

# SPRINGING FORWARD

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Community  
Resilience in  
a Country  
Anticipating  
Natural Disasters



Kaitlyn Bishay  
Summer 2019

# Preface & Acknowledgements

## About the Author

Kaitlyn Bishay is a senior at The University of Alabama (UA), located in Tuscaloosa, Alabama and will graduate in May 2021 with a B.S. in Civil Engineering and a minor in Educational Studies. She currently serves as a Vice President of Beat Auburn Beat Hunger Food Drive, where she manages the on-campus food pantry and is Treasurer of the UA's Asian-American Student Association. She is also a member of Tau Beta Pi and Chi Epsilon Honors Societies, the American Society of Civil Engineers (ASCE), as well as Alpha Omega Epsilon, a social and professional sorority for women in engineering and technical sciences. Upon graduating from UA, Kaitlyn plans on pursuing a graduate degree in engineering and public policy.

## About the WISE Program

The Washington Internships for Students of Engineering (WISE) program was founded in 1980 through the collaborative efforts of several professional engineering societies to encourage engineering students to contribute to issues at the intersection of science, technology, and public policy. The nine-week program allows students to spend the summer in Washington, D.C. to gain exposure to the legislative and regulatory policy-making process through meetings with leaders in the Administration, federal agencies, and advocacy groups. In addition, each student is responsible for independently researching, writing, and presenting a paper on a topical engineering-related public policy issue that is important to the sponsoring society. For more information about the WISE program, visit [www.wise-intern.org](http://www.wise-intern.org).

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## Acronyms

ASCE – American Society of Civil Engineers	NRDC – National Resource Defense Council
BOCA – Building Officials and Code Administrators	NRF – National Response Framework
BRIC – Building Resilient Infrastructure and Communities Program	NRF-CIA – National Response Framework Catastrophic Index
DHS – Department of Homeland Security	NWR – Weather Radio All Hazards
DOE – Department of Energy	PDM – Pre-Disaster Mitigation Grant Program
EOC – Emergency Operations Center	PETS – Pets Evacuation and Transportation Standards Act
EPR – Emergency Preparedness and Response Department (housed under DHS)	PIA – Primary Inspection Agency
ESF – Emergency Support Function	PKEMRA – Post Katrina Emergency Management Reform Act
ESSA – Every Student Succeeds Act	SAA – State Administrative Agency
FEMA – Federal Emergency Management Agency	SBA – Small Business Administration
FMA – Flood Mitigation Assistance Grant Program	SBCC – Southern Building Code Congress
HMGP – Hazard Mitigation Grant Program	SES – Socioeconomic Status
HSOC – Homeland Security Operations Center	
HUD – Department of Housing and Urban Development	
HUD Code – Manufactured Home Construction and Safety Standards	
IBC – International Building Code	
ICBO – International Conference of Building Officials	
ICC – International Code Council	
ICS – Incident Command System	
IDP – Internally Displaced Person	
IEBC – International Existing Building Code	
IMDC – Internal Displacement Monitoring Centre	
IRC – International Residential Code	
LID – Low-Impact Development	
NIMS – National Incident Management System	
NMSZ – New Madrid Seismic Zone	
NOAA – National Oceanic and Atmospheric Administration	
NRC – Norwegian Refugee Council	

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## Executive Summary

The sheer size and geographic diversity of United States has, along with the looming threat of global climate change, led to elevated levels of natural disasters. Natural disasters include large-scale meteorological events such as floods, tornadoes, hurricanes, earthquakes, tsunamis, and other geologic processes, and can cause rampant destruction in populated areas of the U.S. These disasters occur more frequently and at greater intensity than pre-industrial levels, hitting coastal towns and inland municipalities with no regard for the communities of people who live there. Community resilience can be defined as a community's ability to utilize resources to plan for, withstand, and recover from disasters of this sort.

While the U.S. has enacted legislation to protect those affected by natural disasters, most federal money is spent by FEMA after disaster strikes with little to no emphasis on disaster risk mitigation. Additionally, by leaving the issue of standardizing building codes to state governments, the U.S. federal government has little control over the standards to which new developments are built, especially in rural areas where building codes are typically not enforced. This only compounds issues surrounding America's aging infrastructure which is not designed up to the standards of today, especially in areas of the country which were in significantly less danger of becoming the target of a tropical storm or a system of tornadoes.

The U.S. federal and state governments have faced criticism time and time again regarding their preparations for and response to natural disasters, and as a result have passed landmark pieces of legislation aimed to further simplify and clarify what the federal government does to assist communities pre-, during, and post-disaster. Many of these policies do not take into consideration the hierarchy of needs post-disaster, the socioeconomic status of community residents, or the way a lack of mitigation funds affects small, rural communities. In response to these issues, the federal government should implement the following policy recommendations:

- 1) Decentralizing Water and Power in Large Metropolitan Areas.** The federal government should consider using and/or investing in research into energy microgrids and water micronets in an attempt to prevent these systems from failing in the immediate chaos of a natural disaster.
- 2) Providing Federal Incentives for Inter-Community Planning.** FEMA should invest part of its HGMP funding as provided by the DRRA into communities in a similar fashion to Title I and II education funding, as well as raise taxes in areas with higher disaster risk in order to devote this money to mitigation programs.
- 3) Creating a Rural Communities Mitigation and Response Plan (RCMRP).** FEMA, HUD and the USDA must collaborate to assist rural communities in creating communications plans as well as implementing stricter standards and enforcement on manufactured building codes.

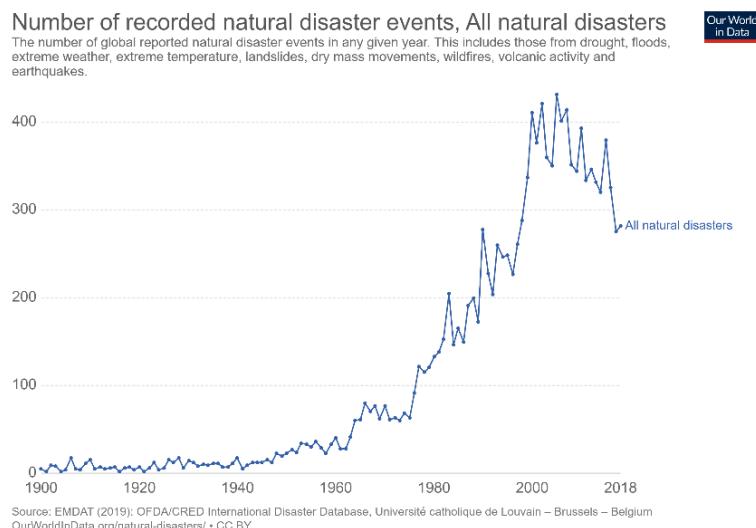
These recommendations will allow the federal government the ability to legislate and account for these communities while still allowing local-level authorities the flexibility to determine what best benefits their communities – improving resilience policy on a local and federal level.

# 1. Introduction

The developed world has undergone growth in every sector in the last few decades. This includes areas such as population density (the United States has a net gain of one person every 14 seconds)<sup>1</sup>, greenhouse gas emissions, average temperatures, and in turn, natural disasters<sup>2</sup>. Many natural disasters cause severe damage to communities, derailing citizens' lives for years to come. This means that after communities heal from the initial shock of a disaster, they must spend several years rebuilding, nowhere close to returning to life as usual. However, it can be difficult to convince lawmakers – both at a local or a federal level – that upgrading old buildings or putting in the money to upgrade facilities and planning is worth the money until it is too late. In an attempt to explain how the United States has changed their approach to combatting the devastating effects of natural disasters, this report will focus on changes to resilience policy as it relates to a few of the biggest natural disasters of the last century.

## 1.1 The Problem: Why Now?

Although natural disasters have always existed, the frequency and severity of these disasters have increased significantly since the 1980s. There has been a severe uptick of natural events globally.



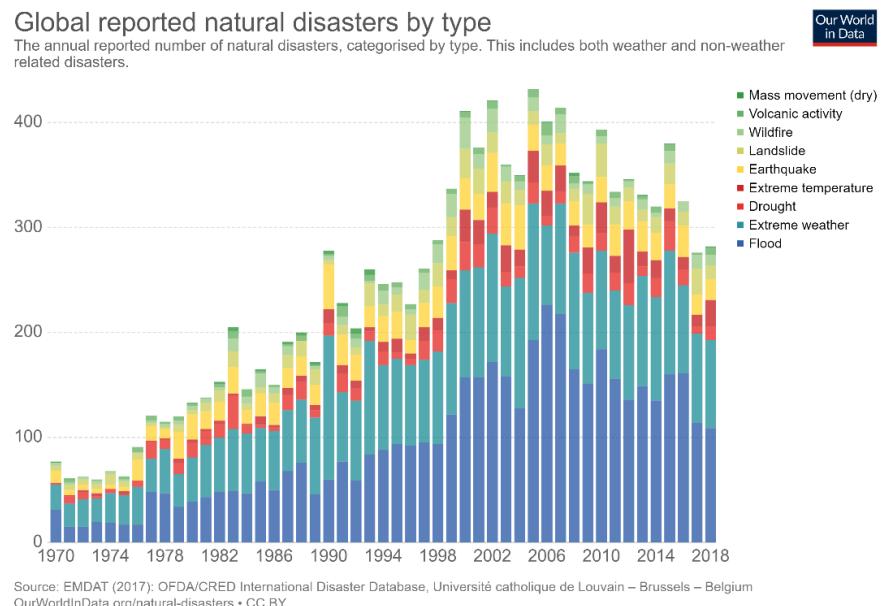
**Figure 1:** Natural disasters have been steadily increasing since the late 1980s, with a peak in 2005. Although there were less in 2018, the trendline suggests that 2019 (and further) will continue see increased numbers of natural disasters.

<sup>1</sup> United States Census Bureau, "U.S. and World Population Clock."

<sup>2</sup> Ritchie and Roser, "Natural Disasters: Empirical View."

While this can be attributed to a few different causes, it is most generally because the world post-Industrial Revolution is a significantly different place than the world before it. Despite some years having more or less natural disasters than others, as shown in (**Figure 1**),<sup>3</sup> the general trend shoots upwards in recent years, leading many to believe no area or climate is safe from the devastation of a natural disaster.

An important caveat, however, is that many natural events are not inherently harmful to the environment. Many times, large-scale natural events such as tornadoes, wildfires, and hurricanes can provide equilibrium to land the same way animal populations hit a critical mass. However, when people get involved, natural events can become natural disasters. According to the World Health Organization (WHO), “a natural disaster is an act of nature of such magnitude... in which the day-to-day patterns of life are suddenly disrupted and people are plunged into helplessness and suffering,”<sup>4</sup> and in many cases, require food, shelter, and medical care.



**Figure 2:** Global natural disasters have been on the rise more generally, but with the addition of climate change as a catalyst for climate instability, floods and extreme weather have been the two types of disasters that have risen the most.

Climate change has a direct effect on many natural disasters. As climate change accelerates, so too do the rates of natural disasters across the globe. According to the (USGS), “As more water vapor is evaporated into the atmosphere it becomes fuel for more powerful storms to develop. More heat in the atmosphere and warmer ocean surface temperatures can lead to increased wind speeds in tropical storms. Rising sea levels expose higher locations not usually subjected to the power of the sea and to the erosive forces of waves and currents.”<sup>5</sup> In this way,

<sup>3</sup> Ritchie and Roser.

<sup>4</sup> World Health Organization, “Environmental Health in Emergencies.”

<sup>5</sup> United States Geological Survey, “How Can Climate Change Affect Natural Disasters?”

climate change is a catalyst which only exasperates existing problems. While warmer temperatures (or colder temperatures, as climate change leads to more variability in temperature rather than only highs) do not always mean that natural disasters will occur, they lead to more associated storms and droughts than in past years. In (**Figure 2**)<sup>6</sup> databases worldwide were compiled to give a better look at the trends in type of disasters occurring – with floods, extreme weather, and droughts on the rise. Although most types of disasters showed at least slight increases, earthquakes and volcanic activity stayed fairly consistent, whereas the number of floods, extreme weather incidents, and droughts all rose.

## 1.2 Disaster Has No Zip Code

When looking at these disasters on a global scale, it is important to consider the impacts natural disasters can have on different communities. Most of the natural disasters with the highest death tolls are in countries with no infrastructure in place to protect their citizens. One example of this is the 2010 earthquake recorded in Haiti, with estimated deaths over 230,000 citizens, an additional 300,000 injured, and a million homeless<sup>7</sup>. In the United States, natural disasters typically do not have as many casualties – the largest loss of life due to a natural disaster in recent history is Hurricane Katrina in 2005, which killed 1,833 people and caused over 81 billion dollars in damage<sup>8</sup>. New Orleans, Louisiana is still recovering from these damages fifteen years later, despite having a government-mandated plan in place to help save the city. The same goes for Puerto Rico, which was devastated in 2017 by Hurricane Maria, killing more than 4,600 people and leaving over 62,000 people without power for almost a year.<sup>9</sup>

When considering the effects of these disasters, deaths and injuries are not the only relevant statistics. Even if families have evacuated and their lives are not immediately at stake, their place of residence and personal effects may be. According to the Norwegian Refugee Council (NRC), disasters will displace 14 million people per year in the next two decades without a global effort to increase community resilience.<sup>10</sup> This report suggests that Asia will contain the majority of these internally-displaced people (IDP), as 8 out of 10 of the countries at highest risk for this sort of displacement are situated in Southeast or Eastern Asia. The United States is ranked as the 10<sup>th</sup> most likely country to have significant numbers of IDP within the next two decades, as the countries with the highest numbers of estimated displacement of people typically display a lack of infrastructure (i.e. Haiti) or high population density coupled with aging infrastructure (the U.S.).<sup>11</sup>

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<sup>6</sup> Ritchie and Roser, "Natural Disasters: Empirical View."

<sup>7</sup> Amadeo, "Haiti Earthquake Facts, Its Damage, and Effects on the Economy."

<sup>8</sup> Gibbens, "Hurricane Katrina , Explained."

<sup>9</sup> Amnesty International, "Puerto Rico One Year After Hurricane Maria."

<sup>10</sup> Ingvild Vetrhus, "Disasters Will Displace 14 Million People Every Year | NRC."

<sup>11</sup> Ingvild Vetrhus.

In 2018 alone, the United States has had 1,247,000 IDP related to natural disasters.<sup>12</sup> According to the Internal Displacement Monitoring Centre (IDMC), California suffered their “most destructive outbreak of wildfires in its history” in 2018, displacing 350,000 people, and the American Southeast was hit by hurricanes Florence and Michael, displacing an additional 850,000 people.<sup>13</sup> In 2017, a year earlier, the Federal Emergency Management Agency (FEMA), reflected on a “historic year, including unprecedented disasters that affected more than 25 million Americans (almost 8 percent of the U.S. population).”<sup>14</sup> Though many people do not enjoy confronting the possibility that a natural disaster could level their hometown or put them or someone they care about in danger, the increases in rates of natural disasters are not slowing down. No U.S. or global citizen is out of the path of natural disasters; all U.S. citizens are affected by these large-scale events, whether they are affected by them personally or are merely a spectator, watching and providing aid.

### 1.3 Defining Resilience

Resilience is a multi-faceted issue, spanning many different facets of government. A simple definition of community resilience is “the ability to prepare for anticipated hazards, adapt to changing conditions, and withstand and recover rapidly from disruptions,”<sup>15</sup> and in this way, it can be applied to any disturbance of normalcy. Even when the concept of resiliency is applied to natural disaster mitigation, it is important to holistically consider community well-being – what good is a house if there are no longer any jobs and families cannot support themselves? Community resilience must consider the physical, social, and economic well-being of citizens. An alternative definition of community resilience is the idea of communities “bouncing or springing forward”<sup>16</sup> after natural disasters – looking at the changes that occur within communities after they have been destroyed. As example, this would cover communities which have historically been located in floodplains, who have relocated after a large flood, or communities which grow stagnant economically, and who utilize the destruction of a disaster to mobilize their community and transform their areas for the better.

Even within municipalities, there are large discrepancies in the levels of preparedness for natural disasters. In spite of the fact that existing policies work to standardize preparedness, much of community resilience is based on other socioeconomic factors. Natural disasters do not discriminate between rich countries and poorer, developing countries, but poor countries often have significantly higher rates of deaths than rich countries do. This is due to a myriad of factors, including but not limited to: having less money in infrastructure per capita, more people per square

<sup>12</sup> Internal Displacement Monitoring Centre (IDMC), “Country Profile: United States.”

<sup>13</sup> Internal Displacement Monitoring Centre (IDMC), “Disasters and Violence Displaced Two Million People Across the Americas in 2018.”

<sup>14</sup> Federal Emergency Management Agency (FEMA), “FEMA Reflects on Historic Year.”

<sup>15</sup> National Institute of Standards and Technology (NIST), “Community Resilience.”

<sup>16</sup> Siambabala et al., “Disaster Resilience: A Bounce Back or Bounce Forward Ability?”

mile, etc.<sup>17</sup> In Rio de Janeiro, the loss of life and money are not homogenous between and within municipalities, and the majority of those who lose their homes are from poor neighborhoods. These communities had never had access to public goods the way may other neighborhoods had, and many communities like this vacate after natural disasters, never to return.

Even within the continental U.S., the same pattern emerges. On April 27, 2011, a group of tornadoes hit Tuscaloosa, Alabama and followed a similar pattern of destruction – 5,144 out of 6,580 (or approximately 75%) of the households in the area experienced some level of damage or destruction disproportionately affecting lower socioeconomic status (SES) and renter-occupied neighborhoods.<sup>18</sup> In this case, rebuilding efforts focused on student/temporary housing, which left out lower-SES residents, and made it more difficult to advocate for housing for those who remained in the city. Even with the assistance of FEMA, five years later, 28% of the [lots] affected were still vacant.<sup>19</sup> Rebuilding efforts can help communities recover, but many times those who are displaced find homes elsewhere, sometimes affecting the economy of the area for years to come.

Additionally, when applied to a city or town, community resiliency considers the building codes which govern the area, the materials used during construction, et. cetera. In this context, cities and towns must adapt to become resilient to single event disasters, such as fires, tornadoes, floods, or other natural disasters, as well as long-term stresses, such as rising water levels and global climate change, and as a result is always evolving.

## 2. Background

As long as humans have recorded history, they have recorded natural disasters. The United States is no different, and as natural disasters have increased, so have the efforts to document and respond to them.

In the early 1900s many disasters were especially deadly, including the Great San Francisco Earthquake of 1906, in which a magnitude-8.2 earthquake shook San Francisco, ruptured gas and water lines – leading to at least 3,000 deaths and leaving more than 200,000 citizens homeless.<sup>20</sup> Initial damages were estimated around \$500,000 in 1906, equivalent to \$14,000,000 in 2019. President Theodore Roosevelt and his congress appropriated an additional 2.5 million dollars (approximately \$65,000,000 in 2019),<sup>21</sup> as was standard for the time, as there was no singular governing body working to simplify disaster preparedness and response.

<sup>17</sup> Albuquerque Sant'Anna, "Not So Natural: Unequal Effects of Public Policies on the Occurrence of Disasters."

<sup>18</sup> Smart and Prohaska, "Disaster Capitalism, Housing Vulnerability, and the Tuscaloosa Tornado: A Critical Analysis of Rebuilding Efforts."

<sup>19</sup> Crawford et al., "Five Years after the April 27, 2011, Tuscaloosa Tornado: A Study in Community Resilience."

<sup>20</sup> Hopper, "After Katrina: An American History of Disaster and Response."

<sup>21</sup> Epstein, "The Great Quake : 1906-2006 / As with Katrina , Federal Role Caused Discord."

FEMA was not created until July 20, 1979, when President Jimmy Carter issued an Executive Order delegating the functions of the President and related federal agencies to FEMA.<sup>22</sup> By law, FEMA works to mitigate all disasters, not just those caused by natural events – in 2002, after the September 11, 2001 terrorist attacks on the U.S., then President George Bush transferred FEMA over to the Department of Homeland Security (DHS), working under Emergency Preparedness and Response (EPR) in the DHS.<sup>23</sup> Over the years, the role of FEMA has changed, but although the goal of FEMA is to “develop policies which provide that all civil defense and civil emergency functions, resources, and systems of Executive agencies are developed, tested and utilized to prepare for, mitigate, respond to and recover from the effects on the population of all forms of emergencies”<sup>24</sup>, FEMA typically spends more manpower responding to natural disasters rather than mitigating them.

## 2.1 The Disaster Management Cycle

The Disaster Management Cycle (**Figure 3**) is the process FEMA utilizes as they work with those who have been affected by natural disaster and with those who may be affected by natural disasters in the future.<sup>25</sup>



**Figure 3:** The Disaster Management Cycle can be split up into four quadrants representing the four different stages of disaster management, which happen continuously.

<sup>22</sup> Carter, “Executive Order 12148 --Federal Emergency Management.”

<sup>23</sup> 107th Cong., “Homeland Security Act of 2002, H.R. 5005.”

<sup>24</sup> Carter, “Executive Order 12148 --Federal Emergency Management.”

<sup>25</sup> Kennedy, “A Guideline to Facilitate Over the Air Communication in a Disaster Scenario.”

The four categories are:

### **1) Mitigation**

Mitigation is the act of working to prevent hazards or disasters from forming, and to prevent or reduce damages and/or consequences of these disasters. A good example of this would be constructing barriers to prevent flooding or weighing down outdoor furniture to combat high wind speeds.

### **2) Preparedness**

Preparedness focuses mainly on disaster literacy – developing plans, making sure citizens know what to do in the case of an emergency. This includes undergoing disaster drills in primary schools and creating emergency kits for different types of disasters – examples include earthquakes and tornadoes.

### **3) Response**

The response is what happens in the wake of a natural disaster. Typically, this looks like first responders reacting to help people in the area, whether its undergoing search and rescue missions or contacting FEMA/the federal government for assistance.

### **4) Recovery**

Recovery is often the longest battle. FEMA money is being distributed, buildings are being rebuilt, and if all goes right, people begin to return home, to some sense of normalcy. This is not always the case, as many areas stuck by natural disasters do not return to their former occupancies.

All four stages of the Disaster Management Cycle are related, but when looking in terms of federal spending, every \$1 spent in mitigation efforts translates to \$6 saved for taxpayers.<sup>26</sup> These mitigation efforts can look a million different ways, but generally include retrofitting buildings and strengthening foundations. Most of the federal funding for mitigation efforts comes via FEMA, as well as other agencies such as the Department of Housing and Urban Development (HUD), the Small Business Administration (SBA), and the Departments of Agriculture and Commerce.

## **2.2 FEMA's Responsibility in Disaster Mitigation**

FEMA funds three main mitigation programs which aim to help communities better prepare themselves for natural disasters and prevent hazards: the Hazard Mitigation Grant Program (HMGP), Pre-Disaster Mitigation Grant Program (PDM), and the Flood Mitigation Assistance Grant Program (FMA). The biggest of these programs in terms of monetary assistance is the HMGP, which provides funding and “grants to states and local governments to implement long-term hazard mitigation measures after a Major Disaster Declaration.”<sup>27</sup> Major Disaster Declarations begin

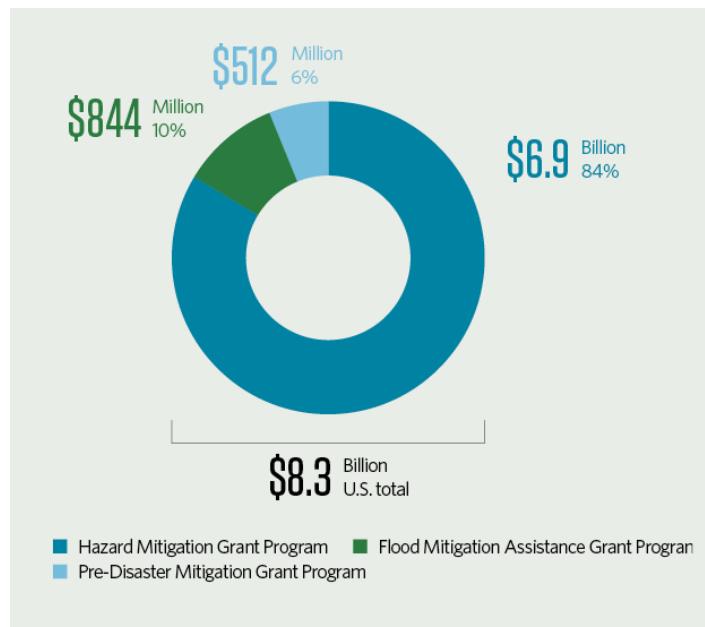
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<sup>26</sup> The Pew Charitable Trusts, “Natural Disaster Mitigation Spending Not Comprehensively Tracked.”

<sup>27</sup> Federal Emergency Management Agency (FEMA), “Hazard Mitigation Assistance Unified Guidance.”

with a local request – either from the governor of a state or a Tribal Chief Executive of an affected tribe – for federal assistance within 30 days of an incident. Typically, Major Disaster Declarations include natural events such as hurricanes and tornadoes and allow for money from FEMA to be distributed via HMGP to be used to rebuild and prevent future disasters. Local governments and citizens are expected to pay for 25% of the rebuilding efforts, and FEMA covers the remaining 75%.<sup>28</sup>

Although this falls under the umbrella of “mitigation” by combining rebuilding with efforts to provide more sustainable infrastructure for the future, this program still requires a disaster happen in the first place – and by virtue of its classification as a Major Disaster Declaration, this disaster must have caused more than \$5 million in damages.<sup>29</sup> As the Disaster Management Cycle is, by nature, cyclical, the four components are designed to overlap and coexist – but in waiting until a natural disaster strikes, FEMA is waiting until cities and states require assistance, in the middle of the rebuilding of infrastructure, sometimes from the bottom up. While this program does still help mitigate future disasters, it is a bigger component of the recovery process than the mitigation process. By comparison, FEMA’s PDM program actually does provide funding before natural disasters and can be applied for by U.S. States, Territories, and Federally-Recognized Tribes.

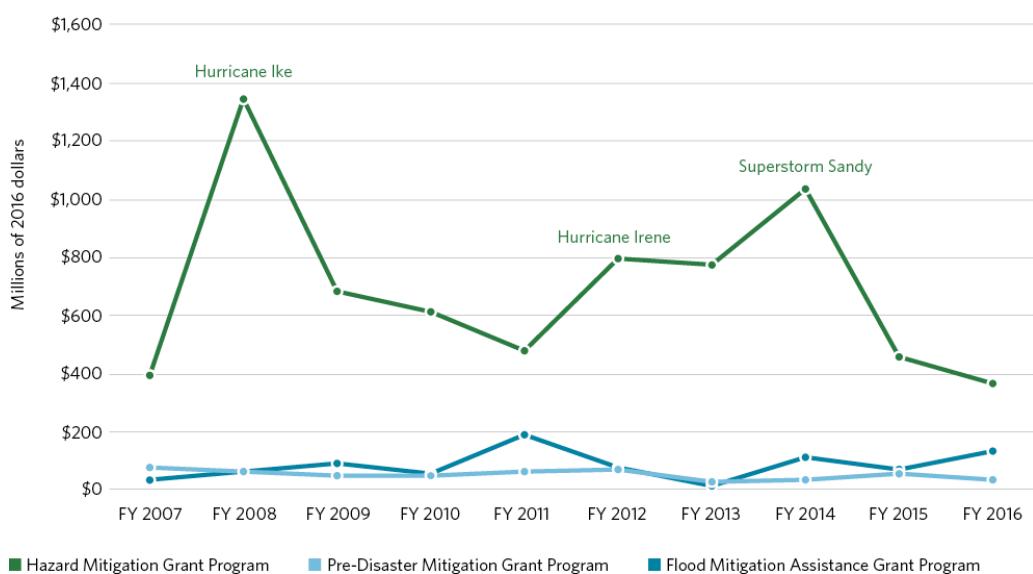


**Figure 4:** FEMA provides most mitigation assistance after disasters strike. This chart shows the breakdown of FEMA funding for their three mitigation programs (adjusted for inflation) from FY 2007-2016.

<sup>28</sup> Federal Emergency Management Agency (FEMA).

<sup>29</sup> Baca, “History of Disaster Legislation.”

As (**Figure 4**)<sup>30</sup> shows, the majority of FEMA disaster mitigation efforts are after the fact. Of the \$8.3 billion spent in the 10-year period, 84% of mitigation efforts were provided as grants to communities responding and rebuilding after disaster. As a result, much more money is spent periodically by FEMA in response to natural disasters and Major Disaster Declarations, whereas the PDM and FMA Grant Programs provide significantly less money to cities and states requesting resources before disaster strikes which can be seen in (**Figure 5**).<sup>31</sup> In this figure, each peak in the money provided by FEMA for the HMGP correlates to a Major Disaster Declaration, whereas the funding provided by other grant programs are more consistent but are worth significantly less, as these funds are typically used for smaller-scale projects – retrofitting existing buildings instead of designing new ones.



**Figure 5:** Large spikes in federal funding through HMGP correlate with episodic Major Disasters, such as Hurricanes Ike and Irene. Funding for PDM and FMA stay relatively constant over the 10 year period.

## 2.3 The Role of Standardization

When looking at the Disaster Management Cycle the origin of this cycle can become muddled and overlooked. Many of the cities and towns in the U.S. were built based on existing building codes – but these have not always been standardized across the U.S.

Now, there are a few minor differences between standards and codes. For one, standards are completely mandatory, and are typically narrow in scope. A standard will apply to one part of a process or a particular product and may contain mandatory language but do not require this. Building codes are a collection of standards, written in mandatory language to ensure standardization. In the U.S., these codes are required by law, and typically reference standards

<sup>30</sup> The Pew Charitable Trusts, "Natural Disaster Mitigation Spending Not Comprehensively Tracked."

<sup>31</sup> The Pew Charitable Trusts.

written by experts in their fields. For example, ASTM International, an international standards organization, writes standards which are referenced by U.S. building codes and followed by civil engineers when designing new structures. These are usually based around topics, such as their committee on the Performance of Buildings (E06), which define specific aspects of the building process. A U.S. code body can reference these standards and require them, simplifying and standardizing the construction of these buildings across the country.

In the early 20<sup>th</sup> century, there were three code bodies who governed building codes regionally. These included the Southern Building Code Congress (SBCC) which dealt with the Southeast, the Building Officials and Code Administrators (BOCA), who helped to standardize the Northeast, and the International Conference of Building Officials (ICBO), who mainly worked in the West as can be seen in (**Figure 6**).<sup>32</sup> As a result, these different groups were catered to their regions – ICBO focused more on wildfires and had higher seismic standards, SBCC focused on flooding and tornadoes, and BOCA focused on snow and sleet. However, these three codes overlapped significantly, leading them to merge into the International Code Council (ICC) in 1994.



*Figure 6: A map of the U.S. building codes before ICC merger.*

The ICC updates the International Building Code (IBC), International Residential Code (IRC), and the International Existing Building Code (IEBC) every three years<sup>33</sup>. ICC requires that codes be in mandatory language, meaning if they are incorporated into laws, they must be followed. The ICC is typically used as a national guideline, but local governments decide on a state by state, city by city level whether or not to adopt these codes as local laws. As a result, many large cities have inconsistent, tougher building codes than the states they live in, whereas many rural areas simply do not follow a building code at all.<sup>34</sup>

A glaring example of the lack of standardization of these codes nationwide can be seen when looking at the implementation of seismic codes. Following the 1994 Northridge, California

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<sup>32</sup> Rossberg and Leon, “Evolution of Codes in the USA.”

<sup>33</sup> Federal Emergency Management Agency (FEMA), “Building Codes Fact Sheet.”

<sup>34</sup> Rossberg and Leon, “Evolution of Codes in the USA.”

Earthquake, the IBC, IRC, and IEBC were updated to provide adequate resistance to seismic forces. However, FEMA reports that many jurisdictions may not have updated their building codes, meaning new structures built after this may not be able to withstand "high levels of seismic hazard."<sup>35</sup>

Furthermore, most Americans believe the biggest earthquakes to happen on U.S. soil happen in California. This is actually not the case. In New Madrid, Missouri in 1811-12, "three massive earthquakes with intensities ranging from 8.4-8.7 Richter occurred along the New Madrid Fault Zone; ... among the most powerful earthquakes ever recorded (no measured earthquake has exceeded 8.9)." <sup>36</sup> There are seven states which intersect the New Madrid Seismic Zone (NMSZ). Four of these – Arkansas, Indiana, Kentucky, and Tennessee – have statewide standardized building codes, and the remaining three – Illinois, Mississippi, and Missouri – leave local governments the authority to determine what building codes they must adopt.<sup>37</sup>

The closest "big" city near the NMSZ is approximately 120 miles southeast of New Madrid and is Memphis, Tennessee, with an estimated metropolitan population of 1.3 million. As mentioned before, Tennessee requires state-wide standardized building codes, which may allude to higher standards for citizens who are in areas that are considered to have high or very high seismic risk. However, of the 75 jurisdictions in the state of Tennessee which are considered to have high or very high seismic risk, only 32 have building codes with residential seismic-resistant provisions.<sup>38</sup> According to a different study, if a 7.7-magnitude earthquake shook the NMSZ today, "the number of damaged buildings in Tennessee is far greater than all other states [which surround the NMSZ]..."<sup>39</sup> With approximately 2.1 million buildings in the state of Tennessee, "over 264,000 buildings are moderately or more severely damaged and nearly 107,000 of these buildings are completely damaged,"<sup>40</sup> with Shelby County, Tennessee comprising over half of all infrastructure damage, as it contains the Memphis metropolitan area. Roughly one third of all of the bridges in the state will sustain structural damage, and if the earthquake occurs at 2:00AM, there are an estimated 34,000 casualties.<sup>41</sup> This estimate does not consider the ignorance of the general population, and potential lack of preparation for a seismic event.

By comparison, Los Angeles experiences upwards of 10,000 earthquakes per year.<sup>42</sup> Many of these are under a magnitude 3, but as a result, city and state governments have robust seismic

<sup>35</sup> Vaughan and Turner, "The Value and Impact of Building Codes."

<sup>36</sup> IMUA Natural Disasters Committee, "Earthquakes: A Summary of Non-California Regional Variations in Seismic Risk."

<sup>37</sup> Federal Emergency Management Agency (FEMA), "Building Codes in the New Madrid Seismic Zone (NMSZ)."

<sup>38</sup> Federal Emergency Management Agency (FEMA).

<sup>39</sup> Elnashai et al., "New Madrid Seismic Zone Catastrophic Earthquake Response Planning Project."

<sup>40</sup> Elnashai et al.

<sup>41</sup> Federal Emergency Management Agency (FEMA), "Building Codes in the New Madrid Seismic Zone (NMSZ)."

<sup>42</sup> United States Geological Survey, "Earthquake Facts."

codes in place. Los Angeles also has a significantly larger metropolitan population – 13 million people call LA County their home – but when a 7.1 earthquake hit Ridgecrest California, around 120 miles from Los Angeles, there were no casualties. There was infrastructure damage, but nothing came crashing down.<sup>43</sup> Part of the reason for this large seismic event causing little to no damage is because the city is bracing itself for a much larger quake and has been instituting more exhaustive building codes to mitigate risk. In 2017, the city passed Ordinance 183893, which specifically targets wood-framed soft story buildings and non-ductile concrete buildings.<sup>44</sup> In both of these cases, a structural evaluation is required, and the city believes most of the old buildings which are being evaluated (generally, all buildings which acquired building permits on file before January 1, 1978) will require upgrades.<sup>45</sup> If retrofitting is needed, proof of work by a civil or structural engineer is required within the next seven years. This is an instance in which local government has taken the initiative to work ahead and mitigate some of the risks that come with natural disasters. Many cities are not as lucky as Los Angeles, however.

## 2.4 Hurricane Katrina: A Case Study in Government Mismanagement

When talking about natural disasters, it would be remiss not to discuss Hurricane Katrina in more depth. Hurricane Katrina hit the coast of Louisiana as a Category 3 storm on August 29, 2005.<sup>46</sup> Initial reports did not suggest the level of destruction that the storm would cause, as most of the damage in the city was due to the breach of a levee, eventually overwhelming several more and flooding the city. As New Orleans sits in a natural basin, partially below sea-level, in less than a day, an estimated 80% of the city was completely submerged.<sup>47</sup> A few days earlier, the state government issued a mandatory evacuation, which according to then-Governor Kathleen Blanco, “developed a new evacuation plan that includes contra-flow, where both sides of the interstates are used for outbound traffic. I am proud that we rapidly moved over 1.2 million people – some 92% of the population – to safety without gridlock or undue delay prior to Katrina.”<sup>48</sup> Citizens who had been identified as sick or elderly were taken to the Superdome, which was appropriated for use as a special-needs shelter,<sup>49</sup> and many of those who decided to ignore orders for evacuation were low-income or did not have a way to leave the city. This left more than 10,000 stranded in the Superdome, which was understaffed, did not have portable toilets (as all of the existing toilets

<sup>43</sup> Lin, “Ridgecrest Earthquake Mystery: Why so Little Destruction from Huge Temblors ?”

<sup>44</sup> City of Los Angeles, Ordinance No. 183893.

<sup>45</sup> MHP Structural Engineers, “Summary and Overview City of Los Angeles Ordinance #183893.”

<sup>46</sup> Gibbens, “Hurricane Katrina , Explained.”

<sup>47</sup> Gibbens.

<sup>48</sup> Davis, “Select Bipartisan Committee to Investigate the Preparation for and Response to Hurricane Katrina.”

<sup>49</sup> U.S. Senate Committee on Homeland Security and Governmental Affairs, “Hurricane Katrina: A Nation Still Unprepared.”

became clogged and overflowing within one day<sup>50</sup>), and consistently ran out of food and water.<sup>51</sup> These estimates rose to over 40,000 citizens as people are recovered from their homes.<sup>52</sup> Although state legislators claim in testimony to Congress that "Contrary to what you heard in the news media, the people in the Dome have water. They have food. They have shelter. They have medical care. They have security. And, they have all of this for the entire time that they are there,"<sup>53</sup> medical professionals on-site shared their concerns about diseases like dysentery – "'With no hand-washing, and all the excrement,' said Sgt. Debra Williams, who was staffing the infirmary in the adjacent sports arena, 'you have about four days until dysentery sets in. And it's been four days today.'<sup>54</sup> The city had no way to support the citizens who remained.

There were three main sources of legislative failure in the case of Hurricane Katrina:

**1) The failure of the federal government to activate the National Response Plan's (NRP) Catastrophic Incident Annex (NRF-CIA).**

Typically, as outlined in the NRF-CIA, if there is a "no-notice or short-notice incidents of catastrophic magnitude, where the need for Federal assistance is obvious and immediate"<sup>55</sup> state governments can request federal assistance with programs such as: Mass Evacuations, Mass Care, Housing, and Human Services, and Search and Rescue. According to the then-governor of Louisiana, "had the DHS recognized Katrina [and] implemented the [NRF-CIA], Louisiana should have had a significant number of Federal troops and Federal assets... leaning towards preparing."<sup>56</sup>

**2) A lack of planning by the DHS's Homeland Security Operations Center (HSOC), regarding situational awareness**

The director of the Homeland Security Operations Center (HSOC) "testified "there was no plan," [to maintain situational awareness]," during Hurricane Katrina, despite the HSOC having planned months in advance for the Super Bowl.<sup>57</sup> The HSOC did not update information quickly or accurately, typically providing "breaking news" that was several hours old. This misinformation did not allow citizens to stay updated on their conditions.

**3) The DHS denied several attempts from Louisiana to appropriate more money for general catastrophic planning.**

<sup>50</sup> Gerhart, "'And Now We Are in Hell.'"

<sup>51</sup> Treaster, "Superdome: Haven Quickly Becomes an Ordeal."

<sup>52</sup> Davis, "Select Bipartisan Committee to Investigate the Preparation for and Response to Hurricane Katrina."

<sup>53</sup> Davis.

<sup>54</sup> Gerhart, "'And Now We Are in Hell.'"

<sup>55</sup> Federal Emergency Management Agency (FEMA), Catastrophic Incident Annex.

<sup>56</sup> Davis, "Select Bipartisan Committee to Investigate the Preparation for and Response to Hurricane Katrina."

<sup>57</sup> U.S. Senate Committee on Homeland Security and Governmental Affairs, "Hurricane Katrina: A Nation Still Unprepared."

In 1999, FEMA recorded that southeast Louisiana had severe risk for hurricanes, along with a lack of resources to retrofit infrastructure without federal interference. However, FEMA's plans to update the New Orleans area continued slowly and were abandoned before Louisiana requested funding in FY 2004 and FY 2005 from FEMA to update catastrophic housing planning, which was denied by the DHS.

Hurricane Katrina was one of the worst-managed disasters ever to hit the mainland United States. They had a plan, but the plan failed. While disasters like these may seem anecdotal, there are distinct reasons more communities must shift their focus towards resiliency before these natural disasters strike, leaving them unprepared for the worst.

### 3. Current Regulatory Environment

When it comes to regulating for and preventing natural disasters, many politicians will purport that community resiliency is not a partisan issue, and at its core it is not – no one political party will admit to wanting communities to be unprepared. At this moment in time, there are four main federal policies that must be considered when looking at community resilience at a federal level.

#### 3.1 Federal Frameworks for Disaster Mitigation

##### 3.1.1 National Response Framework

The National Response Framework (NRF) is the U.S.' main framework for responding to and preparing for large scale disasters. It is a part of DHS' response to the September 11, 2001 terrorist attacks and has been based on the National Incident Management System (NIMS) and the Incident Command System (ICS), which both previously worked to provide order, hierarchy, and standardization to the disaster process. The NRF transitioned from the National Response Plan (NRP) in 2008, and was last updated June 16, 2016.<sup>58</sup> The main job of the NRF is to help direct the "tiered response", as "most incidents start at the local and tribal level, and as needs exceed resources and capabilities, additional local, state, tribal, and Federal assets are applied [when needed]"<sup>59</sup> as well as providing roles to the private and public sectors, making sure to keep management at the "lowest level" possible – i.e., as long as higher oversight is not required, it will not be provided, keeping decisions at a local and state level.

The NRF Emergency Support Function (ESF) Annexes also provide protocols for states and communities who have emerging problems or disasters regarding transportation, communications, public works and engineering, firefighting, information and planning, long-term community recovery, and many more topics. The NRF also provides Incident Annexes, which can span from identifying and mobilizing FEMA troops to Catastrophic Incidents, Mass Evacuation Incidents, and

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<sup>58</sup> Department of Homeland Security, National Response Framework, Third Edition.

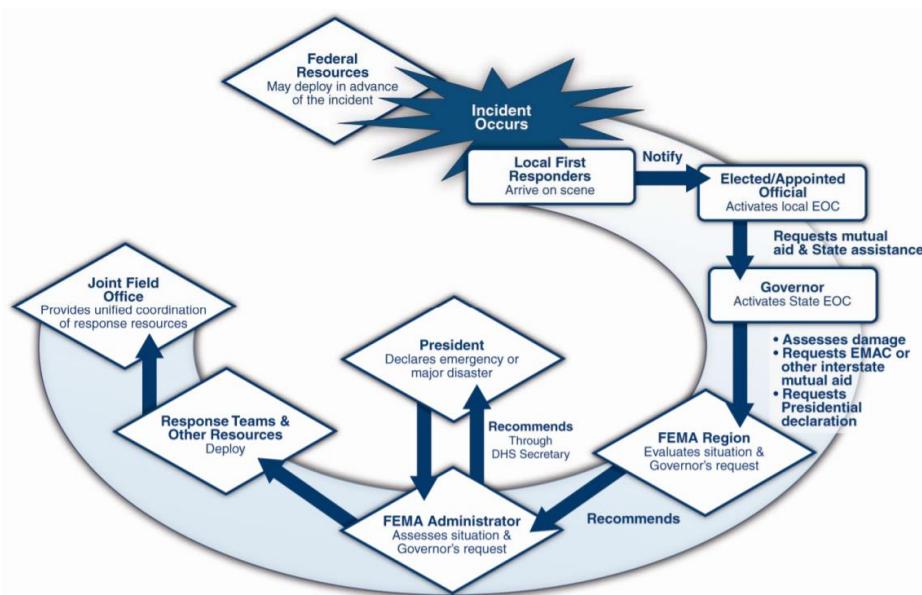
<sup>59</sup> Department of Homeland Security.

Biological Incidents. In many of these cases, this can mean cities, towns, and tribes will receive help before natural disasters even happen.

### 3.1.2 The Stafford Act

The Robert T. Stafford Disaster Relief and Emergency Assistance Act (known as the Stafford Act) was initially passed on November 23, 1988, by the 100<sup>th</sup> U.S. Congress.<sup>60</sup> This act is the general framework by which the federal government provides states aid after any kind of disaster.

Although there have been amendments, the most recent version of the Stafford Act (published in 2016) gives the President the authority to declare a major disaster or emergency in response to state governments.<sup>61</sup> Typically, state plans must already be in effect in order to receive federal assistance and have set up emergency operations centers (EOCs) and begun working on responding to the disasters which have struck.



*Figure 7: The basic framework of the Stafford Act, from incident to response.*

There are a few reported “issues” with the Stafford Act, however, a few of which came to light during the response to Hurricane Maria in Puerto Rico.<sup>62</sup> Although the Stafford Act does refer to Puerto Rico as a part of the United States, the Stafford Act only covers repairs post-disaster which restore an area to the level of infrastructure it already possessed. In Puerto Rico, one of the biggest issues post-disaster was the failing power grid on the island, which had not been updated in many years, and was specifically vulnerable to the hurricane. This, along with the red tape and waiting time associated with receiving funds from the Stafford Act, was part of why it took almost a

<sup>60</sup> 114th Cong., “Robert T. Stafford Disaster Relief and Emergency Assistance Act, Public Law 93-288, as Amended, 42 U.S.C. 5121 et Seq., and Related Authorities.”

<sup>61</sup> Federal Emergency Management Agency (FEMA), “National Response Framework: Stafford Act Support to States.”

<sup>62</sup> Amnesty International, “Puerto Rico One Year After Hurricane Maria.”

year to restore power to Puerto Rico after Hurricane Maria, with a required \$26 billion more to bring the Puerto Rican grid up to resilient standards.<sup>63</sup> Simply put, if a hurricane knocked down a public university which hadn't been updated since the 1950s, the Stafford Act would require it be built to those standards, rather than the standards of the 2010s.

### 3.1.3 Post-Katrina Emergency Management Reform Act of 2006

As the title of this law suggests, this was written in response to the way the federal government responded to Hurricane Katrina in 2005, which is widely regarded as one of the worst natural disasters on American soil, as well as a distinctly mismanaged situation as was discussed earlier.

The Post-Katrina Emergency Management Reform Act of 2006 (PKEMRA) was written to fill gaps in legislation which were discovered by the advent of Hurricane Katrina in 2005. This piece of legislation makes it possible for federal assistance from FEMA to be sent before a state government requests it, accelerating the recovery process and saving lives.<sup>64</sup> Before, as outlined by the Stafford Act and NRP, state governments were required to reach out to the federal government before receiving any aid from FEMA. After the PKEMRA, the federal government also committed to creating a National Disaster Recovery Strategy and National Disaster Housing Strategy<sup>65</sup>, and considered what could be done to protect household pets and service animals, leading to the Pets Evacuation and Transportation Standards Act of 2006 (PETS Act) in an attempt to consider the humanity which can be lost in large-scale disasters, as a 2006 poll found that "44% of people who did not evacuate for Katrina made that choice because of their companion animals."<sup>66</sup>

#### "Snowball! Snowball! Snowball!"

Approximately 600,000 animals were killed or abandoned in the wake of Hurricane Katrina, with estimates of nearly 500 human/owner deaths as the result of staying behind with their pets.<sup>67</sup> Tom Lantos, a former California Representative, co-sponsored this bill as a reaction to "the scene from New Orleans of a 9-year-old little boy crying because he was not allowed to take his little white dog Snowball was too much to bear," Lantos said. "As I watched the images of the heartbreaking



**Figure 8:** A policeman carries small white dog, Snowball, away from his owner, a small boy who is being evacuated to the Superdome. He leaves Snowball on the side of the road.

<sup>63</sup> Sullivan, "Nearly A Year After Maria, Puerto Rico Officials Claim Power Is Totally Restored."

<sup>64</sup> 109th Cong., Post-Katrina Emergency Management Reform Act of 2006, S.3721.

<sup>65</sup> 109th Cong.

<sup>66</sup> 109th Cong., "Pets Evacuation and Transportation Standards Act 2006."

<sup>67</sup> Nolen, "The PETS Act: A Legal Life Preserver."

choices the Gulf residents had to make, I was moved to find a way to prevent this from ever happening again.”<sup>68</sup>

### 3.1.4 Disaster Recovery Reform Act of 2018

The most recent and most transformative legislation regarding natural disaster response and recovery was signed into law by President Trump on October 5, 2018. The Disaster Recovery Reform Act (DRRA) is nestled into the Federal Aviation Administration Reauthorization Act of 2018 and is a direct response to 2017’s bevy of natural disasters – from California’s costly wildfires to Hurricanes Harvey, Maria, and Irma.

Widely lauded as a bipartisan bill, the DRRA made major changes to the Stafford Act, most notably updating funding and rebuilding regulations. The DRRA authorizes a new National Public Infrastructure Pre-Disaster Mitigation fund, funded as a “six percent set aside from estimated disaster grant expenditures.”<sup>69</sup> This language is specifically important because it allows the DHS to provide pre-disaster mitigation funds from a constant base of money, rather than relying on appropriations bills to provide varying money per year, as the HGMP did, only as a result to Major Disasters. As a result, FEMA has created the Building Resilient Infrastructure and Communities (BRIC) Program, which aims to “focus on traditional mitigation projects and incentivize new, innovative large infrastructure projects that build resilient communities and [reduce] risks from all hazards,”<sup>70</sup> and is currently being crowdsourced for ideas on Ideascale, a website designed to gather responses from the public, listening to the concerns of everyday Americans. The DRRA also provides updated guidance from the Federal Highway Administration to cities who may struggle with evacuation routes, as well as overwriting the portion of the Stafford Act which requires buildings must be repaired to the standards they existed at pre-disaster, instead of updated building codes, helping communities rebuild for the current day, not the past.

However, the most common complaint about the DRRA is that it provides incentives for communities to rebuild in place instead of relocating to area which hold more certain futures. Although some natural disasters – i.e. tornadoes, extreme weather, etc. – do not discriminate and generally affect large regions randomly, many areas which are vulnerable to flooding and hurricanes will only see these impacts compounded in the next few decades as a result of rising sea levels and climate change. The DRRA provides FEMA the ability to divert funds to the Army Corps of Engineers for preventative projects such as levees, seawalls, and similar investments in infrastructure. While this may initially sound like a sound form of disaster mitigation, according to Rob Moore, a Senior Policy Analyst at the Natural Resource Defense Council (NRDC), it can “take money that would have been used for much-needed, underfunded efforts to buy out flood-prone homes, build green infrastructure, install backup power supplies, or develop disaster mitigation plans,”<sup>71</sup> and will cost the federal government more money than smaller scale mitigation projects, along with creating a false sense of security to residents in areas like New Orleans, who may

<sup>68</sup> Nolen.

<sup>69</sup> 115th Cong., “FAA Reauthorization Act of 2018, H.R. 302.”

<sup>70</sup> Federal Emergency Management Agency (FEMA), “Infrastructure Mitigation Projects.”

<sup>71</sup> Moore, “Disaster Recovery Reform Act Is a Smart Move ... Mostly.”

believe that their homes will be safe from future disasters, when hurricanes will continue to ravage the city year after year.

Although the DRRA is a valuable piece of legislation aimed at improving community resilience and disaster mitigation, it leaves much to be desired in terms of acknowledging current scientific understanding of the world around us.

## 4. Viable Policy Directions

### 4.1 Decentralizing Water and Power in Large Metropolitan Centers

In the immediate chaos following a natural disaster, in many places in the U.S. the power goes out, the water turns off, and communications systems may be down. Depending on the disaster, there are the facets of civilization that are most needed. In pivoting to resilience, the U.S. must make an effort to keep basic utilities working to the best pf their ability after disasters. This is especially true now, as the U.S.' aging infrastructure is being eroded at by different natural disasters and the basic changes associated with time passing. The two main resources citizens of the U.S. depend on daily are electricity and water, which are "critical resources of which our society depends; delivery reliability is expected and based on a traditional large-scale, centralized model."<sup>72</sup> **As a result, the U.S. must put resources into researching and implementing large-scale water and energy microgrids to combat aging infrastructure.**

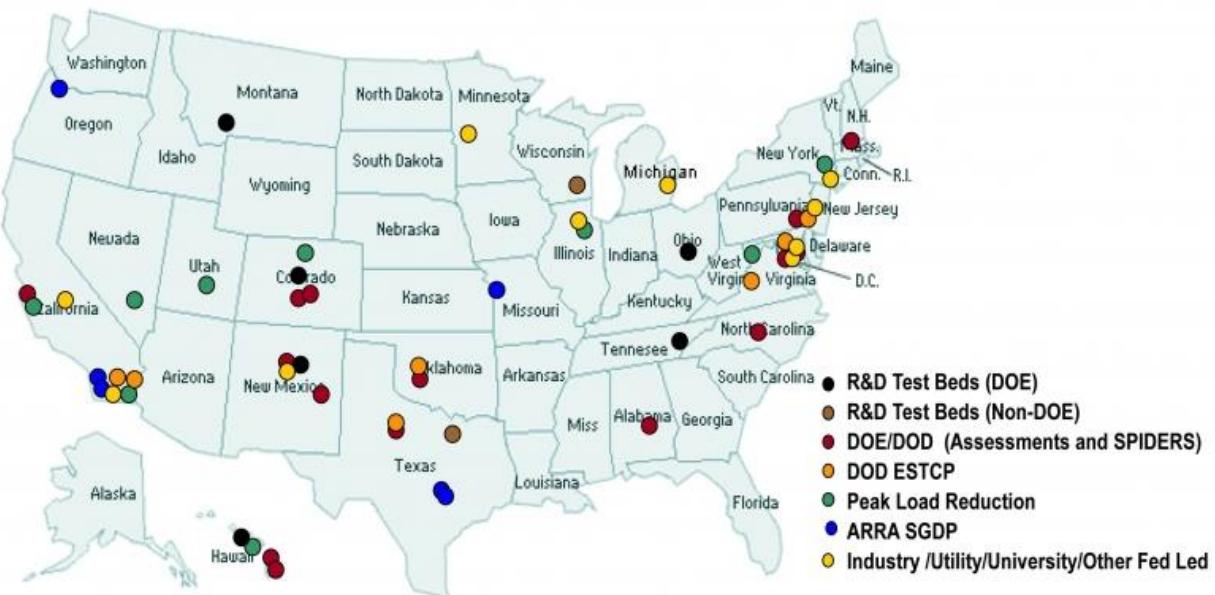
In the case of power, many countries have already begun looking at the potential benefits of microgrids. The U.S. Department of Energy (DOE) defines microgrids as "a group of interconnected loads and distributed energy resources within clearly defined electrical boundaries that acts as a single controllable entity with respect to the grid. A microgrid can connect and disconnect from the grid to enable it to operate in both grid-connected or island mode."<sup>73</sup> Part of the appeal of microgrids is that many microgrids are able to work nested inside other microgrids, meaning if disaster strikes, microgrids are able to disconnect from the centralized grid and use some form of local power generation – solar, wind turbine, or diesel, to name a few – in the coming hours or days. If a building or group of buildings is connected to the centralized grid, if the power goes out to the main grid, they will lose power even if they have their own capability to produce power via a local process or generator. The microgrid aims to fix this problem, and has seen early success in countries like Japan, who have become a world leader in the implementation microgrids after their disastrous 2011 earthquake and tsunami, which disrupted power lines and eventually caused a nuclear meltdown. The power throughout much of much of Japan remained down for days, and since then Japanese-owned companies such as Honda and Toyota have

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<sup>72</sup> Falco and Webb, "Water Microgrids: The Future of Water Infrastructure Resilience."

<sup>73</sup> Tom and Smith, "The U.S. Department of Energy's Microgrid Initiative."

funded huge initiatives to provide the framework for “smart cities” which rely on a bevy of different power sources, including natural gas, solar panels, and an array of old Prius batteries, which can keep phones and computers running for up to four days.<sup>74</sup> In looking at disaster preparedness, their goal is to “produce the energy on site that [they] need to consume on-site. That is the new meaning of “smart” in Japan.”<sup>75</sup>



**Figure 9:** As of 2016, a map of all DOE and non-DOE microgrid test sites in the U.S.

There has already been a DOE push to fund microgrid research, as well as a handful of sites in use and testing as can be seen in (Figure 9)<sup>76</sup>. Microgrids hold specific promise in improving the resiliency of large metropolitan centers, such as Los Angeles, CA and New York City, NY, which both have significantly higher population density than most of the continental U.S. A microgrid would also have helped in disasters like Hurricane Maria in Puerto Rico, where the power was down for almost a year, and can be relatively simple.

In a similar vein, water is the most important natural resource the world has been provided. When large-scale disasters hit, it is often one of the first concerns families face – often times when water systems are down, there are two main issues that arise. Clean drinking water can be hard – or even impossible – to come by, and human waste is significantly harder to dispose of when indoor plumbing is not working, which can lead to accelerated cases of disease and general health concerns. Despite water’s importance and large infrastructure demands, ASCE’s 2017 Infrastructure Report Card gave U.S. Drinking Water and U.S. Wastewater systems failing grades of D and D+,

<sup>74</sup> Harbert, “Post-Fukushima, Japanese Companies Build Microgrids.”

<sup>75</sup> Harbert.

<sup>76</sup> Tom and Smith, “The U.S. Department of Energy’s Microgrid Initiative.”

respectively.<sup>77</sup> The estimated need of these systems over the next 25 years rings up with a price tag of over \$1 trillion.<sup>78</sup> Implementing water microgrids designed to mimic the general functions of electric grids must be the future of water infrastructure to keep citizens safe and healthy.

Using energy microgrids as a model for water micronets, researchers have proposed plans for testing and implementing these nets in the U.S. The main reasonings behind switching to water micronets is similar to the benefits gained by energy microgrids – in the case of water, the main difference between these two “fluid” systems is the space water takes up – it is not nearly weightless and does not move imperceptibly fast. Water is a much more tangible problem. The infrastructure powering it is also more concrete and understandable to the average person. One of the main benefits of using a micronet system, where “small-scale water systems [are] built on top of existing water supply network infrastructure”<sup>79</sup> is that the system remains centralized but can island-off in a similar fashion to energy microgrids.

There are environmental and resilience considerations that micronets can help improve. One specific benefit of a water micronet is the idea of sustainable design, as many water reservoirs can be up to 300 miles away from their destinations.<sup>80</sup> This goes against the ideals behind low-impact development (LID) plans that exist in many states’ building codes. Additionally, if micronets are designed and implemented correctly, they also reduce the strain of giant dams and centralized water infrastructure on the environment, which interrupt the flow of rivers and cut off existing routes for indigenous animals. In a resilience context, water micronets will be an important asset to coastal areas at risk of flooding or those prone to earthquakes/breakage as they create greater redundancies in the system – if one branch of the water must be shut off, the entire system does not go down, and much of the water would be stored locally, vs. pumped into a faraway area. This would be helpful in situations like Hurricane Katrina – when housing large numbers of people in a structure similar to the Superdome, it would vastly improve community experiences to have water and power microgrids keeping the power on and the water running.

## 4.2 Providing Federal Incentives for Inter-Community Planning

As many disasters vary significantly by region, most policy and planning must be written at the local level. Planning for natural disasters can be considered at the state or city level and must be put into place by those who know the area, considering what the community already has as assets. In many cases, communities can take advantage of the resources they already have – hospitals, churches, and companies – to prepare a comprehensive plan before disaster strikes.

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<sup>77</sup> ASCE, “Wastewater Infrastructure Report Card”; ASCE, “Drinking Water Infrastructure Report Card.”

<sup>78</sup> ASCE, “Drinking Water Infrastructure Report Card.”

<sup>79</sup> Falco and Webb, “Water Microgrids: The Future of Water Infrastructure Resilience.”

<sup>80</sup> Falco and Webb.

Local governments must be able to spend some of their own money on improvements in planning, but many areas – specifically rural or low-income areas – do not have the money to do this themselves. In many cases, funding for resilience and disaster mitigation should be similar to that of education – locally provided and federally supported.

In the case of education, school funding is mainly supported by local and state taxes, with about 10% of the money spent in education coming from the federal government.<sup>81</sup> States decide what the minimum amount of money provided per student should be, and local property taxes per district provide a baseline for funding. From there, the state provides enough money to raise all of the districts past the minimum amount of money which should be provided per student. Typically, if there is an excess of money in high-income neighborhoods based on property taxes, these school districts are allowed to use these funds. Although students in high-income areas typically do have more funding than low-income students, state funding is provided to schools who have been provided less money in taxes. In this way, school funding is based on location, with state assistance if deemed “necessary”.

When it comes to federal funding, however, much of the money comes in through the Every Student Succeeds Act (ESSA) which was reauthorized in 2015 and includes a flexible block grant program. Title I, Section A includes stipulations which help provide grant funding for low-income students – if a school’s student population includes more than 40% federally-defined low-income students, they can use the money provided for general projects that positively impact the entire student body; if a school’s population includes less than 40% federally-defined low-income students, they must use the provided funds to specifically target their low-income students.<sup>82</sup> Additionally, in Title II, Section A, funds are provided to schools identified by a formula based on the percentage of low-income students and the number of children to recruit talented teachers and staff. Both of these programs can be translated into terms which can be used to help support communities plan for community disaster mitigation projects.

**Funding mitigation projects comes from a different source of money, but part of FEMA’s budget for the HMGP and/or BRIC in the years to come must be set aside in a similar title-based program to ESSA.** In communities which house less than 40% of people in low-income housing or renting, federal funds can be used to retrofit general community buildings, including churches, community centers, and hospitals (funding for school retrofitting would come from the Ed budget for the anticipated FY), whereas communities which house more than 40% of people in low-income housing or renting would focus on retrofitting or buying out neighborhoods, based on whether or not the respective city is prone to reoccurring natural disasters (i.e. New Orleans/similar floodplains). As mentioned earlier in this report, low income neighborhoods are significantly more likely to get destroyed by disasters, as well as typically do not have the additional funds required to rebuild – and typically end up vacant.<sup>83</sup> Additionally, Title II must be amended to include a formula based on % of low-income housing, population, and strength of building codes to provide money

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<sup>81</sup> Blagg et al., “How Do School Funding Formulas Work?”

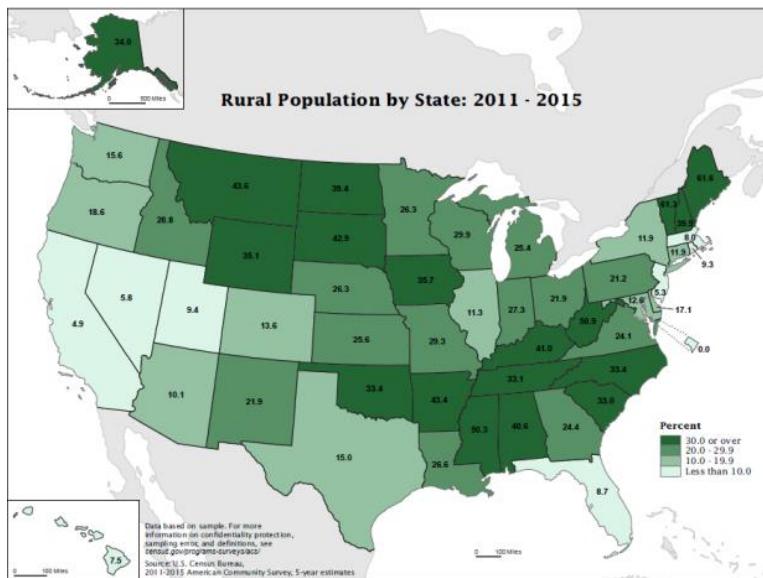
<sup>82</sup> 114th Cong., “Every Student Succeeds Act, S. 1177.”

<sup>83</sup> Albuquerque Sant’Anna, “Not So Natural: Unequal Effects of Public Policies on the Occurrence of Disasters.”

to cities who are looking to recruit staff – civil engineers and/or city planners who can help revitalize and retrofit existing buildings as well as help communities plan for the future. This would also be used to create plans for standardizing building codes in disaster prone areas, where cities will be asked to look at rural communities surrounding them, as well as creating comprehensive city-wide plans.

This plan would need to consider the different levels of disaster risk there are in different areas. In addition to using local property taxes for schools, local taxes will be used to provide better infrastructure for those living there – areas with significantly higher risk, as noted by the National Oceanic and Atmospheric Administration's (NOAA) National Hazard and National Storm Surge Hazard Maps, will require higher taxes than areas with no associated geographic risk. Additionally, communities would be able to grandfather in their current citizens – keeping citizens with lower SES safe from the threat of higher taxation and keeping them from being required to move – mainly targeting people who are trying to move into these areas. This will cause residents to take responsibility for living in areas with higher risk, or to convince current residents who have the means to leave, which was what the federal government assumed would happen once people were informed that they lived in dangerous areas. These taxes would be used in different mitigation and rebuilding efforts, based on the current status of the community, and will likely become more important in the next few decades, as sea levels rise and natural disasters continue to increase in frequency and intensity.

### 4.3 Creating a Rural Communities Mitigation and Response Plan (RCMRP)



**Figure 10:** This map shows the percentage of rural citizens per state from 2011 to 2015, largely concentrated in the Southeast region of the United States.

Rural communities are generally the last to get mentioned in the political sphere, despite making up 19% of the population, amounting to almost 60 million Americans.<sup>84</sup> The Census Bureau determines whether communities are urban or rural by their populations – Urbanized Areas (UAs) house more than 50,000 people, while Urban Clusters (UCs) house between 2,500 and 50,000 people. Any area that is not regarded as a UA or a UC is considered a rural area, making up 97% of the land area in the U.S.<sup>85</sup> In terms of geographic location, more than 60% of the rural population lives east of the Mississippi River, largely clustering in the Southeast as seen in (**Figure 10**).<sup>86</sup> This map looks at rural percentage, which does not include large cities – if the largest city in each state was removed, much more of the map would be dark green (>30%).

As a result, this report will mainly focus on the Southeast, and will consider the implementation of a RCMRP in this area of the continental U.S., despite generally applying to the entire country.

In looking at existing legislation promoting the community resiliency of rural areas, there are existing gaps that must be filled as well as best practices which must be defined. Although the U.S. Department of Agriculture (USDA) does provide housing assistance for individuals who live in rural areas by way of “home renovation and repair programs, [as well as] financing to elderly, disabled, or low-income rural residents,”<sup>87</sup> these programs do not target the specific needs of rural communities in terms of natural disasters. While general infrastructure planning is still needed, as well as general federal assistance for programs that offer loans and housing assistance for those living in rural communities, these solutions will not offer longtime solutions to these communities.

The two most pressing issues many rural communities face include the lack of:

- 1) Communications infrastructure**
- 2) Implementation and enforcement of mobile/manufactured building codes**

All three of these problems must be systematically targeted before rural communities will be resilient to natural disasters.

### 4.3.1 Communications Infrastructure

In the South, the most common natural disasters are tornadoes and hurricanes, which typically come with minutes to days of warnings. Many urban areas have warning sirens, but as the decision to install outdoor warning systems is completely compulsory many rural communities do not have the money or desire to implement these types of systems. Even so, these warning systems are typically not useful indoors, and typically cannot be heard inside houses or businesses. Instead, many people in rural communities either refer to television, social media, or their family and friends to stay up to date on weather-related events.

<sup>84</sup> United States Census Bureau, “Rural America.”

<sup>85</sup> Fields, Holder, and Burd, “Life Off the Highway: A Snapshot of Rural America.”

<sup>86</sup> Fields, Holder, and Burd.

<sup>87</sup> USDA, “USDA Housing Assistance.”

In trying to reach those in rural communities, it is important to consider the lack of infrastructure such places may have. The USDA has used its Rural Development program to aid cities before – in 2012, after Hurricane Sandy hit New York, the USDA selected four rural communities to receive “\$20,000 in grants and \$15,000 in loans to replace their old [storm] sirens with new models that feature two-way digital communication and other features to make sure they will function properly when needed most.”<sup>88</sup> But these warning systems do not always work.

Emergency sirens are also installed at great cost to rural communities. According to a market report published by the DHS, sirens can cost anywhere from \$14,000 to more than \$55,000 per siren.<sup>89</sup> This does not include power costs, or the costs of parts after the sirens’ warranties end; spanning from 2-5 years. When looking at the money the USDA provided those communities, it is



**Figure 11:** Despite the low price tag and public campaigns to get NOAA radios into U.S. households, very few families own them.

safe to assume they only received enough to purchase and install one or two emergency sirens. These sirens typically cannot broadcast noise long distances, as well as do not take into account the sprawl many rural communities emulate – if each person owns more than an acre of land, how are they supposed to be able to hear a siren in their home? People may be miles away from existing emergency infrastructure.

In many cases, people trust their local weatherman or woman to stay up to date with the current trends and look to them for science-based advice on what to do in case of a natural disaster. Typically, weather people – in addition to administering the daily forecast – focus on

<sup>88</sup> Czech, “USDA Funds Upgrade Storm Sirens in Four Rural Minnesota Communities.”

<sup>89</sup> Atlantic, “Outdoor Warning Sirens Market Survey Report.”

educating the public as particularly visible members of the community. One such weatherman is James Spann, a television meteorologist based in Birmingham, Alabama who many Alabamians trust with their lives. In a personal interview, Spann reiterates that "The main reason people die in Alabama during a tornado event is the "siren mentality". The notion you should hear a siren before a tornado arrives. Sirens have never been effective at reaching people in a home, business, church, or any indoor venue. They only reach a limited number of people outside. This is the biggest challenge we have."<sup>90</sup>

**The simplest solution to this problem is the implementation of existing technology.**

NOAA produces a nationwide network of radio stations which update continuous weather information from regional National Weather Service offices. The Weather Radio All Hazards (NWR) alerts listeners during emergencies for all types of hazards, including "weather (e.g., tornadoes, floods), natural (e.g., earthquakes, forest fires and volcanic activity), technological (e.g., chemical releases, oil spills, nuclear power plant emergencies), and national emergencies (e.g., terrorist attacks)"<sup>91</sup> NOAA radios can be fairly inexpensive compared to outdated storm siren systems, and "can be the baseline for getting a severe thunderstorm, flash flood, and tornado warning, [but] very few people have them," according to James Spann, who estimates that less than 10% of family units have a NOAA radio in their house.<sup>92</sup>

Instead of spending upwards of \$20,000 on siren systems, rural communities should consolidate their money, whether it is from the USDA or in their own budgets and provide a NOAA radio to every family unit in their communities. One siren is equivalent to 800 NOAA radios, at \$25 apiece. With an average household of 2.6 people, these radios will more personally affect over 2,000 people – just using the funds from one storm siren.

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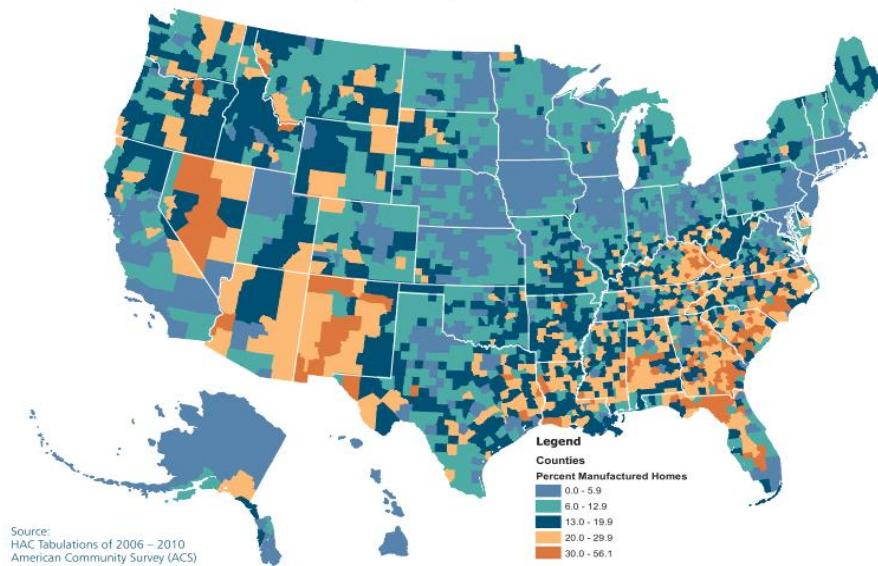
<sup>90</sup> Spann, "James Spann Interview."

<sup>91</sup> National Oceanic and Atmospheric Administration, "All-Hazards Emergency Messages on NOAA Weather Radio."

<sup>92</sup> Spann, "James Spann Interview."

### 4.3.2 Implementation and Enforcement of Mobile/Manufactured Building Codes

Manufactured Homes as a Percent of All Occupied Housing Units



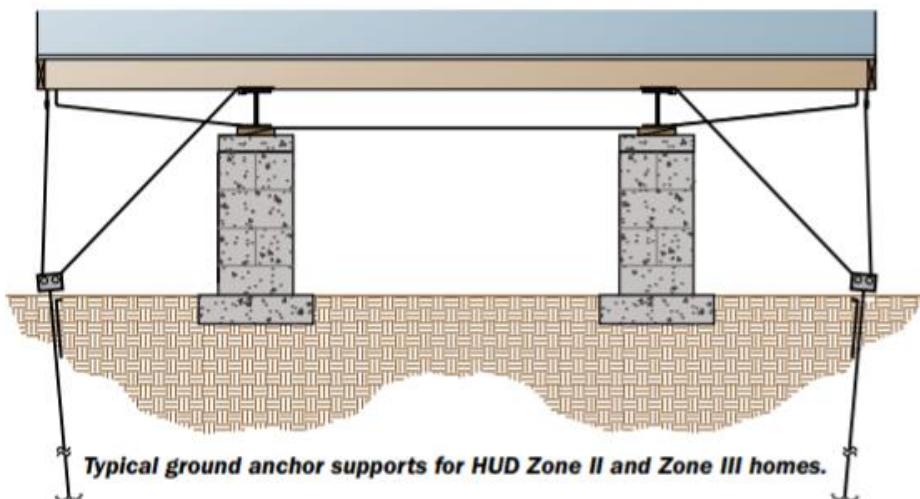
**Figure 12:** The Southeast has the highest percentage of manufactured homes, the majority of which are anchored in areas which are also considered rural.

While it is important all communities implement and enforce building codes, it is specifically important for rural communities to shift towards the enforcement of federal and local building codes. Rates of homeownership in rural communities is higher than the national average with 71.6% of occupied homes owned by their inhabitants.<sup>93</sup> However, rural communities are also more likely to own mobile or manufactured homes, as more than half of these homes are located in rural and small town areas.<sup>94</sup> Any factory-built home built prior to 1976 is considered a mobile home, and those built after 1976 are considered manufactured homes. For clarity, this report will refer to all mobile homes as manufactured homes.

<sup>93</sup> Housing Assistance Council, "Housing in Rural America."

<sup>94</sup> Housing Assistance Council.

These homes are required to be built to the Manufactured Home Construction and Safety Standards (HUD Code), which is a federal code designed to keep residents safe. In the South, where most manufactured homes reside (as can be seen in **(Figure 12)** in rural areas, the median annual income of households which live in manufactured homes is only \$30,000, up to 40% less than in non-manufactured homes.<sup>95</sup> Although manufactured homes are marketed as a safe, sturdy, cheap alternative to traditional houses, with a federal code in place to protect people who buy them, more often than not they lead to strikingly large numbers of fatalities. From 1985 to 2017, 39% of all tornado-related deaths occurred in association with manufactured homes – 872 of 2248 deaths.<sup>96</sup> In fact, on March 3, 2019, 34 tornadoes hit the Southeast U.S. (including Florida, Georgia, and Alabama) and resulted in 23 fatalities, making it the deadliest tornado outbreak since 2013. 19 of 23 – over 80% – of these deaths occurred in manufactured homes.<sup>97</sup> “If they incorporate a simple safety measure—one that’s mandated by law but was found to be absent or insufficient in every home where a fatality occurred,”<sup>98</sup> some of these homes may have survived. In every case, the manufactured homes were not anchored to the ground properly, allowing the strong winds to uplift, slide, or roll a house off of its foundation.



**Figure 13:** A typical ground anchor for a manufactured home in a region expecting heavy winds.

When it comes to the enforcement of the HUD Code, there are two steps at which the system fails manufactured homeowners. The initial building inspections, at which point third-party Primary Inspection Agencies (PIAs) review designs and manufacturing quality and program enforcement, which allows 37 state governments the ability to designate State Administrative

<sup>95</sup> Housing Assistance Council.

<sup>96</sup> Strader and Ashley, “Finescale Assessment of Mobile Home Tornado Vulnerability in the Central and Southeast United States.”

<sup>97</sup> Lenjani, “StEER : Structural Extreme Event Reconnaissance Network.”

<sup>98</sup> Lenjani.

Agencies (SAAs) which process consumer complaints and conduct random inspections of manufactures houses in the state. The other 13 states which are not covered by SAAs fall under the jurisdiction of HUD. In all manufactured homes, the manufactures must provide provisions to anchor the building to the foundation most generally by ground anchors and steel straps as can be seen in (**Figure 13**).<sup>99</sup> Although HUD does encourage regular inspections, there is no legislation demanding this of SAAs.

**HUD must update the HUD Code to reflect the need of SAAs to inspect mobile/manufactured homes for proper anchoring based on the register location of rental retail lots.** Anchorage specifically must be inspected on a semi-regular basis, depending on where the manufactured home sits. If it is considered water-front (less than two miles of from a coast or significant body of water), it must be inspected every two years. If it is considered inland (more than two miles from a coast or significant body of water) it must be inspected every five years. These standards must be required at a federal level, and SAAs can determine how best to cycle through these inspections. These findings have been supported by FEMA, who have written several reports on understanding and improving the performance of manufactured homes' updated building codes.<sup>100</sup>

## 5. Conclusion

In considering all three recommendations, it is important to propose realistic solutions. As a result, the RCMRP is by far the most cost-effective and feasible solution proposed. This solution would not cost the federal government any additional money, as the budget has already been set by the USDA. Additionally, it would help protect communities which are generally overlooked, as well as provide more support for citizens who are not generally considered.

The U.S. still has much to implement to improve community resilience to natural disasters. Issues which much be targeted contain areas of the U.S. population which are typically forgotten – those who live in rural areas, those with lower SES, and minorities. Although resilience is most effective when planned for at a community level, there is still much the federal government can do to encourage mitigation instead of rebuilding, and to provide communities and local jurisdictions the ability to better prepare themselves for potentially damning natural disasters. The recommendations provided are just one path forward. Any step towards clearer federal policies outlining how to better mitigate the damages of natural disasters is a step in the correct direction.

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<sup>99</sup> Federal Emergency Management Agency (FEMA), "Understanding and Improving Performance of New Manufactured Homes During High-Wind Events."

<sup>100</sup> Federal Emergency Management Agency (FEMA).

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