FLOODING AS A DRIVER FOR SUSTAINABLE GOVERNANCE AT THE LOCAL LEVEL

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Abstract. Water has a particularly destructive potential, by means of flooding and heavy storms, to damage infrastructure and livelihoods. Floods continue to cause the most damage to human communities among all natural hazards in the United States. So then, why do or don't local governments learn from floods and adopt stronger mitigation and adaptation policies? Past studies recognize that extreme events and natural disasters create opportunities for local governments to address the damages they've faced by implementing proactive policy changes that reduce the adverse effects of future events; however, this factor is not well understood. Specifically this research project examines how flooding events influence sustainable policy learning at the local level. To operationalize this, I look particularly at the relationship between FEMA CRS ratings and flood induced property damage, as well as the influence of outside factors on that process, because I think social and natural factors together drive policy change. I do this by analyzing a national data set to look for this relationship empirically and then I look closer at a few cases where there was more or less policy learning to explore why that occurred. Results indicate that communities in the CRS program are slightly influenced by past flood damage, but the influence is very small. This suggests that other outside forces impact a community's level of flood management and preventative practices.

INTRODUCTION

Public policies and investments of local governments have a large role in determining the sustainability of urban water systems. Local governments make decisions about infrastructure, land use patterns, building codes, public education, floodplain management, and other regulations. It is important to understand what drives sustainable governance at a local level. Past studies recognize that extreme events and natural disasters create opportunities for local governments to learn from the damage inflicted upon them and make proactive policy changes to reduce the adverse effects of future events; however, this factor is not well understood (Johnson et al. 2005). Water has a particularly destructive potential, by means of flooding and heavy storms, to damage infrastructure and livelihoods. They continue to cause the most damage to human communities among all natural hazards in the United States (Brody et al. 2009). So then, why do or don't local governments learn from floods and adopt stronger mitigation and adaptation policies? Examining the role of floods in sustainable policy learning contribute to a better understanding of why local governments act sustainably. This allows us to take advantage of the phenomenon to motivate sustainable policy development, and perhaps to simulate it. This research also provides a better understanding of the relationship in terms of coupled natural and human systems (CNH). Specifically I examine how flooding events affect resilience and mitigation policy at the local level. To operationalize this, I look particularly at the relationship between FEMA CRS ratings and flood events, as well as the influence of outside factors on that process, because I think social and natural factors together drive policy change. I do this by analyzing a national data set to look for this relationship empirically and then I look closer at a few cases where there was more or less policy learning to explore why that occurred.

Recent studies demonstrate the growing importance for communities to adopt more sustainable policies to better adapt to, prevent and reduce the threat of extreme events. The United States' average annual flood count has increased dramatically from 394 floods per year in the 1960s to 2,444 flood events a year in the 1990s. Data also show that property damage from floods is increasing over time from an average of $45.65 million dollars in damage per year in the 60's to $19.13 billion dollars a year in the 90's (inflation adjusted at 1960 dollars) (HVRI 2015). This supports the claim that that floods pose a major risk to communities across the country and that the problem is getting worse. Flood control policy has become increasingly a responsibility for decision makers at the local level (Brody et al. 2010). Sustainability is beginning to embed in local land-use plans, zoning ordinances, building codes, and local education programs.

Adaptation and mitigation are the primary components of sustainable policy. In general, adaptation seeks to reduce the potential damages and recovery from a certain event, while mitigation seeks to lessen the likelihood of such an event occurring. Resiliency is the extent to which a system can withstand shocks without losing functionality, which is attained through adaptation. The literature identifies two factors that influence the resiliency of a system: adaptive capacity and robustness. The diversity of institutions and available assets in social systems generally determines its adaptive capacity. Robustness refers to the properties that allow a system to accommodate distress without additional alterations (Perrings 2006). Mitigation strategies address and reduce the factors that adversely affect or disrupt natural systems. For example, cities often exacerbate the severity of floods by increasing impervious surfaces and removing natural landscapes that slow runoff. These types of hydrographical disruptions can be mitigated. Local governments that embrace both types of mechanisms are likely to achieve the most success and strength in the face of extreme events.

The current literature on policy change and crises describe several mechanisms that could explain policy change and learning in the aftermath of an extreme event or crisis. Policy adoption occurs in a political context that can be described in terms of the Advocacy Coalition Framework (ACF) in which decisions regarding policy programs are conditioned by complex stakeholder interactions. Under the ACF, policy is governed by coalitions made up of individuals that share a common beliefs system and demonstrate coordinated activity through time. The ACF defines policy learning as changes in the beliefs held by these coalitions and explicitly identifies beliefs as the causal driver for political behavior. Within this framework there appear to be moments of opportunity made possible by extreme events where these types of shocks to the system can lead to policy change by shifting the power or beliefs among the coalitions in a policy system. The Punctuated Equilibrium Theory identifies "focusing events" which are sudden, relatively rare and harmful events that may "elevate issues on the policy agenda, leading to group mobilization and increased discussion of ideas" (Albright 2011 and Johnson et al. 2005).

Other studies have looked at whether policy adoption can be linked to extreme events. This has been done for national level policy, with nuclear emergencies, for example. It's also been done at the city level, including for floods, which is the subject of this study. One study identified the major factors that contribute to flood policy changes by examining the FEMA community rating scores for each local jurisdiction participating in the National Flood Insurance Program (NFIP) over a seven-year period. Their results indicate that local jurisdictions learn from histories of flood risk and this process is expedited under specific conditions (Brody et al. 2009). Another study conducted a hazard planning survey for local Swedish municipalities and compared the findings to a dataset of all the floods that have taken place in Sweden from 1901 to 2010. They found that the nature and frequency of external events had an influence but policy development was more associated with an increase in knowledge about local-level risks and vulnerabilities (Nohrstedt and Nyberg 2015).

Based on this theoretical policy framework and prior studies, I hypothesize that there is a positive relationship between flooding events and the adoption of sustainable flood policy at the local level; however, the relationship is not uniform. It is dependent on outside social and political factors such as administrative capacity and attitudes towards government regulations. In addition, I expect that the reaction will depend on the severity of the flood, and that communities in proximity to those that have been impacted by flooding will also have a reaction.

METHODS

This study uses two primary datasets at the county level and a multi-method approach to analyze these datasets and examine the relationship between local policies and flooding events. First I use a cross-sectional design to look each community's achievements in flood policy at a specific point in time compared to the amount of flood damage they have experienced over specific historic time periods. Then I select outliers and use qualitative methods to learn why these communities reacted differently and whether those changes are related to the size and proximity of the flood, or the capacity and politics of the community. This multi-method approach enables a more holistic analysis of a local level phenomenon occurring at a national scale. By looking at one specific point in time, the cross-sectional method allows me to examine the current level of flood policy in these jurisdictions and then analyze the factors behind those scores. Then I am able to bridge the gap between the results of the tests and my hypotheses by using a qualitative case study.

Dependent Variable / Policy data

I measured local policy using the FEMA National Flood Insurance Program (NIFP) Community Rating System (CRS). The ratings indicate the extent to which a community has implemented sustainable policy in regards to flooding. This is evaluated based on 18 activities that participating communities can choose to implement. These activities fall under public information, mapping and regulation, flood damage reduction, and flood preparedness. The ratings range from 1 being the most active to 9 being the least active. The CRS program encourages communities participating in NFIP to go beyond minimum floodplain management standards by offering discounts on flood insurance premiums. The discount increases with class rating. The CRS program is an ideal measurement of policy change over time because it requires all participating communities to recertify each year, and enables communities to modify its application by adding or changing specific activities to potentially increase their score on a yearly basis. These CRS communities make up my sample size of 1288 cities and counties nationwide, I used the most recent (2015) rating scores for the dependent variable; however, I organized the counties into five CRS groups based on their CRS class, combining classes 1 through 5 (Figure 1).

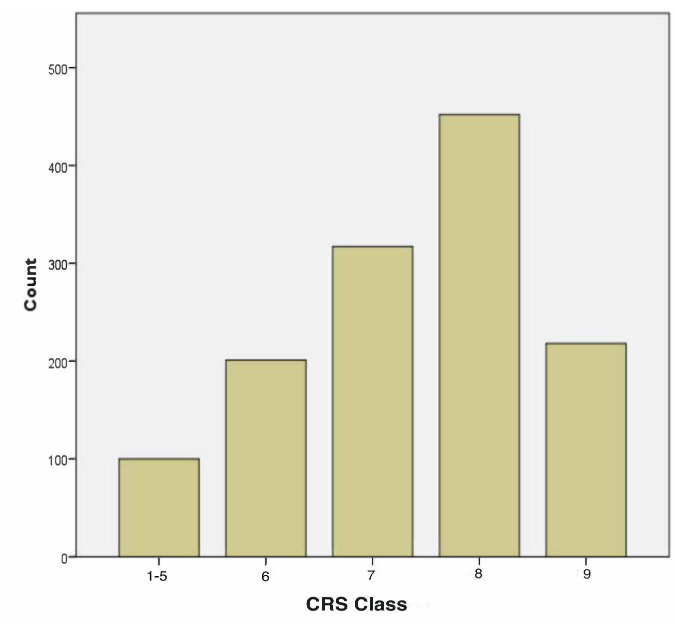

FIGURE 1. Number of Communities in each CRS group.

Independent Variable / Flood Data

To measure the independent/focus variable, I used flood data from the Spatial Hazards Events and Losses Database for the United States (SHELDUS). This database provides a county-level inventory of flood data from 1960 to 2014. Hazard event records include a start and end date, estimated property damage, and crop loss, as well as the number of human injuries and deaths. I chose this dataset because it provides national coverage and extensive aggregate data for county-level data. In terms of accuracy, the SHELDUS data are derived from public sources such as National Climatic Data Center. I used total property damage (adjusted to 2014 inflation in US Dollars) from 1960 to 2014 as the primary focus variable in addition to damage over last 10 years.

Analysis

I merged the two datasets using the county of each CRS community to create a single database of nationwide flood and policy data at the county level. Then I followed a cross-sectional design to compare the CRS communities in each group to see if they differ on average in terms of past flood events over a 55 year period and a 10 year period. In terms of statistical analysis, this process requires basic descriptive statistics and difference of means tests. I use the ANOVA test to determine whether the mean damage among CRS groups is significantly different and the Regression test to determine how much of the variation in class is explained by property damage. Then I selected particular outstanding cases from the dataset and use qualitative methods, such as interviews, to explore why these communities reacted differently. I interviewed the CRS representatives and floodplain managers of the selected communities to learn what motivates them to try for high or settle for low scores. Specifically I looked at differences based on my hypothesis about other influential factors, such as conflicts with core beliefs of dominant coalitions, insufficient organizational capacity, no skillful exploitation of the opportunity by minority coalition, no knowledge of CRS. I recorded these responses and identified key themes.

RESULTS

The initial analysis of the data indicated that the distribution for the total damage variable was not normal (Figure 2). I normalized the distribution by using a log conversion, creating a new variable from Property Damage by taking its $\log_n$. This yielded a relatively normal distribution (Figure 3).

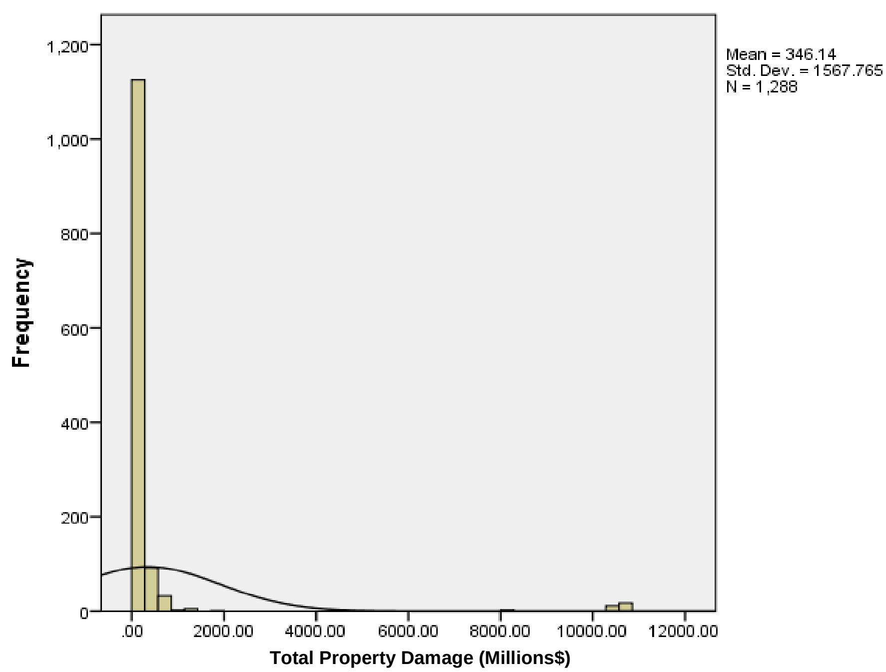

FIGURE 2. The distribution for the total property damage variable in millions of dollars.

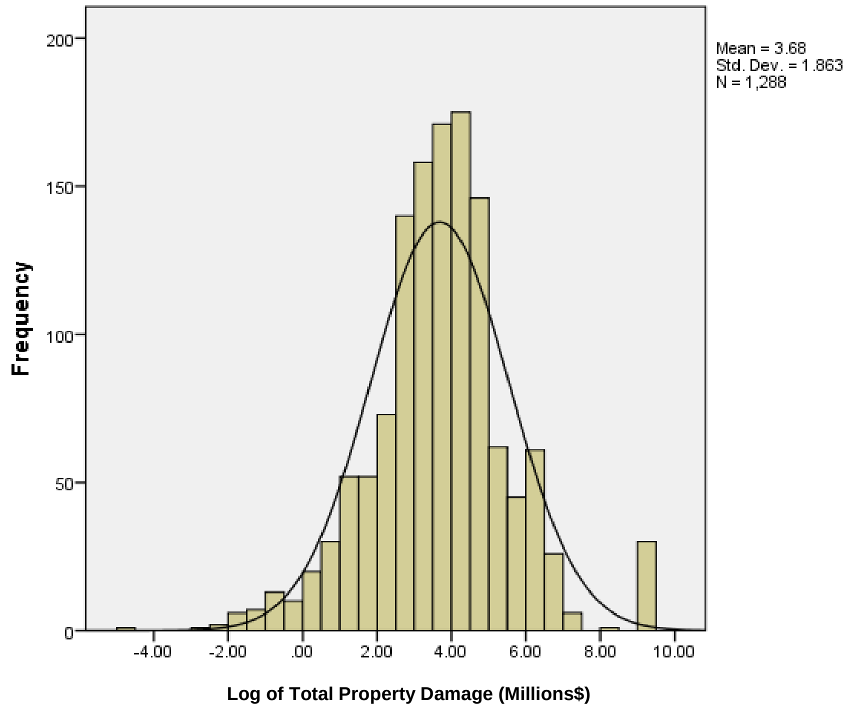

FIGURE 3. The distribution for the log of total property damage variable in millions of dollars.

Using the Log of Damage variable for the ANOVA Test produced a significance level of less than .001, which indicated that the mean property damage for each is not equal. The relationship is negative, indicating that more damage is associated with lower CRS class (stronger policy). This relationship is shown in Figure 4.

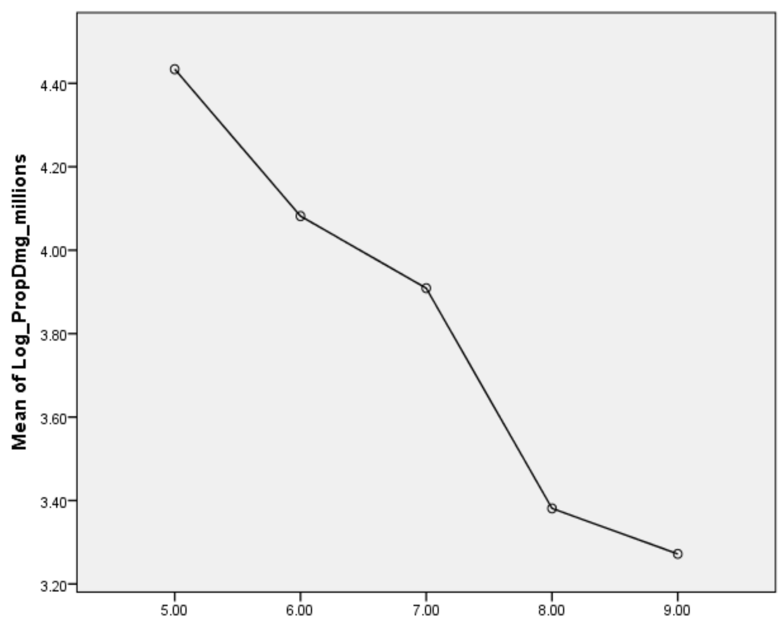

FIGURE 4. The mean log of total property damage for each CRS Class.

The result of the regression model, in which $R^2 = .038$, indicates that property damage only explains about 4% of the variation of CRS class (Table 1). Running the same tests with the 10 year damage variable yielded very similar results.

TABLE 1. Regression Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.196[a]	.038	.038	1.14095

Essentially, these results indicate that communities in the CRS program are only slightly influenced by past flood damage. The influence of flooding on policy change is very small. This means that there must be other forces that influence a community's CRS score, which was the focus of the exploratory case studies. The communities were selected for the exploratory interviews based on their class rating and property damage in relation to the mean property damage of their respective class.

TABLE 2. Communities selected for exploratory interviews.

Community	Class	Property Damage	Class Mean Property Damage
A	1	$97,457,878.31	$705,279,964
B	5	$323,008.35	$705,279,964
C	6	$199,086.12	$681,633,969
D	8	$10,591,294,235.60	$239,909,663
E	8	$10,591,294,235.60	$239,909,663
F	9	$1,306,604,728.16	$78,718,507

The responses can be differentiated as communities with higher CRS ratings (lower class numbers) and communities with low CRS ratings.

Reasons for high CRS ratings:

- Grant Assistance
- Pre-existing policies and master plans
- County-wide department strength and effective communication
- Location on FEMA's Flood Map, esp. 100 year floodplain
- Damage from other extreme storm hazards

Reasons for low CRS Ratings:

- Limited funds and staff
- Political limitations and red tape
- Public opinions towards regulation
- Real estate market factors

Among these responses, several factors stood out as particularly influential. In some cases, CRS scores may be influenced more by the community's location on the flood map and associated flood risk, than the actual experienced threat of flooding. Despite the level of damage a community may experience, its ability to respond is dependent on the availability of resources and capacity for change. As a relatively large county, Community C was able to increase their score because they had preexisting programs and infrastructure in place in addition to a multitude of equipment and resources available to them. Community B on the other hand, a smaller local jurisdiction within a county, has shorter chains of command that allow for quick and effective communication between decision makers and stakeholders. In terms of limitations, Community E expressed a strong desire to increase their score and significant public knowledge and outreach; however, the community is very small and has extremely limited staff and funding. Community D, a community in the same county as Community E, is larger and more affluent, but there is strong opposition from homeowners against regulation. It is clear that the relationship between flooding and policy change is dependent on outside factors

DISCUSSION

The results above indicate that there is weak support for my primary hypothesis. There is an association between mean property damage and class in the relationship I expected, and it is not accidental. However, property damage only accounts for a small percentage of the variation in CRS class. The results of the exploratory interviews begin to identify the factors that may explain this variation and set the course for further investigations and in-depth case studies.

The literature suggests that when a focusing event occurs, changes in policy may ensue do to the increase in diversity of voices and opinions. Specifically, communities that have more open and deliberative processes may motivate greater change and learning. The results of this study indicate that this signal exists, but it is very weak. My research suggests that flooding may create the opportunity for policy change, but there are a number of outside factors at play that enable or restrict a community’s ability or desire to react to flood events. Roseville, CA (Community A) for example is the only CRS community to achieve a class 1 rating. The community experienced a devastating flood in 1995 damaging more than 300, a number of which were submerged in more than 6 feet of water. In 1996 the city launched a series of flood management projects, using more than $3 million of its own funds and $2 million in grants, and another $15 million in improvements in 2001. This is an example of how flooding creates the opportunity for policy learning; however, the driver of change was the availability of funds and public support. Other research suggests that the process of policy learning is expedited under specific conditions. In terms of CRS ratings, my research suggests that these specific conditions are necessary for change.

While the datasets were optimal for the purpose of this study, there were some limitations associated with merging them. CRS participants include county governments and local municipalities, while the flood data is at the county level. This study was unable to account for how this damage was distributed across these counties. There were also a number of communities located across more than one county that were omitted from the dataset. For further investigation of the complex relationship between flooding events and policy learning, it would be useful to explore other sources of flood data and varied measures of policy changes. In addition, controlling for and measuring other variables, such as those listed from the interviews, would help to further understand the role of outside factors on sustainable flood policy.

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