Institutional Collective Action (ICA) Framework: Linking Smart Growth Policies and Natural Disasters

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Abstract

Public administration and urban scholars often examined the effect of smart growth policies on local economic conditions such as land prices and housing affordability in cities. Few, however, have examined the extent to which risks associated with natural disasters have influenced local government decisions to adopt smart growth policies. The objectives of this research are twofold: (1) to extent the Institutional Collective Action framework in the context of natural disasters, and (2) to empirically test whether there is an association between local government decisions to adopt smart growth policies and incidence of natural disasters. This research is conducted against the backdrop of climate change mitigation and adaptation policies. While an adoption of climate change mitigation policies has often been linked to risk reduction; other policy options such as climate change adaptation policies are less understood. Based on data collected among 165 municipalities in Florida, the results of our analysis suggest that climate change mitigation policies appear to have an association with incidence of natural disasters.

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INTRODUCTION

Climate change and disaster risks are closely interlinked phenomena. Solecki et al. (2011) identifies disasters as manifestations of climate change. Changing weather conditions have increased incidence of extreme events that have interacted with population vulnerabilities and thus resulting in disasters. According to Schipper and Pelling (2006, p.20-21) "successful mitigation of anthropogenic climate change can decrease disaster risk directly by reducing weather-related uncertainty and hazard, and by diminishing the threat of asset depletion among vulnerable natural resource dependent societies; indirect influence comes from the impacts of climate change on national development and, consequently, the asset base available for building resilience and coping with disasters."

With the formulation and implementation of the Kyoto Protocol in 2005 and the *Hyogo Framework for Action 2005-2015*, there has been increasing focus internationally on climate change and disaster risk reduction. While the Kyoto framework highlighted the importance of inter-organizational efforts to tackle challenges posed by climate change, the Hyogo framework promoted strategic and systematic efforts to reduce vulnerabilities towards risk to hazards. With the recent United Nations General Assembly endorsement of the *Sendai Framework for Disaster Risk Reduction 2015-2030*, much of the global efforts are turning to regional governance structures for climate change adaptation (CCA) and disaster risk reduction (DRR) policies. With the emergence of regional governance roles in climate change policies, smart growth policies have received increasing focus (Outka and Feiock, 2012). However, very little has been done to understand the association between climate change, smart growth policies, and risk reduction strategies at the local level.

The emphasis of smart growth policies to mitigate the effect of climate change is not surprising. Smart growth policies ---broadly defined by a set of 10 principles---mostly focus on policies related to green infrastructure investment, urban development, technologies, and a reduction in traffic congestion and building livable communities (EY Report, 2016). Scholars have pointed out that smart growth policies believe to be able to reduce GHG emissions and insured losses from natural disasters (Brown and Southworth, 2008; Coaffee, 2008; Burby, 2005). Other forms of smart growth policies contributing to climate change policies include a reduction of vehicle miles travelled, compact development, and optimizing infrastructure requirement for development.

This research extends the ICA framework by arguing that extreme weather related events also influence the decision of local governments to adopt certain types of smart growth policies: mitigation and adaptation. The assumption is that smart growth policies –when translated into mitigation and adaptation approaches are not homogenous – but generate tangible or intangible benefits to certain interest groups. While the ICA framework has been employed to explain the incentives and motivation of local governments adopting smart growth policies, we extent the framework by arguing that disasters create a window of opportunity for policy change.

This paper is guided by the following questions: What smart growth policies have cities undertaken in response to extreme climate related weather events? Are there associations between smart growth policies and natural disasters? These questions not only provide an overview of policy options associated with weather related events, they also highlight the motivation and incentives of multiple interest groups in coordinating policy preferences. By answering this research question, policy makers can be better informed on how to translate the concept of smart growth policies in the context of climate change.

The empirical analysis is based on data collected among 165 municipalities in Florida. The results based on nonparametric analysis suggest that climate change mitigation policies appear to have an association with incidence of natural disasters, especially in a policy area that is related to in-fill development. We also found that local governments that experienced natural disasters but did not require/encourage GHG emission policies tend to have a lower amount of property damages compared to those that have policies related to reduction in GHG emission. Similar results on property damages can be found among local governments with compact development policy and LEEDs/Green certification for new development/redevelopment policy. As for the association between climate change adaptation policy and natural disasters, we found that a significant difference in property damages between local governments with mechanisms to encourage green construction and technology related to reduced water use and permeable paving.

This paper is organized in the following: the next section provides an overview of climate change, smart growth policies and natural disasters. The paper then explains the hypothesis related to the association between natural disaster and climate change adaptation and mitigation policies. Before the conclusion section, we present the research design and analysis.

CLIMATE CHANGE, SMART GROWTH POLICIES, AND NATURAL DISASTERS

Focusing on the role of local jurisdictions and their constituents in climate change policy as well as disaster risk reduction activities had drawn much of the attention to policies related to smart growth. According to Schipper and Pelling (2006, p.20) “Disaster risk reduction is largely a task for local actors, albeit with support from national and international organisations, particularly in humanitarian action.” Outka and Feiock (2012) point out that states in the U.S. have delegated responsibilities in land-use planning (the major tool for climate change policies) to local jurisdictions. Local governments have jurisdictional power to influence individuals and corporate behaviors in their actions towards adopting sustainable development because of their proximity to local constituents. They also enforce building codes that directly affect GHG emissions.

However, smart growth policies involve multiple instruments. The American Planning Association, for instance, identifies that smart growth involves multiple objectives that revolve around efficient and sustainable land development, infrastructure investments and preservation of open spaces. Each of these objectives are catered through policies in multiple sectors like housing, transportation, community development etc. At the same time, implementing a broad set of smart growth policies--in order to reduce the consequence of disasters---has political and adverse policy consequences.

Smith et al. (2014) suggest that, if not carefully considered, smart growth can increase exposure to hazards. Since different tools of smart growth align themselves with different categories of climate change policies, they are often contradictory to each other. Political consequences of smart growth adoption often involve balancing conflicting priorities of multiple interest groups involved in the process. Proponents of smart group policies include interest groups[1] advocating for land preservation and protection of green spaces, including environmental protection groups, college graduates, and neighborhood associations (O'Connell, 2008; O'Connell, 2008; Park, Park and Lee, 2012; Cruz, 2009).

However, few scholars have linked smart growth policies to natural disasters at the local level. Disaster scholars, for example, identify extreme events as "windows of opportunity" wherein policies are adopted after extreme events due to sudden policy focus in this area. It can be argued that since hazards are manifestations of changing climate (Brien et.al 2006), there is a possibility that local jurisdictions will integrate climate change policies with disaster risk reduction management plans. Moreover, Brien et al. (2006), Schipper and Pelling (2006) argued that climate change policies should be integrated with disaster management in order to enhance community resiliency and mitigate risk. Berke et al. (1993) suggest that disaster incidences lead

[1] Political opposition to smart growth approach in building a resilient city is often associated with restriction of urban sprawl. The argument has been regarded as anti-growth, especially legislation and land-use policies restricting property rights and the enforcement of environmental preservation related to open spaces and land-use control. Smart growth policy adoption hence often faces oppositions and need adjustments of conflicting priorities.

to better recovery investment, zoning strategy and adaptation of land use policies to “fit” post-disaster requirements.

Moreover, local governments’ smart growth policies share similar goals with hazard mitigation. While smart growth aims at providing better living condition for communities, hazard mitigation contributes to the same objective, i.e., lessening a community’s exposure to risk from changing climatic conditions. Both the policies utilize tools spanning multiple sectors like transportation, land-use, construction etc. Some scholars have also argued that land-use planning is an important tool in order to build stronger communities towards disaster risks (Burby et al., 2000). Since smart growth policies are comprehensive tools that involve sustainable land-use development and improvement in quality of life for communities, they help in advancing hazard mitigation initiatives after disasters.

However, different smart growth tools contribute to hazard mitigation differently. Conflicting strategies can also emerge. While hazard mitigation policies support compact development to intend urban sprawl, other forms of smart growth tools like introducing heat islands (open areas) within the urban area may work against compact development. Hence, a proper analysis of smart growth tools that work towards mitigation should be considered in order to avoid unintended consequences (Smith et al., 2014). Hence because of increased focus and new opportunity to implement mitigation policies after disasters, it is expected that there will be an increased adoption of smart growth tools that contribute towards mitigation after disasters.

CLIMATE CHANGE MITIGATION AND ADAPTATION POLICIES

In the context of smart growth planning, what are the differences between climate change mitigation and adaptation policies? Scholars have categorized local response to climate change into two major concepts: climate change adaptation and climate change mitigation (Larsen and Ostling, 2009; Antonio and Oliveira, 2009; Hamin and Gurran, 2009; Laukkonen et al., 2009). For instance, climate change mitigation refers to reducing factors contributing to climate change, like greenhouse gas emissions, through control of vehicle transmissions and regulating the built environment. Climate change adaptation, on the other hand, refers to adjusting built and social environment to minimize negative impacts of unavoidable climate change effects (implying changes that are already happening). Adaptation policies may include tools like counteracting effects for rising water levels in coastal areas and creating larger open spaces within the urban fabric for environmental cooling effects in response to rising global, i.e., temperatures (Hamim and Gurran, 2009).

Mitigation policies with their goal of reducing GHG emissions require compact urban form of development that help in reducing vehicle transit. Climate change adaptation policies, on the other hand ---with the goal of controlling rising heat due to global warming—often focus on the implementation of open spaces within the urban fabric to reduce heat island impacts. In other words, while mitigation policies might advocate compact urban forms, adaptation policies promote a dispersed development pattern thus causing both categories of policies in conflict to one another.

However, climate change mitigation and adaptation policies are often associated with externalities, i.e., horizontal, vertical and functional externalities (Feiock, 2013). For example, horizontal externalities can be lined to policy tools such as a reduction of GHG and vehicular emissions. They can reduce pollution and improve regional climate, they can also led to free-rider problems from other jurisdictions. Similarly, policies related to pedestrian walkways and public transit systems may improve livability of surrounding communities and foster regional economies, other jurisdictions may contribute very little to the implementation of such policies and still reap the benefits (Frank, 2000; Scott, 2007; Barbour and Teitz, 2001). Similarly, compact development may incur negative externalities like reduced regional housing affordability (Dawkins and Nelson, 2012).

Climate change mitigation and adaptation policies can also lead to vertical externalities, particularly when smart growth policies are pursued by state, regional, and local governments together. In Florida, for example, state and regional-level agencies are strong advocates of smart growth policies, suggesting that local governments will create positive vertical externalities if they also propagate such policies. At the same time, vertical externalities occur because local governments will be motivated to implement climate change policies when higher level governments (federal/state/regional levels) have put on such a strong incentive on the implementation of the policy. Externalities can be found in term of functional externalities, which are associated with multiple and overlapping policy areas like transportation, land use planning, and housing.

We hypothesize that natural disasters have an association with climate change mitigation and adaptation policies. Solecki et al. (2011), for example, identify that DRR planning and management generally emerged after occurrence of a major catastrophe. Sudden natural disasters create external shocks that provide "window of opportunity" for local government to adopt new policies (Birkland, 1997). The recovery period with increased external aid offers communities opportunities for social, economic and physical development that can reduce disaster losses in the future (Berke, Kartez and Wenger, 1993). Moreover, according to Birkmann et al. (2010), sudden significant changes can lead to institutional changes and propel organizations previously not involved with climate change initiatives to renegotiate on leadership factors and become involved in CCA with already engaged institutions.

Two causal mechanisms may explain the association between incidence of natural disasters and climate change mitigation and adaptation policies. First, based on the agenda setting literature, disaster events come to dominate policy agenda highlighting voluntary acceptance of responsibility by elected and appointed officials. Policies and strategies adopted to mitigate the consequence of disasters trigger public investment in the preparation for and response to disasters. Second, media attention explaining why the events occurred influenced public opinions. The media bring experts to explain why events might occur and change the public understanding of the problems. The media also makes policies visible by raising public awareness and consciousness. For example, Hamin and Gurran (2008) noted that the framework for adaptation tends to focus on technology and construction allowing for weather forecasting techniques, changing land use, energy, and building codes, and developing/encouraging investment in new technology to accommodate change in climate conditions.

RESEARCH DESIGN

Research Site

The study is conducted in the state of Florida. The state is suitable for this study because of several reasons (Outka and Feiock, 2012). First, Florida has traditionally been a "purple state" implying that it has been under the influence of varying political ideologies that have placed varying emphasis on climate change policies. Second, municipal home rule is granted in the state constitution thus allowing individual cities sufficient power to implement their own policies, thus creating much variation in policy implementation. Third, Florida also exhibits variation in city government structures like council-manager or mayor-council forms of government, thus providing variation in political/management structures of cities (Outka and Feiock, 2012).

Other than the variation in political environment over the years regarding climate change, Florida also offers an important study area for smart growth because it has been a strong advocate of smart growth since the passage of the Florida Growth Management Act in 1985. Over the years, forms of smart growth implementation in Florida have changed, thus creating variation in the how smart growth is implemented. Zadok (2005) identifies that smart growth policies have been implemented in Florida in primarily three stages of development- consistency (1985-93), concurrency (1986-93) and compact development (1993-2002). Consistency refers to coordination between state mandates and local development plans, concurrency aimed at controlled growth and economic development and compact development aimed at creating higher density development, curbing sprawl and economic development. It is identified that since the 3Cs as advocated by the GMA in Florida indicate uniform rules for all communities, making and enforcing these rules have raised many tensions and conflicts. The author identifies that while during the ‘consistency’ period of regulation; it was a more top-down approach of implementing smart growth in Florida.

However, because of conflicts arising out of the situation, the state has allowed more discretion in the subsequent stages of concurrency and compact development. While discretion has introduced flexibility in the growth management process, it has also created variation in the success of these policies across the cities.

Being one of the most active states for natural disasters, Florida is also appropriate to study policy implementation and changes after a disaster because of data that can be gathered on natural disasters. In a 2013 report by FEMA, for example, Florida ranks 5th in the number of disaster declarations among U.S. states. The average amount of damages suffered by Florida per year was about $15 billion. The major types of disasters that inflict maximum losses in the state have been hurricane, floods/flash-floods, and tornadoes. Other extreme weather events prevalent in the state are thunderstorms and lightning, hail, heavy rain, and rip current.

Sample Selection

The data to determine the association between natural disasters and smart growth policies in Florida were based on a survey that was conducted by the Florida State University (Outka and Feiock, 2012). The climate change policy data from the "Energy Sustainable Florida Communities" research instrument captured important strategies adopted by local governments in Florida. The instrument seeks to gather information about the capacity and initiative among Florida local governments to implement sustainable climate change policies that include smart growth policies, energy efficiency and green innovation practices. The survey also records community, political, and economic conditions that can affect implementation of these policies.

The survey was administered to all 327 jurisdictions that exceeded 1,000 population in Florida in 2009 and directed to the chief planning officers of each government. With a response rate of 50.5%, the sample size is 165 jurisdictions (Outka and Feiock, 2012).

Survey Instrument: Energy Sustainable Florida Communities (ESFC)

Climate Change Mitigation Policies: In the ESFC instrument, one question asked about local governments' climate change mitigation policies. The question asked "Has your jurisdiction established land use policies or programs to encourage or require the following." The respondents were presented with 8 types of policies or programs: (1) reduce greenhouse gas emissions, (2) compact developments in new and existing neighborhoods, (3) mixed-use development, (4) transit-oriented development, (5) In-fill development, (6) Community-wide bicycle/pedestrian plan, (6) street design for multi-modal mobility in developments and (6) LEED or other Green development certification for new development or redevelopment projects.

The respondents can answer each tool through three options: encourage, require, or no programs or policies in place.

The responses were recoded and reclassified as a dummy variable, i.e., if local governments have policies that encourage and require the implementation of each of the policy categories was coded as 1, otherwise 0. Table 1 summarizes the response. For example, about 68.8% of respondents reported having no policies/program related to reduction of GHG emission, while 75.6% have policies that encourage or required in-fill development.

[Table 1 about here]

Climate Change Adaptation Policies: Another question in the ESFC instrument asked about climate change adaptation policy. The question asked "Does your jurisdiction's site plan and development review encourage the following green Construction & Technology issues?" The respondents were presented with 10 types of policies or programs: (1) daylighting, (2) certified green buildings, (3) energy efficient buildings, (4) reduced water use, (5) heat island reduction, (6) passive and/or active solar collection, (7) on-site renewable energy sources, (8) light pollution reduction, (9) green roofs, and (10) permeable paving. The respondents can answer each tool either through a "Yes" or a "No." Table 2 below summarizes the response provided by local governments in our sample. The majority of local governments reported that they do not have a site plan and development review for the listed green construction and technology.

[Table 2 about here]

Data on Natural Disasters in Florida

Natural Disaster in Florida: Disaster data for this study is collected from the National Climatic Data Center. Scholars have used different kinds of datasets to record extreme events. The Presidential declaration that is kept by FEMA is one of them. Extreme events are also otherwise classified depending upon casualties/ damage sustained by disaster victims (Boer, 1990), or introducing risk assessments and socio-economic data (Cutter, 2001). Using Presidential Declarations is, however, criticized because of political motivations behind the declaration process and hence might not capture the total number of extreme events occurring in a certain area. The NCDC dataset provides any extreme event and the list does not depend on whether an event has been declared as disaster or emergency. The dataset is thus expected to give a more appropriate account of the number of events in each jurisdiction and the associated damages caused.

In the NCDC data, extreme weather events are defined as those occurring events that are "lying in the outermost 10 percent of a place's history." The events are classified as droughts, heat waves, snowfall, severe storms (i.e., tornadoes, hail, straight-line winds), tropical cyclones, freeze events and winter storms. In Florida, the frequency of disaster events for each city was collected from the year 2005 to 2009. The number of extreme events during this period for the 165 jurisdictions ranged from 0 to 50 events. About 19.4% of the sample reported 0 events during this time period. The frequency of natural disasters was recoded as dummy, where local government experiencing a disaster between 2005 and 2009 was coded 1, otherwise 0. There are

32 (19.4%) local governments reporting 0 disasters and 132 (80%) jurisdictions reporting some form of extreme event.

Property Damage Caused by Natural Disasters: Disaster data from the National Climatic dataset is integrated to find the number of disasters that each city experienced between 2005 and 2009. We also gathered data related to the total property damage that resulted from the disasters.

An inspection of the skewness and kurtosis measures and standard errors as well as a visual inspection of the histogram showed that the data on property damages were not approximately normally distributed. The range of property damage reported by jurisdictions varied from \$0 and \$68 million. A non-parametric Levene's test was performed to verify the equality of variance in the data (homogeneity of variance) $p > 0.05$).

ANALYSIS AND RESULTS

Is there an association between incidence of natural disasters and climate change policies? Climate change mitigation policies appear to have an association with incidence of natural disasters, especially in a policy area that is related to in-fill development (*see* Table 3). The association is moderately low (Phi value = .165, $p<0.10$). Local governments experiencing natural disasters tend to have policies that either encourage or require in-fill development [$\chi^2(1, 3.364)$, $p=0.063$].

However, a higher number of local governments experiencing natural disasters tend not to have a mitigation policy related to a reduction in GHG emission. In other words, local governments that experienced natural disasters and did not require/encourage GHG emission policies tend to have a lower amount of property damages compared to those that have policies related to reduction in GHG emission (*see* Table 4).

There is also significant difference in property damage from natural disasters between local governments that encourage/require LEEDs/Green certification for new development or redevelopment and those who do not have any policies for the same (*see* Table 4). Property damage was found to be significantly higher for those who encouraged/required such policies. The significance of the difference is high ($t=3.579$, $p=.000$). There is also evidence to suggest difference in property damage from natural disasters is statistically significant between jurisdictions who encourage/require policies on compact development in new/existing neighborhoods and those who do not have any such policies in place, i.e., $t= 2.065$, $p=.01$ (*see* Table 4).

[Table 3 about here]

[Table 4 about here]

What are the associations between climate change adaptation policies and natural disasters? Table 5 shows that there is no evidence to suggest a statistically significant association between occurrence of natural disasters and climate change adaptation policies, i.e., (1) certified green building, (2) energy efficient building, (3) reduced water use, (4) light pollution reduction, and (5) permeable paving. However, when property damage resulting from natural disasters is considered, we found a significant difference in property damage from natural disasters between local governments who adopted and did not adopt policies for reduced water usage. Property damage was found to be significantly higher for those adopting reduced water usage policy ($\boldsymbol{t}$=1.993, p<.05) (*see* Table 6).

A significant difference between property damage from natural disasters was also seen between local governments who adopt and do not adopt policies regarding permeable paving (*see* Table 6). Property damage was significantly higher for local governments who adopted tools for permeable paving (t=1.674, p<.1).

[Table 5 about here]

[Table 6 about here]

DISCUSSION AND CONCLUSION

Based on data collected among 165 municipalities in Florida, the results of our analysis suggest that climate change mitigation policies appear to have an association with incidence of natural disasters. In particular, the association is significant in a policy area that is related to in-fill development. We also found that local governments that did not require/encourage GHG emission policies tend to have a lower amount of property damages compared to those that have policies related to reduction in GHG emission. Similar results on property damages can be found among local governments with compact development policy and LEEDs/Green certification for new development/redevelopment policy. As for the association between climate change adaptation policy and natural disasters, we found that a significant difference in property damages between local governments with mechanism to encourage green construction and technology related to reduced water use and permeable paving.

How to make sense of the analysis and results based on the Florida dataset? In other words, why property damages (caused by natural disasters) are linked to prevalence of mitigation policies? One possible explanation is that a higher amount of damages would encourage local governments to adopt mitigation policies such as reduction of greenhouse gas emissions, green certification for new development/redevelopment and compact development in new/existing neighborhoods. These policies aim at reducing expansion of urban area and reduction of vehicular transit.

The association between natural disasters and climate change mitigation policies (as manifested through the smart growth policies) can also be attributed to the fact that with increase in tangible losses from natural disasters, local governments become more cognizant of the economic risks associated with climate change. Hence, in order to mitigate future risks from disasters, policies that help in reducing GHG emissions---one of the most prominent factors leading to climate change---are adopted. Compact development, for example, helps in restricting urban growth to open areas that might be more vulnerable to disasters, thus such policy can mitigate future risks.

However, other smart growth policies such as transit oriented development or pedestrian friendly street design, though also indirectly associated with reducing GHG emissions, are generally linked to enhancing quality of life of local communities and hence are not directly associated with risk mitigation. This might explain why we might not find a significant difference in property damage between local governments that encourage/require the provision for these latter policies than those that do not.

We also found that the incidence of natural disasters are associated with in-fill development policies. In-fill development, for example, helps in restricting spatial growth of urban areas by utilizing vacant lands within existing communities for new development. However, Farris (2001) suggests that urban infill (one of the tools of SG) face potential market problems. Emphasis on infill development and restricting new development limit lifestyle choices of contemporary urban families, affect land prices and property values in suburban regions and homeownership rates.

Based on our analysis, it can be suggested here that, with occurrence of disasters, local governments adopt policies that restrict development in new hazardous areas that will increase future risk to disasters. Infill/compact development policies also aim at efficient utilization of infrastructure and natural resources. Redevelopment and increasing densities within existing neighborhoods promotes usage of existing infrastructure networks like water and sewerage systems instead of building anew when vacant/new land is acquired for development. Hence more optimum utilization of existing resources also helps in mitigating climate change factors, thus motivating local governments to implement these policies.

The results indicate that there is no significant association between incidence of disasters and adoption of climate change adaptation policies. However, property damage resulting from natural disasters do have a significant association for adopting reduced water usage and permeable paving. Both of the adaptation policies aim at managing water resources. Permeable paving helps in reducing run-off and maintaining ground water levels. The reason for the significant association with the mentioned tools and no evidence for other adaptation tools is not clear. Water saving policies in Florida may have been already in place due to state water shortage or other geographical and area specific factors. Hence further investigation is required to understand the association between occurrence of disasters and adoption of climate change adaptation policies.

Table 1

Whether Local Governments Established Land Use Policies/Programs

Established Land Use Policies/Programs	Require /Encourage	No Policies/Program
1. Reduce Greenhouse Gas Emission (n=128)	40 (31.3)	88 (68.8)
2. In-fill Development (n=135)	102 (75.6)	33 (24.4)
3. LEEDs/Green Cert. for New Dev./Redevelopment (n=129)	48 (37.2)	81 (62.8)
4. Compact Dev. In New/Existing Neighborhoods (n=135)	85 (63.0)	50 (37.0)
5. Transit Oriented Development (n=130)	75 (45.5)	55 (42.3)
6. Comm. Wide Bicycle/Pedestrian Plan (n=134)	84 (62.7)	50 (37.3)
7. Street Design for Multi-Modal Mobility in Dev. (n=132)	76 (57.6)	56 (42.4)
8. Mixed-Use Dev. (n=135)	111 (82.2)	24 (17.8)

Table 2

Whether Local Governments have Site Plan and Development Review Encourage the Green Construction and Technology Issues

Site Plan and Development Review Encourage the Green Construction & Technology	Yes	No
1. Daylighting (n=144)	7 (4.9)	137 (95.1)
2. Certified Green Building (n=145)	29 (20.0)	116 (80.0)
3. Energy Efficient Building (n=145)	36 (24.8)	109 (75.2)
4. Reduced Water Use (n=145)	58 (40.0)	87 (60.0)
5. Heat Island Reduction (n=145)	20 (13.8)	125 (86.2)
6. Passive and/or Active Solar Collection (n=145)	10 (6.9)	135 (93.1)
7. On-site Renewable Energy Sources (n=144)	7 (4.9)	137 (95.1)
8. Light Pollution Reduction (n=146)	36 (24.9)	110 (75.3)
9. Green Roofs (n=145)	16 (11.0)	129 (89.0)
10. Permeable Paving (n=146)	46 (31.5)	100 (68.5)

Table 3

Association between Incidence of Natural Disasters and Climate Change Mitigation Policies/Programs

Local Government Established Land Use Policies/Programs (Expected Counts)	**Natural Disasters (2005-2009)** Yes	No	χ^2	**Phi Value**	***p*-value**
Reduce Greenhouse Gas Emission (n=127)					
Encourage/Require	**32.1**	**7.9**			
No Policies/Programs	**69.9**	**17.1**	**3.464**	**0.165**	**0.063**
In-fill Development (n=134)					
Encourage/Require	**81.4**	**20.6**			
No Policies/Programs	**25.6**	**6.4**	**3.220**	**0.155**	**0.073**
LEEDs/Green Cert. for New Dev. Or Re-dev. (n=128)					
Encourage/Require	38.3	9.8			
No Policies/Programs	63.8	16.3	1.557	0.11	0.212
Compact Dev. in New/Existing Neighborhoods (n=134)					
Encourage/Require	67.2	17.8			
No Policies/Programs	38.8	10.2	1.484	0.105	0.223
Street Design for Multi-Modal Mobility in Dev. (n=131)					
Encourage/Require	60.3	15.7			
No Policies/Programs	43.7	11.3	1.359	0.102	0.244
Transit Oriented Development (n=129)					
Encourage/Require	59.9	15.1			
No Policies/Programs	43.1	10.9	0.886	0.083	0.346
Comm. Wide Bicycle/Pedestrian Plan (n=133)					
Encourage/Require	66.3	17.7			
No Policies/Programs	38.7	10.3	0.91	0.026	0.763

Mixed Use Dev. Policies/programs category was been excluded because expected count was less than 5.

Table 4

Property Damage Differences and Land-Use Policies/Programs (Climate Change Mitigation Policies)

Whether Local Government Established Land Use Policies/Programs	**Property Damages* (2005-09) Mean**	**Mean Diff.**	***t*-value****	***p*-value**
Reduce Greenhouse Gas Emission				
Encourage/Require (n=40)	$ 2,120,693			
No Policies/Programs (n=87)	$ 400,537	$ 1,720,156	3.047	0.003
In-fill Development				
Encourage/Require (n=102)	$ 1,153,220			
No Policies/Programs (n=32)	$ 73,031	$ 1,080,189	1.136	0.258
LEEDs/Green Cert. for New Dev./Redevelopment				
Encourage/Require (n=48)	$ 2,203,677			
No Policies/Programs (n=80)	$ 172,134	$ 2,031,542	3.579	0.000
Compact Dev. in New/Existing Neighborhoods				
Encourage/Require (n=85)	$ 1,239,247			
No Policies/Programs (n=49)	$ 298,500	$ 940,747	2.605	0.010
Street Design for Multi-Modal Mobility in Development				
Encourage/Require (n=76)	$ 1,426,611			
No Policies/Programs (n=55)	$ 204,036	$ 1,222,575	1.270	0.206
Transit Oriented Development				
Encourage/Require (n=75)	$ 1,522,140			
No Policies/Programs (n=54)	$ 105,032	$ 1,417,107	1.200	0.232
Comm. Wide Bicycle/Pedestrian Plan				
Encourage/Require (n=84)	$ 1,243,324			
No Policies/Programs (n=49)	$ 414,790	$ 838,533	0.735	0.464

*Property damage data virtually inspected with histograms indicating they were not normally distributed.
**Nonparametric tests were performed after testing for Levene's equality of variance.

Table 5

Association between Incidence of Natural Disasters and Climate Change Adaptation Policies/Programs

Site Plan and Development Review encourage the Green Construction & Technology (Expected Counts)	**Natural Disasters (2005-2009)**				
	Yes	**No**	χ^2	**Phi Value**	***p*-value**
Certified Green Building (n=145)					
Yes	23.2	5.8			
No	92.8	23.2	0.172	0.034	0.678
Energy Efficient Building (n=145)					
Yes	28.8	7.2			
No	87.2	21.8	0.748	0.072	0.387
Reduced Water Use (n=145)					
Yes	46.4	11.6			
No	69.6	17.4	2.328	0.127	0.127
Light Pollution Reduction (n=146)					
Yes	28.8	7.2			
No	88.2	21.8	0.167	0.034	0.683
Permeable Paving (n=146)					
Yes	36.9	9.1			
No	80.1	19.9	0.004	0.005	0.951

*Daylighting, Heat Island Reduction, Passive/Active Solar Collection, and On-site Renewable Energy Sources categories were excluded from final analysis

Table 6

Property Damage Differences and Green Construction & Technology (Climate Change Adaptation Policies)

Site Plan and Development Review encourage the Green Construction & Technology	**Property Damages* (2005-09)**		***t*-value****	***p*-value**
	Mean	**Mean Diff.**		
Certified Green Building				
Yes (n=29)	$ 2,787,758			
No (n=116)	$ 398,299	$ 2,389,459	0.898	0.371
Energy Efficient Building				
Yes (n=36)	$ 2,257,041			
No (n=109)	$ 420,130	$ 1,836,910	0.064	0.949
Reduced Water Use				
Yes (n=58)	$ 1,874,086			
No (n=87)	$ 210,928	$ 1,663,158	1.993	0.048
Light Pollution Reduction (n=146)				
Yes (n=36)	$ 2,649,951			
No (n=110)	$ 288,606	$ 2,361,344	0.374	0.709
Permeable Paving (n=146)				
Yes (n=46)	$ 872,565			
No (n=100)	$ 869,107	$ 3,457	1.674	0.096

*Property damage data virtually inspected with histograms indicating they were not normally distributed.
**Nonparametric tests were performed after testing for Levene's equality of variance (Nordstokke et al. 2011).

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