0.134)
Percent Democratic voters (dem)	0.210
	(0.223)
Pseudo r-square	0.030
Log-pseudolikelihood	-367.369^{c}

Note: (^{a}) 10% significant level; (^{b}) %5 significance level; (^{c}) 1% significance level; robust standard errors are in parentheses.

Table 6: Probit regression for city officials' motivations to prioritize adaptation as method to address climate change (n=168).

Independent variables	Coef. Estimates	Margin. Effect at Mean x
Intercept	1.792	
	(-0.839)	
Supply-Side Factors		
Council-manager government (govt_form)	0.470^{a}	0.187
	(0.245)	
Climate change staff (cc_staff)	-0.351	-0.121
	(0.270)	
General fund (lngfund)	0.125	0.056
	(0.150)	
Mayor (mayor)	-0.300	-0.114
	(0.224)	
Climate change issue salience (cc_imp)	-0.381^{c}	-0.149
	(0.146)	
Urban forest plan (uf_plan)	0.364	0.142
	(0.315)	
Action on green infrastructure (cc_green)	0.728^{c}	0.269
	(0.270)	
Importance of urban forests if funding available (budg_uf)	0.024	0.009
	(0.079)	.
Importance of urban forests in climate change strategies (cc_uf)	0.300^{b}	0.111
	(0.224)	
Demand-Side Factors		
Environmental awards (award)	-0.209	-0.063
	(0.266)	
Median income (lnmedinc)	-0.404	-0.170
	(0.292)	
Population (lnpop)	0.128	0.053
	(0.098)	
Population density (sqmi_pers)	4.1e-1	4.8e-6
	(1.1e-0)	
Percent white population (pct_white)	0.587	0.278
	(0.876)	
Percent Democrat (dem)	0.409	0.192
	(1.084)	
Pseudo r-square	0.142	
Log-pseudolikelihood	-99.289^{c}	

Note: (^{a}) 10% significant level; (^{b}) %5 significance level; (^{c}) 1% significance level; standard errors are in parentheses.

the proportion of variation accounted for by the model as R^2 does in OLS regression. We examined the model fit graphically and also obtained goodness-of-fit tests, one based on deviance residuals and one based on Pearson residuals. Both tests yielded probabilities greater than 0.05, suggesting that the predicted counts are insignificantly different from the observed ones, and therefore the Poisson model was a good fit.

3.3 Factors Contributing to Climate Change Adaptation

The probit model yielded and significant coefficient estimates for the following variables: government form, climate change salience, green infrastructure, and urban forests (Tab. 6). The coefficient estimate for government form was positive, different from in the previous model, suggesting that respondents with council-manager governments may be more likely to prioritize and pursue climate change adaptation strategies. Whether a respondent's city had taken action within the past five years on *green infrastructure* and *urban forests* also resulted in positive and significant coefficient estimates, underscoring their important relationship to climate change adaptation strategies. The level of importance (*climate change salience)* the city official placed on his/her city to address climate change was negative and significant, different from the last model, and suggests that the less im-

portance a mayor assigns on addressing climate change issues, the more likely climate change adaptation is addressed. This result supports the premise that the level of importance assigned to limit or reduce climate change has no bearing on the importance of addressing risks or vulnerabilities associated with climate change. The probit model yielded no significant coefficients for the sociodemographic characteristics, which is consistent with Wang's (2012) California study.

To assess the magnitude of the effects of the independent variables on the dependent variable, examining either the conditional marginal effects for continuous variables or the conditional discrete effects for the binary variables is necessary. The conditional marginal effects appear in Table 5. For the variable *mayor*, the marginal effect at the mean was 0.187. For two hypothetical mayors with average values, the predicted probability of prioritizing adaptation would be 0.187 greater for a mayor of a city that has a council-manager government form than one that has a mayor-council government form.

3.4 Actions on Urban Forests

The majority of respondents (75 percent) indicated that urban forests should be part of climate change strategies and 87 percent of respondents stated that urban forests were already part of city planning. In addition, more than half of the respondents responded that there were plans for their city to increase urban forests within the next five years. Some respondents who did not plan on increasing forests said that they were located adjacent to forested public land, were already quite forested already, had significant forest health issues with current forests, or already had been increasing forests for many years.

4 Discussion and Conclusion

Local government leaders are important to facilitate the implementation of climate change actions in forwarding both the mitigation and adaptation agenda, where government form was an important variable, although differing depending on the agenda emphasized. This article suggests that the political market framework is useful to examining form of government and its effects on local policy decisions in climate change. It is easy to assume that increased vulnerability to climate change results in increased support of mitigation measures; however, this study shows that this is not the case. Although adaptation and mitigation are inexorably intertwined, drivers to act are different for each measure.

Costs related to climate protection require high level of investments, yet the amount of government budget available per capita was not a significant variable in either model, suggesting that motivations to pursue climate change activities may not be based on available resources and perhaps political willpower and community consensus instead. Although 47 percent of the respondents had a carbon inventory, only 20.8 percent of the respondents had taken some sort of action on carbon offset programs, suggesting funding constraints. However, from those 20.8 percent, 60 percent were respondents in cities with council-manager forms of government and the balance had mayor-council governments. Previous research showed that the presence of fiscal stress increased the likelihood of mayor-council cities joining climate change programs, but decreased the likelihood that the same cities would make progress on implementing the program (Sharp et al. 2011). This suggests that mayor-council governments are more likely to use climate change programs and networks as symbolic policy.

In model 1, the presence of a mayor-council government, the presence of climate change staff, increased population density, and environmental awards received increased the propensity for the number of climate change actions MCPA cities have taken. Competing supply and demand forces seem to compel political responsiveness in addressing climate change mitigation, particularly for mayor-council governments. The results seem to support Lubell et al. (2009) conclusion that as mayoral power increases, increased socioeconomic status of the population shifts the balance of changes to be more pro-environment. The effect of environmental awards received also aligns with the belief that resources helping reelect the mayor are favored in the mayor-council government form (Feiock and Bae 2011). The results to model 1 are consistent with past studies, but in addition, we also found that climate change issue salience, the level of importance a mayor assigns to addressing climate change, was an important factor.

Although the main focus of the MCPA is to address climate change mitigation through the reduction of greenhouse gas emissions, the results of model 2 show that participants with a council-manager form of government were more likely to consider climate change adaptation. None of the sociodemographic variables that predicted climate change mitigation action were present for climate change adaptation. This suggests that the predictors of local climate change adaptation in California (Wang 2012) also extends to a nationwide basis. Zahran et al. (2008) found that communities located in high climate risk areas were less likely to participate in ICLEI's CCP campaign. Adaptation projects often require a lot of planning and design or are only efficient over the long term (Hallegatte and Corfee-Morlot 2011), requiring comprehensive policies rather than symbolic policies. Appointed executives in council-manager governments are presumed to not reap the same benefits from symbolic policies that mayor-council governments

would (Carr 2015). Furthermore, climate change adaptation was selected as the top method to address climate change by half of the respondents, notable because there is little evidence in literature showing that climate change adaptation at the urban level exists (Bulkeley and Tuts 2013). When we evaluated qualitative data provided by the respondents, we found that adaptation actions taken have included dealing with sea level rise and code requirements, protecting vulnerable green areas, recycled water programs, and better tree care and planting.

Urban forests can be considered in approaches for both climate change mitigation and adaptation. Many of the respondents believed that urban forests should be included in climate change strategies and planned to increase urban forests over the next five years. Most cities already had some form of urban forest planning in place (87 percent) and integrating it into climate change considerations as well as coordinating with bordering municipalities and governments as well as state-level entities is a logical next step. Urban forests ranked highest on the list when respondents were asked to rank environmental priorities according to preference, contingent on available funding. Large cities often receive more attention due to high visibility, leaving smaller cities to be neglected. However, there are many lessons learned from the larger cities. For instance, the *MillionTreesNYC* initiative leveraged the engagement of thousands of volunteers from diverse communities to adequately plant and care for the trees (Fisher et al. 2015). However, the actual prioritization of urban forests was not significant in predicting the increased motivation to address climate adaptation, but the past actions of increasing urban forests and green infrastructure were. Many cities have long-standing urban forests programs, indicating maturity in such programs. Priorities may be placed on more innovative adaptation actions or needs not yet addressed.

Although the MCPA may not increase the number of local climate change actions, assessing their environmental priorities would help guide national climate change policies. Transportation and electricity generation have been shown to be the sectors with the largest shares of greenhouse gas emissions (U.S. Environmental Protection Agency 2015). The results of this study indicated that cities are pursuing actions to improve land use planning and energy efficiency of buildings, and addressing electricity generation. Transportation improvements are last on the list of environmental priorities for cities, which is not surprising because addressing transportation is more challenging and costly, requiring infrastructure investments affecting both spatial and housing policies and indirectly affecting other markets such as real estate.

Overall, this study shows that multiple and varied local actions to address climate change are being pursued by member MCPA cities. Examining local action provides insight for understanding the political economy of climate change policy. The capacity for adaptation is highly variable and shaped by a range of social and physical attributes, making it difficult for a one-size-fits-all approach (Bulkeley and Tuts 2013), underscored by this study's examination of one potential adaptation strategy: urban forests. Local governments have the possibility of reforming existing local policies and practices such as urban forests and other green infrastructure to integrated adaptation to expected climate impacts as well as mitigating emissions. However, cities will need additional scientific assessments on how climate change will impact people, urban settlements, and local infrastructure. Funding will need to come from national governments to stimulate meaningful adaptation across urban regions with particular attention to small- and medium-sized cities. The international climate change regime does not acknowledge the role of cities tackling climate change, even though they are vulnerable settlements and important emitters at the same time (Dreyfus 2013). However, because of climate change risks, cities have been taking action on climate change adaptation rather than wait for national government response (Hughes et al. 2013). Since the signatories of the MCPA represent the most heavily populated states as well as the majority of the state capitals, international and federal policymakers may choose to seriously consider the role these mayors have in tackling climate change. The mayors of these cities (or their representatives) not only think that it is important to address climate change issues, but also think that local governments should have more of a role in national climate change policy design.

Acknowledgements

We are grateful to three anonymous reviewers for their valuable comments helping in improvement of the manuscript.

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