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Before Disaster Strikes: Preparing America to be Disaster Resilient

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BEFORE DISASTER STRIKES: PREPARING AMERICA TO BE DISASTER RESILIENT

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INTRODUCTION

Major natural disasters in the United States are occurring more frequently and are causing more damage and destruction than ever before in the nation's history.[1] With the increased number and intensity of natural disasters, America's failing infrastructure and current resiliency plan are inadequate to successfully prepare and respond to such catastrophic events.[2] As a direct result, natural disasters in the United States cause scores of deaths and injuries, inflict billions of dollars' worth of damage per disaster, and make it increasingly more difficult for Americans to recover and return to a sense of normalcy.[3]

The World Health Organization ("WHO"), offers one of the most comprehensive definitions of a natural disaster:

> A natural disaster is an act of nature of such magnitude as to create a catastrophic situation in which the day-to-day patterns of life are suddenly disrupted and people are plunged into helplessness and suffering, and, as a result, need food, clothing, shelter, medical and nursing care and

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[1] Umair Irfan & Brian Resnick, *Megadisasters devastated America in 2017. And they're only going to get worse*, VOX (Mar. 26, 2018), https://www.vox.com/energy-and-environment/2017/12/28/16795490/natural-disasters-2017-hurricanes-wildfires-heat-climate-change-cost-deaths [https://perma.cc/E6N3-7VWL].

[2] *See* Morten Wendelbo, *3 Reasons Why the U.S. is Vulnerable to Big Disaster*, SCI. AM. (July 2, 2018), https://www.scientificamerican.com/article/3-reasons-why-the-u-s-is-vulnerable-to-big-disaster/ [https://perma.cc/YV78-ZQYW].

[3] Adam B. Smith, *2017 U.S. billion-dollar weather and climate disasters: a historic year in context*, CLIMATE.GOV (Jan. 8, 2018), https://www.climate.gov/news-features/blogs/beyond-data/2017-us-billion-dollar-weather-and-climate-disasters-historic-year [https://perma.cc/FZA5-4THT].

> other necessities of life, and protection against unfavourable environmental factors and conditions.[4]

Natural disasters in the United States have occurred long before the nation's birth.[5] Notable natural disasters in the past few centuries include the Great Galveston Storm of 1900, the 1906 San Francisco earthquake and fire, the Johnstown Flood in 1889, and the Great Chicago Fire in 1871.[6] While these natural disasters differ by type and region, each was incredibly destructive and together caused thousands of deaths and an unimaginable amount of damage and ruin.[7]

In the past three decades, the increase of cost and destructiveness of natural disasters has spiked.[8] The five most costly disasters in American history have all occurred since 2005, according to the National Oceanic and Atmospheric Administration ("NOAA").[9] Similarly, "[i]n California, 15 of the 20 largest fires in state history have burned since 2000."[10] The Camp Fire, which is now the "deadliest and most destructive wildfire" in California's history, killed over 71 people, and destroyed more than 9,800 homes.[11] Further, in the United States, "[n]ine of the top 10 years for extreme one-day precipitation events have occurred since 1990."[12] This dangerous trend will only continue, promoting even more damage and

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[4] M. ASSAR, WORLD HEALTH ORG., GUIDE TO SANITATION IN NATURAL DISASTERS 14 (1971), https://apps.who.int/iris/bitstream/handle/10665/41031/10678_eng.pdf;jsessionid=8D37D65FD1B187EDA7A8A47A547DB251?sequence=1 [https://perma.cc/6LP4-H9HS].

[5] *Hurricane timeline: 1495 to 1800*, SUN SENTINEL (May 21, 2001), https://www.sun-sentinel.com/news/weather/hurricane/sfl-hc-history-1495to1800-htmlstory.html [https://perma.cc/N4Z7-HY6H].

[6] Dave Roos, *The Deadliest Natural Disasters in US History*, HIST. (June 22, 2018), https://www.history.com/news/deadliest-natural-disasters-us-storm-flood-hurricane-fire [https://perma.cc/QYK2-VUGL].

[7] *Id.*

[8] Smith, *supra* note 3.

[9] *Billion-Dollar Weather and Climate Disaster: Table of Events*, NAT'L CTRS. FOR ENVTL. INFO., NAT'L OCEANIC & ATMOSPHERIC ADMIN., https://www.ncdc.noaa.gov/billions/events/US/1980-2017 [https://perma.cc/S6P6-GU8F] (last visited Mar. 9, 2020).

[10] Tim Wallace et al., *Three of California's Biggest Fires Ever Are Burning Right Now*, N.Y. TIMES (Aug. 10, 2018), https://www.nytimes.com/interactive/2018/08/10/us/california-fires.html [https://perma.cc/7PPW-8BKX].

[11] Nicole Chavez & Steve Almasy, *Number of missing grows to more than 1,000 in California's Camp Fire*, CNN (Nov. 17, 2018), https://www.cnn.com/2018/11/16/us/california-fires/index.html [https://perma.cc/8PDL-YFWU].

[12] *Climate Change Indicators: Heavy Precipitation*, EPA, https://www.epa.gov/climate-indicators/climate-change-indicators-heavy-precipitation [https://perma.cc/5SL6-JH94] (last updated Jan. 12, 2017).

destruction.[13] As National Center for Atmospheric Research senior climate scientist Kevin Trenberth explains, "[a]s climate change makes oceans hotter there is more heat—more energy—available, so there is likely to be an increase in hurricane activity. That can be the size of the storms, their duration and their intensity."[14] Instead of denying reality, stakeholders at all levels of government and business should make strong efforts to mitigate as much damage as possible.

In the United States, natural disasters such as floods, intense rain, hurricanes, wildfires, mudslides, tornadoes, earthquakes, and heat waves have become more costly, frequent, and destructive in the past three decades.[15] There is a trifecta of reasons why this has been the case.

First, "increases in population and material wealth over the last several decades are an important factor for higher damage potential."[16] Thus, as America's population and wealth continue to grow, the cost of natural disasters will continue to rise. Additionally, many Americans live in disaster prone areas, which can lead to even more damage and destruction.[17]

Second, the United States' failing infrastructure makes the country more prone to deterioration and collapse as natural disasters become more powerful. In 2017, the American Society of Civil Engineers gave the United States a "D+" score for America's infrastructure overall.[18] Simply put, pothole filled roads, weak dams, crumbling bridges, and outdated electricity grids are no match for major storms. Category 4 hurricanes bring sustained winds of over 130 miles per hour, which can easily down power lines, cause catastrophic damage to buildings, and snap trees in half, making roads and other transportation routes inaccessible.[19]

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[13] Mark Fischetti, *New Data: Hurricanes Will Get Worse*, SCI. AM. (May 16, 2018), https://www.scientificamerican.com/article/new-data-hurricanes-will-get-worse/ [https://perma.cc/BFN7-2QYT].
[14] *Id.*
[15] Smith, *supra* note 3.
[16] *Calculating the Cost of Weather and Climate Disasters*, NAT'L CTRS. FOR ENVTL. INFO., NAT'L OCEANIC & ATMOSPHERIC ADMIN. (Oct. 6, 2017), https://www.ncei.noaa.gov/news/calculating-cost-weather-and-climate-disasters [https://perma.cc/SUU6-GEM4] [hereinafter NAT'L CTRS. FOR ENVTL. INFO.].
[17] Sahil Chinoy, *The Places in the U.S. Where Disaster Strikes Again and Again*, N.Y. TIMES (May 24, 2018), https://www.nytimes.com/interactive/2018/05/24/us/disasters-hurricanes-wildfires-storms.html [https://perma.cc/W6VW-CZGF].
[18] *America's Infrastructure Scores a D+*, 2017 INFRASTRUCTURE REP. CARD, https://www.infrastructurereportcard.org [https://perma.cc/E3KT-VK4K] (last visited Mar. 9, 2020).
[19] *Saffir-Simpson Hurricane Wind Scale*, NAT'L HURRICANE CTR. & CENT. PAC. HURRICANE CTR., NAT'L OCEANIC & ATMOSPHERIC ADMIN., https://www.nhc.noaa.gov/aboutsshws.php [https://perma.cc/EH9Y-PGK6] (last visited Mar. 9, 2020).

Third, climate change has had a noticeable impact on the destructive power of natural disasters. According to NOAA, "[c]limate change is also playing a role in the increasing frequency of some types of extreme weather that lead to billion-dollar disasters."[20] It has also been observed that "[c]limate change is making some kinds of disasters more frequent. Studies show that large wildfires have become more common in the western United States because global warming has made Western forests drier."[21] Further, "[g]lobal sea level is rising. . . . Recent analyses reveal that the rate of sea level rise in the last century was greater than during any preceding century in at least 2,800 years."[22] As the National Park Service has noted, "[s]ea level change and storm surge pose considerable risks to infrastructure . . . ."[23] Even in recent hurricanes, scientists have found that climate change is playing a major role in how destructive natural disasters have become. For example, after Hurricane Harvey, researchers were able to "calculate [that] climate change caused Harvey's rainfall to be 15 to 38 percent greater than it would have been otherwise."[24] This trio of factors makes the United States extremely vulnerable and exposed to significant natural disasters, and it is imperative that the United States prepare and plan to mitigate any potential damage from natural disasters.

I. DISASTER RESILIENCE

Disaster resilience plays a crucial role in the process of mitigating potential destruction from natural disasters and helping the affected communities recover more quickly. The Government Accountability Office ("GAO") has defined disaster resilience as "actions to help prepare and plan for, absorb, recover from, and more successfully adapt to adverse events including those caused by extreme weather."[25] Further, "[d]isaster

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[20] NAT'L CTRS. FOR ENVTL. INFO., *supra* note 16.
[21] Chinoy, *supra* note 17.
[22] MARIA A. CAFFREY ET AL., NAT'L PARK SERV., U.S. DEP'T OF THE INTERIOR, NATURAL RESOURCE REPORT 2018/1648, SEA LEVEL RISE AND STORM SURGE PROJECTIONS FOR THE NATIONAL PARK SERVICE 1 (May 2018), https://www.nps.gov/subjects/climatechange/upload/2018-NPS-Sea-Level-Change-Storm-Surge-Report-508Compliant.pdf [https://perma.cc/Y5CL-YXM3].
[23] *Id.* at viii.
[24] Fischetti, *supra* note 13.
[25] CHRIS CURRIE, U.S. GOV'T ACCOUNTABILITY OFF., GAO-14-603T, DISASTER RESILIENCE: ACTIONS ARE UNDERWAY, BUT FEDERAL FISCAL EXPOSURE HIGHLIGHTS THE NEED FOR CONTINUED ATTENTION TO LONGSTANDING CHALLENGES (May 14, 2014), https://www.gao.gov/assets/670/663179.pdf [https://perma.cc/WU9G-U2GH].

resilience programming aims to save lives whilst protecting infrastructure, livelihoods, social systems and the environment."[26] There are many ways in which local communities, states, and the entire country can become more disaster resilient. The manner in which disaster resilience is fostered is all encompassing. However, major factors that often lead to disaster resilient communities are large investments in infrastructure, adopting new technology, decreasing bureaucratic red tape, improving communication, and supporting mitigation efforts.[27]

Even small steps or efforts taken in disaster resilience can have substantial effects. For example, making electronic copies of valuable information such as passports, deeds, birth certificates, financial information, and insurance policies can play a major factor in being able to more quickly recover following a damaging storm.[28] Other minor, but impactful protocols that may be of use include having a predetermined packing checklist if the need to evacuate rises.

Governments can also do a better job of restricting where homes can be built and increase the standard of homes to withstand more powerful storms and natural disasters.[29] Governments have access to data where natural disasters have occurred most often and have caused the most amount of destruction.[30] Therefore governments, mostly at the local or state level, can pass various laws and regulations to create stronger building standards, similar to what California has done with requiring that existing structures be retrofitted to become more resistant to earthquakes.[31] While there are infinite procedures and plans that citizens and communities can follow, the important point is that action must be taken now.

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[26] Emilie Combaz, *Benefits of disaster resilience*, GSDRC (June 2015), http://gsdrc.org/topic-guides/disaster-resilience/concepts/benefits-of-disaster-resilience/ [https://perma.cc/S2R2-RGBG].

[27] *See, e.g.*, STRENGTHENING DISASTER RESILIENCE IN SMALL STATES: COMMONWEALTH PERSPECTIVES 115, 151 (Wonderful Hope Khonje & Travis Mitchell eds., 2019) (discussing how blockchain technology could help reduce red tape and increase efficiency in disaster relief situations, and quoting Alain Wong Yen Cheong on how "Mauritius is investing in climate-resilient infrastructure").

[28] *Keep Your Important Documents Safe from a Disaster*, FEMA (Nov. 18, 2015), https://www.fema.gov/news-release/2015/11/18/keep-your-important-documents-safe-disaster [https://perma.cc/MMB2-CV46].

[29] John Schwartz, *No Easy Way to Restrict Construction in Risky Areas*, N.Y. TIMES (Mar. 28, 2014), https://www.nytimes.com/2014/03/29/us/governments-find-it-hard-to-restrict-building-in-risky-areas.html [https://perma.cc/47HT-92J8].

[30] Statista Research Dep't, *Natural disasters in the U.S.—Statistics & Facts*, STATISTA (July 2, 2019), https://www.statista.com/topics/1714/natural-disasters/#dossierSummary__chapter2 [https://perma.cc/7S3H-2PC3].

[31] CAL. CODE REGS. tit. 24, § A301 (2016).

II. FEDERAL GOVERNMENT TAKES THE LEAD

As natural disasters have become stronger and tend to impact more than one state, the federal government has most often taken the lead and been primarily responsible for preparing for and responding to natural disasters. In fact, "[t]he federal government is the only level of government capable of providing timely and predictable resources and capacity, irrespective of where disaster strikes, when state and local resources are often thin and uneven."[32] The Federal Emergency Management Agency ("FEMA"), housed within the U.S. Department of Homeland Security, is the federal agency that is tasked with "[h]elping people before, during, and after disasters."[33] Additionally, as natural disasters become more costly, it is often the case that the federal government can better absorb such a price tag, as compared to state and local governments.[34] For example, "[i]n the absence of a guilty third party or adequate private insurance, disaster relief costs fall to the government. The U.S. government typically absorbs 75 percent of state and local governments' recovery costs."[35] In extraordinary circumstances when a natural disaster unleashes catastrophic damage, the federal government can opt to bear an even larger percentage of the recovery cost.[36] Recently, President Trump "increased the federal cost share of debris removal from 75 percent to 90 percent" in the wake of Hurricane Harvey.[37] Importantly, "FEMA's disaster relief fund is the primary source of spending for federal relief efforts, which Congress funds through the annual appropriations process."[38]

While federal agencies no doubt work hand-in-hand with state and local departments, a federal response allows for a single, unified entity to learn from past natural disasters, which can help provide valuable information and insight for future disasters. Federal agencies also tend to have larger budgets than state and local agencies, and as the cost of preparing for and responding to natural disasters increases, it only makes sense

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[32] Amy Liu, *Feds, States, Cities—The All of the Above Disaster Response*, BROOKINGS (Nov. 2, 2012), https://www.brookings.edu/blog/up-front/2012/11/02/feds-states-cities-the-all-of-the-above-disaster-response/ [https://perma.cc/3X9Q-3CCQ].

[33] *About the Agency*, FEMA, https://www.fema.gov/about-agency [https://perma.cc/N25Y-8KW7] (last visited Mar. 9, 2020).

[34] Rocio Cara Labrador, *U.S. Disaster Relief at Home and Abroad*, COUNCIL ON FOREIGN REL. (Aug. 15, 2018), https://www.cfr.org/backgrounder/us-disaster-relief-home-and-abroad [https://perma.cc/L5JB-UN7A].

[35] *Id.*

[36] *Id.*

[37] *Id.*

[38] *Id.*

that the federal government take the lead in most catastrophic natural disasters. However, it is important to note that some critics bemoan the federal government's involvement in natural disasters. These critics argue that federal agencies are not in touch with the needs of the local community, that federal agencies only help recovery efforts in the short term but neglect long-term needs, and that the United States federal government has a poor track record in natural disaster responses.[39] While some of these criticisms may have merit, the resources of the federal government are still unmatched and serve as the best and most immediate way to prepare for incoming natural disasters.

Even with a strong focus on the federal response, state and local agencies are still instrumental in disaster mitigation and resilience. Federal grants are traditionally dispersed to citizens and local communities through state agencies and programs.[40] Further, a lot of the communication to the public is done though state governors and agencies.[41] State governors are also instrumental in declaring state emergencies, which can lead to a flurry of resources and aid to be expedited to those in need.[42] States are also typically in charge of and responsible for infrastructure, including roads, airports, bridges, and hospitals.[43]

Traditionally, states are also responsible for K–12 and higher education, which often is severely impacted by natural disasters.[44] For

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[39] *See generally* Emily Atkin, *America's Natural Disaster Response Is Its Own Disaster*, NEW REPUBLIC (Sept. 26, 2017), https://newrepublic.com/article/145019/americas-natural-disaster-response-disaster [https://perma.cc/LPN2-M5J5].

[40] *See, e.g.*, *Federal Aid to State and Local Governments*, CTR. ON BUDGET & POL'Y PRIORITIES (Apr. 19, 2018), https://www.cbpp.org/research/state-budget-and-tax/federal-aid-to-state-and-local-governments [https://perma.cc/43VQ-NW2X].

[41] *See, e.g.*, Shannon A. Bowen, *Good communication is a key part of disaster response*, CONVERSATION (Sept. 5, 2019), http://theconversation.com/good-communication-is-a-key-part-of-disaster-response-119591 [https://perma.cc/8BAN-HBCX].

[42] OFF. OF LICENSURE & CERTIFICATION, VA. DEP'T HEALTH, DESIGN AND CONSTRUCTION OF HEALTHCARE FACILITIES 1 (Dec. 2018), http://www.vdh.virginia.gov/content/uploads/sites/96/2018/12/Design-and-construction-guidelines-rev.-2018.pdf [https://perma.cc/7NXN-AN69]; *Emergency Declarations and Authorities: Fact Sheet*, ASS'N ST. & TERRITORIAL HEALTH OFFICIALS (Dec. 2011), https://www.astho.org/Programs/Preparedness/Public-Health-Emergency-Law/Emergency-Authority-and-Immunity-Toolkit/Emergency-Declarations-and-Authorities-Fact-Sheet/ [https://perma.cc/7ERX-JGED] (last visited Mar. 9, 2020).

[43] *See, e.g.*, *Airports*, VA. DEP'T AVIATION, https://doav.virginia.gov/resources/airports/ [https://perma.cc/395U-2M7X] (last visited Mar. 9, 2020); *Road and Bridge Specifications and Revisions*, VA. DEP'T TRANSP., http://www.virginiadot.org/business/const/spec-default.asp [https://perma.cc/8CAN-2P5G] (last visited Mar. 9, 2020).

[44] *See* Tom Gjelten, *Frustration Grows As N.C. Schools Are Slow To Reopen After Florence*, NPR (Oct. 12, 2018), https://www.npr.org/2018/10/12/656814372/frustration-grows-as-n-c-schools-are-slow-to-reopen-after-florence [https://perma.cc/4YMB-8PWC].

example, after Hurricane Michael in 2018, North Carolina schools were slow to reopen after the storm.[45] In Robeson County, North Carolina, schools were still closed more than a month after the storm passed.[46] Shanita Wooten, the Robeson County school superintendent, explained the dire situation: "[w]e've got 23,000 children who—we really don't know where they are right now."[47] This can have detrimental impacts on the development of these children, as they will miss a great amount of school. It is therefore crucial for states to also heavily prepare to become more disaster resilient as the damage to the state can be more long lasting than physical damage.

As it is clear that both state and local agencies are imperative in the mitigation and response phases of a natural disaster, it is crucial that all entities and agencies across the various levels of government work seamlessly to assist and serve those in need.

III. HOW CAN SUCCESS BE MEASURED?

Once measures are implemented to make America more disaster resilient, it is important to determine how successful those procedures and policies are. Admittedly, this is not an easy task. There will always be major natural disasters, destruction, and death. However, researchers and policymakers should look to both subjective and objective measures to gauge success. Objective measures should include number of deaths, number of days without power, total number of days schools are closed, and total cost of the natural disaster. Subjective indicators can include how residents felt about the communication from government agencies, whether they had an evacuation plan, and how easy it was to implement natural disaster mitigation efforts. Measuring success is also crucial because it will allow policymakers and stakeholders to recognize the return on the investment of implementing disaster resilience programs.

There are three main segments to the life of a natural disaster: before, during, and after. With a finite amount of resources, including money, human capital, and time, the federal government must decide how to allocate those resources to maximize results which save the most lives and help American citizens recover faster. Research has shown that proactive and preemptive investments by the federal government, such as in the form of federal mitigation grants, which assist Americans in

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[45] *Id.*
[46] *Id.*
[47] *Id.*

preparing for natural disasters, result in a "national benefit of $6 for every $1 invested."[48] The federal government should double down on its efforts and invest more heavily in natural disaster preparation and mitigation. Doing so will save countless lives, allow for victims of natural disasters to recover faster, and make America more disaster resilient. While there are countless recommendations and suggestions on how America should better prepare for natural disasters, this Note will focus on three core areas that have the potential to best maximize the federal government's returns on investment.

First, the United States should invest more on infrastructure and technology during the preparation phase of a natural disaster. Second, the United States should eliminate the mitigation grants program and instead provide tax incentives to homeowners who implement disaster mitigation improvements. Third, the federal government needs to better communicate between the various federal, state, and local agencies, as well as the general public with regards to natural disasters. In the world of disaster resiliency, even small actions can have a tremendous and tangible impact. Proactive investment in these three areas will serve the United States well in becoming more disaster resilient in the years to come.

IV. INVESTMENT IN INFRASTRUCTURE

A. Infrastructure

Critical infrastructure is segments of the nation's infrastructure that "are considered so vital to the United States that their incapacitation or destruction would have a debilitating effect on security, national economic security, national public health or safety, or any combination thereof."[49] In effect, when the critical infrastructure in the United States is crippled, the "public confidence and the Nation's safety, prosperity, and well-being" is at risk.[50] In 2013, President Obama issued the Presidential

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[48] NAT'L INST. OF BLDG. SCI., NATURAL HAZARD MITIGATION SAVES: 2017 INTERIM REPORT 2 (Dec. 2017), http://www.wbdg.org/files/pdfs/MS2_2017Interim%20Report.pdf [https://perma.cc/G9U6-XQJB].

[49] *Critical Infrastructure Sectors*, CYBERSECURITY & INFRASTRUCTURE SECURITY AGENCY, DEP'T HOMELAND SECURITY, https://www.dhs.gov/critical-infrastructure-sectors [https://perma.cc/JQ6X-99YC] (last updated Mar. 3, 2019).

[50] *Presidential Policy Directive—Critical Infrastructure Security and Resilience*, WHITE HOUSE OFF. PRESS SEC'Y (Feb. 12, 2013), https://obamawhitehouse.archives.gov/the-press-office/2013/02/12/presidential-policy-directive-critical-infrastructure-security-and-resil [https://perma.cc/U38D-55JP].

Policy Directive on Critical Infrastructure Security and Resilience, which "advances a national unity of effort to strengthen and maintain secure, functioning, and resilient critical infrastructure."[51]

One of the largest threats to critical infrastructure is natural disasters.[52] Natural disasters have repeatedly demonstrated their ability to burst dams, knock out power, make roads impassable, and create hazardous living conditions.[53] While the presidential directive states that "[c]ritical infrastructure must be secure and able to withstand and rapidly recover from all hazards," it is becoming increasingly difficult to do so with the intensity of natural disasters that have plagued the United States.[54] In order to protect the critical infrastructure that is essential for the prosperity of the United States, the federal government must invest in upgrading critical infrastructure before, not after, the next natural disaster hits. While the Trump administration has made infrastructure one of its main priorities, withdrawing the United States from the Paris Climate Agreement signals to American citizens and the rest of the world that the United States is not concerned with natural disasters or mitigation efforts.[55]

This Note will examine how investment in general infrastructure, social infrastructure, and technology can have positive impacts in making the United States more disaster resilient. More specifically, while there are countless areas of infrastructure that need critical improvement in order to remain effective during natural disasters, such as power grids, food supplies, hospitals, ports, transportation, and bridges, this Note will only focus on how investment in roads and the water supply would make the United States more disaster resilient.

B. Roadways

One of the most important parts of American infrastructure that needs immediate investment is roadways. Roadways, streets, and highways

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[51] *Id.*
[52] Farid Kadri et al., *The Impact of Natural Disasters on Critical Infrastructures: A Domino Effect-based Study*, 11 J. HOMELAND SECURITY & EMERGENCY MGMT. 217, 217 (2014).
[53] Stephen A. Nelson, *Natural Hazards and Natural Disasters*, TUL. U., https://www.tulane.edu/~sanelson/Natural_Disasters/introduction.htm [https://perma.cc/78TK-TQKH] (last updated Jan. 9, 2018).
[54] WHITE HOUSE OFF. PRESS SEC'Y, *supra* note 50.
[55] *See generally* Timmons Roberts, *One year since Trump's withdrawal from the Paris climate agreement*, BROOKINGS (June 1, 2018), https://www.brookings.edu/blog/planetpolicy/2018/06/01/one-year-since-trumps-withdrawal-from-the-paris-climate-agreement/ [https://perma.cc/V36C-Y5KM].

are vital because they are often the only avenues through which citizens can evacuate from natural disasters and are the primary route that emergency personnel and other assistance take to reach affected areas. The 2018 Camp Fire, which devasted entire towns in Northern California, perfectly demonstrates how the road conditions made it nearly impossible for firefighters to reach the blaze. As the *New York Times* reported,

> In the hours after the devastating wildfire broke out around Paradise on Thursday morning, tree-lined streets in the town swiftly became tunnels of fire, blocked by fallen power lines and burning timber. Frantic residents, encircled by choking dense smoke and swirling embers, ran out of gas and ditched their cars. Fire crews struggling to reach the town used giant earthmovers to plow abandoned vehicles off the road as if they were snowdrifts after a blizzard.[56]

As hundreds of thousands of people were forced to flee at once, the roadways were ill prepared to handle such a rush of panicked drivers.[57] Additional reports have noted that it took some residents an hour to move just three miles in their car.[58] During the same time period, the Woosley Fire in Southern California sparked evacuations of over 250,000 residents, who also faced gridlock and bumper-to-bumper traffic when trying to escape the overwhelming flames.[59] As noted, "[a]gain and again in California's battle with wildfires, roads have emerged as a major vulnerability for those escaping."[60]

There are a number of ways that the government can improve road conditions and make evacuations more efficient. First, the government must invest in the construction and repairs of roads and highways. The American Society of Civil Engineers gave American roads a "D" grade in 2017, citing major congestion, traffic, and poor roadway conditions.[61]

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[56] Jack Nicas et al., *Forced Out by Deadly Fires, Then Trapped in Traffic*, N.Y. TIMES (Nov. 11, 2018), https://www.nytimes.com/2018/11/11/us/california-fire-paradise.html [https://perma.cc/PQP9-UAYP].
[57] *Id.*
[58] *Id.*
[59] *Woolsey Fire Destroys 150+ Homes; 250,000 Evacuated As Flames Roar Toward Ocean*, CBS L.A. (Nov. 9, 2018), https://losangeles.cbslocal.com/2018/11/09/woolsey-fire-75k-homes-evacuated/ [https://perma.cc/B3DK-H8Q4].
[60] Nicas et al., *supra* note 56.
[61] AM. SOC'Y OF CIVIL ENG'RS, 2017 INFRASTRUCTURE REPORT CARD: ROADS 76–80 (2017), https://www.infrastructurereportcard.org/wp-content/uploads/2017/01/Roads-Final.pdf [https://perma.cc/5SFF-2V2X].

Repaving roads, strengthening weak bridges, and upgrading traffic light signals will promote safer and more efficient driving, especially during times of evacuation during natural disasters. Next, state and local governments must utilize existing resources to better direct traffic in the wake of mass evacuations before an impending natural disaster. This includes updating traffic signs in real time; dedicating more law enforcement personnel to direct traffic; and opening up additional traffic lanes, such as shoulder lanes and traditionally opposing traffic lanes, in order to accommodate the influx of drivers trying to evacuate a hazardous area.

Government officials must also do a better job of communicating where roads are closed and which routes are the most efficient to evacuate safely. Often times during the peak of a natural disaster, citizens may not be aware of where the hazards lie, creating further confusion and panic. This leads to further congestion, and this dangerous, repetitive cycle, only continues to get worse. It would be wise for governments to team up with GPS apps such as Waze and Google Maps to help direct people where to go in an evacuation. An informal partnership may make the most sense from a legal perspective, as some U.S. cities already participate in the Waze Connected Citizens Program, which uses data to help local governments and organizations improve road and highway conditions.[62] Instead of a formal legal partnership, local governments need to further capitalize and leverage this opportunity. While there have been multiple reports of Waze directing commuters into the heart of a wildfire, instead of away from it, the problem lies not with the app, but with the available information that the app has at the time.[63] If the government was able to give real time information to the app's developers, then every person with access to a smartphone would have the most up to date information and, therefore, knowledge of the best evacuation route possible.[64] Critics may argue that over-relying on smartphones to evacuate, especially during a natural disaster, may be dangerous because of the potential lack of cell phone service. However, governments should still heavily invest in partnering with third-party GPS companies because it

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[62] *Connected Citizens Program*, WAZE, https://www.waze.com/ccp [https://perma.cc/TBU6-YB63] (last visited Mar. 9, 2020).

[63] Jefferson Graham & Brett Molina, *Waze sent commuters toward California wildfires, drivers say*, USA TODAY (Dec. 7, 2017), https://www.usatoday.com/story/tech/news/2017/12/07/california-fires-navigation-apps-like-waze-sent-commuters-into-flames-drivers/930904001/ [https://perma.cc/V84U-TVQD].

[64] Claire Tran, *After the Storm, a Flood of Data*, CITYLAB (Sept. 24, 2018), https://www.citylab.com/transportation/2018/09/after-the-storm-a-flood-of-data/570640/ [https://perma.cc/94KW-5NBK].

is still the best possible way to communicate evacuation routes to scores of affected people.[65]

In order to best prepare for evacuations during natural disasters, city planners and state governments can run evacuation modeling to predict the most efficient evacuation routes.[66] Predicting the best routes prior to a natural disaster will provide the public with the necessary information to make appropriate plans prior to a disaster striking. Further, with predetermined evacuation routes available, government resources could be more efficiently utilized to optimize the traffic flow ahead of mass evacuations and natural disasters.

Other simple measures, such as Los Angeles's Red Flag Parking Restrictions Program, can go a long way in improving roadway conditions during an evacuation.[67] For that program, the city of Los Angeles established "critical areas where parked vehicles could delay citizens trying to evacuate and fire companies attempting to gain access during a Brush Incident."[68] The city then made it illegal to park along those roads during Red Flag conditions or at times when the city was most vulnerable to wildfires.[69] This forward-thinking mitigation project has been a major success, because it is relatively costless, drastically improves roadway conditions, and is easy to implement.[70] As brush and wild fires are beginning to move at unprecedented speeds and the need to evacuate from natural disasters becomes more commonplace, every mitigation and resilience action to improve roadway conditions can combine to make a big, impactful, and noticeable difference.

C. Water Supply

A clean, safe, and robust water supply is perhaps one of the most critical aspects of infrastructure in the United States.[71] Water is used

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[65] *See id.*

[66] Robert Ferris, *How researchers map the routes that save lives when disasters loom*, CNBC (Sept. 20, 2017), https://www.cnbc.com/2017/09/20/how-scientists-model-evacuation-routes-for-natural-disasters.html [https://perma.cc/A3BY-HBPM].

[67] *Red Flag Restricted Parking Program*, L.A. FIRE DEP'T, https://notify.lafd.org/redflag/index.cfm [https://perma.cc/8XXV-2MJ6] (last visited Mar. 9, 2020).

[68] *Id.*

[69] *Los Angeles Fire Department Extends Parking Restrictions*, NBC L.A. (Oct. 25, 2019), https://www.nbclosangeles.com/news/fire-department-extends-parking-restrictions/2040007/ [https://perma.cc/KH4T-G9NX].

[70] *Id.*

[71] *See generally The Importance of Water Infrastructure—August 2017*, SOQUEL CREEK

daily for drinking, cooking, cleaning, and waste management. However, the biggest threat to America's water supply and management is natural disasters.[72] In fact, "[m]any weather events affect public water, regardless of what element that disaster involves."[73]

There are three prominent ways in which natural disasters affect America's water supply. First, natural disasters diminish the supply of available clean drinking water. Most Americans are ill-equipped and do not have an appropriate amount of water to last them through an evacuation.[74] As hurricanes make their final approach, millions of Americans rush to their local grocery stores or supermarkets only to find that all emergency supplies, including water, are sold out.[75] Second, natural disasters destroy and contaminate existing water supply systems, which are often outdated, complex, and difficult to repair. The American Society of Civil Engineers, in their 2017 Report Card for America's infrastructure, gave a "D" grade for America's drinking water.[76] In the United States, "[v]ast networks of underground pipes, often dating back to the 19th century, are nearing or are already past the end of their useful lives."[77] That is why, "[a]ccording to the American Water Works Association, an estimated $1 trillion is necessary to maintain and expand service to meet demands over the next 25 years."[78] America's dilapidated water supply network has real world implications. For example, in Puerto Rico, even a month after Hurricane Maria made landfall, almost one-third of the island lacked potable water, which officials warned could have dire and

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WATER DISTRICT (Aug. 4, 2017), https://www.soquelcreekwater.org/news/latest-news/importance-water-infrastructure-august-2017 [https://perma.cc/JC68-HEUT].

[72] Erica Lies, *Natural Disasters Affect Drinking Water*, AQUASANA, https://www.aquasana.com/info/news/natural-disasters-affect-drinking-water [https://perma.cc/9U7V-7WTH] (last visited Mar. 9, 2020).

[73] *Id.*

[74] Tammie Smith, *Consumers flock to Richmond-area stores and gas stations as they prepare for Hurricane Florence*, RICHMOND TIMES-DISPATCH (Sept. 10, 2018), https://www.richmond.com/business/local/consumers-flock-to-richmond-area-stores-and-gas-stations-as/article_4d1738e9-bca8-58a5-954b-3a9dac12c0c3.html [https://perma.cc/3N4A-JHVC].

[75] Ashley Lewis, *Customers clear local shelves ahead of Hurricane Florence arrival*, CBS (Sept. 11, 2018), https://wtvr.com/2018/09/11/customers-clear-local-shelves-ahead-of-hurricane-florence-arrival/ [https://perma.cc/5YBB-BCK4].

[76] AM. SOC'Y OF CIVIL ENG'RS, 2017 INFRASTRUCTURE REPORT CARD: DRINKING WATER 1 (2017), https://www.infrastructurereportcard.org/wp-content/uploads/2017/01/Drinking-Water-Final.pdf [https://perma.cc/NPE4-8GYN].

[77] *America's Neglected Water Systems Face a Reckoning*, U. PA. (June 10, 2015), http://knowledge.wharton.upenn.edu/article/americas-neglected-water-systems-face-a-reckoning/ [https://perma.cc/LHC7-MHGP].

[78] AM. SOC'Y OF CIVIL ENG'RS, *supra* note 76.

long-lasting health consequences.[79] In the wake of Hurricane Florence in 2018, officials were concerned that inundated septic systems and contaminated water could cause waterborne illnesses.[80] Third, natural disasters can also cause a lack of available water to combat wildfires. During the 2018 Woolsey Fire in Southern California, residents and firefighters complained of the lack of available water in fire hydrants.[81] As reports noted: "[d]uring the firefight, Los Angeles County Waterworks District No. 29, which serves Malibu, saw a significant loss of pressure in its water distribution system, something that didn't go unnoticed by residents."[82] As a result, firefighters had to resort to pumping water from residents' pools in order to protect structures and extinguish the blaze.[83]

Greater attention and investment in updating and managing the American water supply will prove to be critical in making the United States more disaster resilient. Diversification is key when trying to maintain a strong water supply, and cities should have multiple sources of water supplies.[84] The recent drought in Cape Town, South Africa has demonstrated the need for various sources of water as the city depended "almost entirely on a handful of local reservoirs for its water supply, and all of these reservoirs rely on local participation."[85] Many cities in the United States also fall short in diversifying their water supply.[86] California cities in the Central Coast, such as Monterey and Santa Cruz, which were proximate to the deadly wildfires, also primarily "depend on local rainfall."[87] With the extensive droughts in California, this has proved to be a major problem.[88]

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[79] Adrian Florido, *Puerto Rico Health Officials Worry About Contaminated Water Effects*, NPR (Oct. 16, 2017), https://www.npr.org/2017/10/16/557985845/puerto-rico-health-officials-worry-about-contaminated-water-effects?sc=17&f=3?sc=17&f=3 [https://perma.cc/7XM2-EJV9].

[80] Elizabeth Chuck, *Danger may still be lurking in Florence's flood waters even after the storm is over*, NBC NEWS (Sept. 15, 2018), https://www.nbcnews.com/news/us-news/danger-may-still-be-lurking-florence-s-floodwaters-even-after-n909711 [https://perma.cc/UE3S-BDTB].

[81] Matt Hamilton et al., *As toll mounts from Malibu to Thousand Oaks, how did the Woolsey fire become a monster?*, L.A. TIMES (Nov. 13, 2018), http://www.latimes.com/local/lanow/la-me-woolsey-fire-spread-20181113-story.html [https://perma.cc/GK5M-7JHY].

[82] *Id.*

[83] *Id.*

[84] Barton Thompson, *Running Out of Water: Cape Town, the U.S., and Drought*, STAN. L. SCH. BLOGS (Feb. 6, 2018), https://law.stanford.edu/2018/02/06/running-out-of-water-cape-town-the-u-s-and-drought/ [https://perma.cc/EV5T-SHL4].

[85] *Id.*

[86] *Id.*

[87] *Id.*

[88] *Majority of California still suffering from moderate drought despite storms*, ABC (Dec. 6,

However, California has been attempting to fortify and increase its sources of water by "building new water recycling facilities, storing water in underground aquifers, and looking for ways to capture and store stormwater."[89] As Buzz Thompson, a water law expert explains, "[b]y diversifying our water portfolio, we are reducing the risk that we will face a future Day Zero of our own."[90] Furthermore, both federal and local governments can make it a priority to replace outdated waterline systems and fortify existing pipes to be better able to withstand the pressures that natural disasters may bring.

Federal, state, and local governments can also make better efforts to provide all citizens with bottled water in the event that residents need to shelter in place. Instead of solely relying on private businesses such as Target and Walmart to stock their shelves with water, the government should be an active participant in coordinating these efforts.[91] Walmart has publicly stated, "[a]s the severity and frequency of disasters have increased, we are collaborating with others to expand our focus from providing relief to enhancing the preparedness of communities in the face of disaster."[92] Notably, Walmart is "supporting the use of technology to help improve the speed and focus of disaster response so that people, food, water, and other resources are quickly deployed to the right places."[93] While Walmart has become well known for successfully responding to natural disasters,[94] a stronger partnership with federal, state, and local government agencies can increase the overall effectiveness of disaster response. Governments can often provide helpful resources, such as police escorts, demographic data, storage, and personnel to help provide bottled water and other emergency supplies to those in need.

2018), https://abc7news.com/weather/majority-of-calif-still-suffering-from-moderate-drought-despite-storms/4848917/ [https://perma.cc/2ZTV-524N].

[89] Thompson, *supra* note 84.

[90] *Id.*

[91] *See* WALMART STORES, INC., 2016 GLOBAL RESPONSIBILITY REPORT: ENHANCING RESILIENCE IN THE FACE OF DISASTER, https://cdn.corporate.walmart.com/57/25/3d61b8554f09a5410043313b0dc3/grr-19-disasters.pdf [https://perma.cc/4RSX-8KCJ] (last visited Mar. 9, 2020); *LIVE BLOG*: *Walmart's Hurricane Florence Response*, WALMART, https://corporate.walmart.com/newsroom/2018/09/19/live-blog-walmarts-hurricane-florence-response [https://perma.cc/9TWP-E8FS] (last visited Mar. 9, 2020).

[92] WALMART STORES, INC., *supra* note 91.

[93] *Id.*

[94] *Tyson Foods, Walmart Responding to Hurricane Florence, Flooding*, NORTHWEST ARK. COUNCIL (Sept. 21, 2018), http://www.nwacouncil.org/news/2018/9/21/tyson-foods-walmart-leading-response-to-hurricane-florence [https://perma.cc/4DM5-MBUB].

V. SOCIAL INFRASTRUCTURE

Social infrastructure, "the physical places that allow bonds to develop," plays a crucial role in helping to make America more disaster resilient.[95] As Eric Klinenberg, a leading sociologist in the field of social infrastructure wrote, "[w]hen social infrastructure is robust, it fosters contact, mutual support, and collaboration among friends and neighbors; when degraded, it inhibits social activity, leaving families and individuals to fend for themselves."[96] In combating and responding to climate change, Klinenberg argues investing in that social infrastructure will be as important as investing in physical infrastructure projects.[97] For example, "during recent American disasters, including hurricanes Florence, Harvey, and Maria, religious organizations played a vital role."[98] These centers of worship served two key functions during natural disasters. First, the churches and other places of worship were quickly converted into relief zones, where food, shelter, water, and medical care were provided.[99] Second, these religious centers were able to check on their neighbors and congregants to make sure they survived the natural disaster, as well as inquire if they needed additional assistance.[100] Unfortunately, it would be logistically impossible for local, state, and federal governments to provide these same services. While the government can check on the most vulnerable of its population during natural disasters, there will be an untold number of people who the government cannot or will not check in on. Therefore, it is argued that improving informal networks and social infrastructure such as libraries, religious centers, and other gathering locations will foster the conditions to build a stronger community. Research has demonstrated that "[c]ommunity resilience required building neighbor to neighbor reliance and organizational connection."[101] In turn,

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[95] Eric Klinenberg, *Worry Less About Crumbling Roads, More About Crumbling Libraries*, ATLANTIC (Sept. 20, 2018), https://www.theatlantic.com/ideas/archive/2018/09/worry-less-about-crumbling-roads-more-about-crumbling-libraries/570721/ [https://perma.cc/W82D-2ADT].

[96] *Id.*

[97] Eric Klinenberg, *Social infrastructure can help save us from the ravages of climate change*, L.A. TIMES (Sept. 23, 2018), https://www.latimes.com/opinion/op-ed/la-oe-klinenberg-social-infrastructure-20180923-story.html [https://perma.cc/JYV2-NJVL].

[98] *Id.*

[99] *Id.*

[100] *See id.*

[101] *Los Angeles County Community Disaster Resilience Project*, RAND CORP., https://www.rand.org/well-being/community-health-and-environmental-policy/centers/resilience-in

members of this tight-knit community will be more accountable to one another during natural disasters. This accountability, such as checking in on each other, will ensure that help and assistance is directed to those who need it most.

Religious centers have been identified as key resilience zones by those who engage in disaster planning because of the sheer number of locations in the United States.[102] As a group of sociologists noted, "'religious congregations are more common than Subways, McDonald's, Burger Kings, Wendy's, Starbucks, Pizza Huts, KFCs, Taco Bells, Domino's Pizzas, Dunkin' Donuts, Quiznos and Dairy Queens combined and multiplied by three.'"[103] Other non-religious and public places such as schools, universities, libraries, and sports stadiums also have the ability to double as resilience zones during natural disasters.[104] However, as Klinenberg points out, "[o]ur branch libraries are more likely to have decrepit bathrooms than, say, back-up generators and wireless mesh networks to provide power and communications when the grid goes down. Community centers have been left with shoddy facilities and low staffing levels."[105] With limited resources available to achieve climate security and disaster resilience, focused investment in social infrastructure can provide a high return on investment because improvements will be enjoyed year-round, not just in times of natural disasters.[106]

A. Technology

Investment in technology will have profound impacts in helping to make the United States more disaster resilient. There are a host of areas where investment in new technologies can be most impactful. Leveraging the power of artificial intelligence and planning "smart cities" are perhaps two of the most important investments the United States can make to become more resilient.[107]

-action/strategy-development-for-resilient-cities/los-angeles-county-disaster-resilience.html [https://perma.cc/ZX3S-7N3P] (last visited Mar. 9, 2020).

[102] Klinenberg, *supra* note 97.

[103] *Id.*

[104] *Id.*

[105] *Id.*

[106] *Id.*

[107] Greg Scoblete, *We Built This (Resilient) City*, TWICE (Jan. 27, 2019), https://www.twice.com/industry/ces-2019-how-smart-city-technologies-are-improving-urban-resilience [https://perma.cc/R6WW-9VM6].

B. Artificial Intelligence

Artificial intelligence ("AI") is improving America's ability to become more disaster resilient in a number of ways, and as the power and sophistication of AI continues to increase, so too will its use. For example, AI has already been instrumental in helping cities predict where natural disasters will occur.[108] Knowing where natural disasters will hit the hardest, government entities and organizations will know exactly where to place scarce resources such as supplies, equipment, and manpower.[109] Notably, "[w]hen cities can predict more accurately the severity of weather, natural disasters and which areas will be affected most, they can better allocate resources to prepare for relief efforts such as restoring power or evacuating residents at risk."[110] For example, "IBM's outage-prediction tool is also being used, with 70% accuracy, by other cities throughout North America to predict power outages as far in advance as 72 hours before storms are expected."[111]

Beyond storms, AI is also currently being used to predict earthquakes, giving first responders predictions on where the damage will be most destructive.[112] AI companies, such as One Concern, have their AI system obtain "real-time information on the strength of the earthquake and its location from sensors and damage reports. The system also is trained on data from hundreds of past earthquakes throughout the U.S., and each new quake gives it more data to help it become even more accurate in its predictions."[113] AI programs will be instrumental in making America more disaster resilient because they will be "tool[s] for emergency responders who ultimately decide how to best respond in light of limited resources and competing priorities."[114]

Local, state, and federal governmental agencies can help expand the use of AI in disaster mitigation and response in two primary ways. First, governments can monetarily invest in AI companies focusing on disaster resilience. Creating these AI platforms are initially extremely expensive

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[108] *See* Aili McConnon, *AI Helps Cities Predict Natural Disasters*, WALL ST. J. (June 26, 2018), https://www.wsj.com/articles/ai-helps-cities-predict-natural-disasters-1530065100 [https://perma.cc/K66R-DVFG].
[109] *Id.*
[110] *Id.*
[111] *Id.*
[112] *Id.*
[113] *Id.*
[114] McConnon, *supra* note 108.

and have a high cost barrier of entry.[115] However, by receiving stipends or grants from government agencies, companies may ultimately be more successful in developing AI systems that work and are useful in disaster resilience. Second, government agencies must work closer with private companies in the AI sector. It will ultimately be government employees who will utilize these AI technologies, and a closer partnership between the technology companies and first responders will ensure a more successful response after disaster strikes. Furthermore, by providing the AI program with more data, such as the locations of fire stations, hospitals, and traditional emergency response protocol, the AI system will be even more accurate and useful in natural disaster scenarios.[116]

C. Planning Smart Cities

Building smart cities will play a crucial factor in making the United States more disaster resilient. In fact, "[r]oughly 80 percent of Americans live in urban areas."[117] Therefore, focusing limited resources in these areas may have the greatest return on investment. A smart city may be defined as "[a] city that meets challenges through the strategic implementation of ICT resources, networks, and services to provide services to citizens or manage infrastructure."[118] Narayan Mandayam, Professor and Chair of Electrical and Computer Engineering at Rutgers University, explained, "[t]o make a smart city happen, a tremendous amount of investment in infrastructure will be needed, but the benefits will likely far outweigh the costs."[119]

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[115] Sheri Fink, *This High-Tech Solution to Disaster Response May Be Too Good to Be True*, N.Y. TIMES (Aug. 9, 2019), https://www.nytimes.com/2019/08/09/us/emergency-response-disaster-technology.html [https://perma.cc/E4YG-JHSS]; *How Much Does Artificial Intelligence (AI) Cost in 2019?*, AZATI SOFTWARE (Jan. 23, 2019), https://azati.ai/how-much-does-it-cost-to-utilize-machine-learning-artificial-intelligence/ [https://perma.cc/RUF3-9VXP].

[116] Leor Distenfeld, *Data in, insights out: why AI needs robust data to be effective*, MEDIUM (Apr. 12, 2018), https://medium.com/swlh/data-in-insights-out-why-ai-needs-robust-data-to-be-effective-2168b5c1730b [https://perma.cc/T9JR-ZTU4].

[117] Christopher Ingraham, *Americans say there's not much appeal to big-city living. Why do so many of us live there?*, WASH. POST (Dec. 18, 2018), https://www.washingtonpost.com/business/2018/12/18/americans-say-theres-not-much-appeal-big-city-living-why-do-so-many-us-live-there/?utm_term=.2174d6c3166c [https://perma.cc/G5QQ-MZA2].

[118] Nina Lövehagen & Anna Bodesson, *Evaluating Sustainability of Using ICT Solutions in Smart Cities—Methodology Requirements*, PROC. FIRST INT'L CONFERENCE USING ICT SOLUTIONS SMART CITIES—METHODOLOGY REQUIREMENTS 175, 176 (Feb. 2013).

[119] Todd Jaquith, *Here's a Look at the Smart Cities of the Future*, FUTURISM (Jan. 18, 2017), https://futurism.com/heres-a-look-at-the-smart-cities-of-the-future [https://perma.cc/D4KD-EQ49].

There are infinite possibilities of how American cities can be transformed into "smart cities," such as better zoning, use of more disaster resilient materials, and more effective transportation. While flashy benefits of smart cities, such as smart parking and more efficient public transportation are no doubt beneficial, the government should initially focus on investing in smart architecture and a connected infrastructure to foster greater disaster resilience.[120] Prioritizing smart architecture and a connected infrastructure is critical because it will allow smart cities to leverage the use of the Internet of Things ("IoT"), which allows "devices such as connected sensors, lights, and meters to collect and analyze data."[121] With this exponential increase of available data that artificial intelligence can analyze, cities will be able to better endure natural disasters by making smarter, faster, and more effective decisions.[122] For example, sensors implemented in smart architecture and a connected infrastructure can "detect how far and how fast [] the fire [is] spreading" and "monitor water levels to send alerts at the first sign of flooding."[123] This information can automatically guide people in affected areas to the safest evacuation routes before, during, and after disaster strikes.[124] Since partnerships between the government and private entities will need to work closely together on ongoing projects, "[t]he path to [a] 'smart city' starts looking less like a single project and more like a web of partnerships."[125] However, obtaining the data from smart architecture and connected infrastructure is not enough. Government at all levels must learn to capitalize and leverage this new data to fully take advantage of its benefits. For example, "[a]nalytics-backed information would enable local, state, and national teams to geotarget messaging to neighborhoods at most risk—a neighborhood with high concentrations of elderly populations who might not have access to transportation . . . ."[126] These proactive measures in investing in smart architecture and connected infrastructure

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[120] Andrew Meola, *How smart city technology & the Internet of Things will change our apartments, grids and communities*, BUS. INSIDER (Jan. 16, 2020), https://www.businessinsider.com/internet-of-things-smart-cities-2016-10 [https://perma.cc/J7UL-PKCW].
[121] *Id.*
[122] Kris Tremaine & Kyle Tuberson, *How the Internet of Things Can Prepare Cities for Natural Disasters*, HARV. BUS. REV. (Dec. 1, 2017), https://hbr.org/2017/12/how-the-internet-of-things-can-prepare-cities-for-natural-disasters [https://perma.cc/J5U6-ACXY].
[123] *Id.*
[124] *Id.*
[125] Gabriela Barkho, *Are You Already Living in a 'Smart City'?*, N.Y. MAG. (Oct. 29, 2018), http://nymag.com/developing/2018/10/what-is-a-smart-city.html [https://perma.cc/3W4D-M98F].
[126] Tremaine & Tuberson, *supra* note 122.

will save lives, property, and money, leading America to become more resilient in enduring natural disasters.

VI. ELIMINATING THE FEDERAL MITIGATION GRANT PROGRAM

Implementing disaster mitigation efforts can be an expensive undertaking for individual or family homes. As a result, some families hold off on mitigation efforts and instead, spend money on a host of other important areas such as education, healthcare, and taxes.[127] However, taking this chance can expose individuals and families to greater financial risk, especially as the number of catastrophic natural disasters have increased in recent years.[128]

The Federal Emergency Management Agency is the federal agency tasked with distributing mitigation grants in order to make implementing disaster mitigation projects more accessible and achievable for Americans.[129] FEMA currently supports three Hazard Mitigation Assistance ("HMA") programs: (1) the Hazard Mitigation Grant Program ("HMGP"), (2) the Pre-Disaster Mitigation ("PDM") Program, and (3) the Flood Mitigation Assistance ("FMA") Program.[130] While these three grants have no doubt made a noticeable impact,[131] a drastically improved system is needed to ensure that the United States is able to become more resilient in response to natural disasters. There are two primary problems associated with the HMA programs. First, these mitigation grant programs currently make it too difficult for individual homeowners to be eligible to actually achieve the grants. Second, under the current process, there is too much time between when applicants submit their requests and when the funds are actually distributed. To address these major problems, the

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[127] Adriana Belmonte, *What American households spend their money on*, YAHOO! FIN. (Dec. 31, 2018), https://finance.yahoo.com/news/american-households-spend-money-154045675.html [https://perma.cc/5ZTJ-EQPL].

[128] *See* Leah Platt Boustan et al., *Natural Disasters by Location: Rich Leave and Poor Get Poorer*, SCI. AM. (July 2, 2017), https://www.scientificamerican.com/article/natural-disasters-by-location-rich-leave-and-poor-get-poorer/ [https://perma.cc/M47R-6RTJ].

[129] *Hazard Mitigation Grant Program*, FEMA, https://www.fema.gov/hazard-mitigation-grant-program [https://perma.cc/MPH6-C3QW] (last updated Dec. 17, 2019).

[130] FEMA, HAZARD MITIGATION ASSISTANCE GUIDANCE 1 (Feb. 27, 2015), https://www.fema.gov/media-library-data/1424983165449-38f5dfc69c0bd4ea8a161e8bb7b79553/HMA_Guidance_022715_508.pdf [https://perma.cc/UVF3-2XNK].

[131] *FEMA Mitigation Grants Program Eclipses $15 Billion in Helping Communities Rebuild, Recover and Avoid Future Losses*, FEMA (Mar. 6, 2018), https://www.fema.gov/news-release/2018/03/06/fema-mitigation-grants-program-eclipses-15-billion-helping-communities [https://perma.cc/WDV6-87W9].

federal government should eliminate these HMA programs and instead offer a maximum of a $2,500 tax credit to all homeowners who implement disaster mitigation home improvements.

A. The Current Process Makes It Too Difficult and Takes Too Long for Individuals to Receive Grants

Under the current HMA application, individual homeowners, businesses, and private non-profits may apply for funding through eligible subapplicants.[132] These subapplicants include various state agencies, private non-profits, and other local governments and community organizations.[133] Once the application moves to the subapplicants, it is then passed on to "applicants," who typically are territories or states.[134] Finally, the applicants submit the application on the individuals' behalf to FEMA.[135] Therefore, for each individual homeowner to receive a grant, their application has to pass through three different government agencies.[136] This protocol is overly cumbersome and will discourage homeowners who may be less educated, sophisticated, or do not have the time or patience to submit disaster mitigation grant applications. Further, one of the primary purposes of disaster mitigation is to prevent severe physical damage. By preventing severe damage, homeowners will save great sums of money.[137]

Another issue associated with the HMA is that not all applicants are guaranteed funding as "[t]he PDM program is a highly competitive grant program."[138] All homeowners, regardless of where they live, should have an equal opportunity to make improvements to their homes as a disaster mitigation project. Almost all natural disasters are unpredictable, and thus, every homeowner should have the same chance at making improvements to mitigate any potential damage and destruction. As FEMA states, "[d]isasters can happen at anytime and anyplace; their human and financial consequences are hard to predict."[139]

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[132] FEMA, *supra* note 129.
[133] *Id.*
[134] *Id.*
[135] *Id.*
[136] *Id.*
[137] *See Hazard Mitigation Value*, OFF. FOR COASTAL MGMT., NAT'L OCEANIC & ATMOSPHERIC ADMIN., https://coast.noaa.gov/states/fast-facts/hazard-mitigation-value.html [https://perma.cc/9VSW-MBET] (last updated July 10, 2019).
[138] *Pre-Disaster Mitigation Grant Program*, FEMA, https://www.fema.gov/pre-disaster-mitigation-grant-program [https://perma.cc/H9DK-ASPV] (last updated Dec. 23, 2019).
[139] *What is Mitigation?*, FEMA, https://www.fema.gov/what-mitigation [https://perma.cc/J5DB-DZGW] (last updated Jan. 21, 2020).

Even more, FEMA proclaims that every $1 spent on mitigation can have a national benefit of $4.[140] With this profound success, the goal of the HMA and distributing funds to assist in implementing disaster mitigation projects should be to increase the number of homeowners and individuals who receive funds, not limit it.

B. The Solution to the HMA Grant Programs

Instead of providing disaster mitigation funds in the form of large grants, the federal government should propose to offer a maximum tax credit of up to $2,500 to American homeowners who invest in and implement disaster mitigation projects. By making every American eligible, everyone in the United States will have an equal chance to participate in this program. Additionally, a tax credit will incentivize individuals to invest in disaster mitigation projects because it will save them money by making it less expensive to implement such projects. There is strong precedent suggesting that tax credits will encourage consumers to participate in the program. For example, the United States offered tax credits that ranged from $2,500 to $7,500 for individuals who purchased fully electric vehicles.[141] This tax credit helped to offset the purchase price of the electric car and made it more enticing for individuals to purchase fully electric vehicles.[142] It is reasonable to assume that the same principle can be applied to implementing disaster mitigation projects on individual homes.

The tax credit of $2,500 is enough money to help make substantial improvements or significantly reduce the overall cost of some projects.[143] Importantly, disaster mitigation projects have had real, tangible success. For example, Ron Steffovitch, a California resident spent extra money on "concrete tile roof, cement stucco exterior and fire-resistant landscaping" when renovating his home.[144] When the Valley Wildfire ripped through

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[140] FEMA, *supra* note 129.

[141] *See Alternative Fuels Data Center*, OFF. ENERGY EFFICIENCY & RENEWABLE ENERGY, U.S. DEP'T ENERGY, https://www.energy.gov/eere/electricvehicles/electric-vehicles-tax-credits-and-other-incentives [https://perma.cc/D45V-HBXE] (last visited Mar. 9, 2020).

[142] Greg Gardner, *Electric car buyers will still get incentives under tax cut bill*, USA TODAY (Dec. 19, 2017), https://www.usatoday.com/story/money/cars/2017/12/19/electric-car-buyers-still-get-incentives-under-tax-bill/964543001/ [https://perma.cc/TK7W-5NSG].

[143] *See How Much Will it Cost to Raise a House Foundation?*, IMPROVENET, https://www.improvenet.com/r/costs-and-prices/raise-foundation-cost-estimator [https://perma.cc/M7GY-E66K] (last updated Oct. 5, 2018).

[144] FEMA, FIRE-RESISTANT CONSTRUCTION AND SPACE SAVE HOME (Nov. 2, 2015), https://www.fema.gov/media-library-data/1447680585087-0d9e09a6c94898fdcc90baa2b7a39

his neighborhood, Steffovitch's mitigation efforts were put to the test.[145] Upon returning to his property, Steffovitch was relieved to find only minor damage, while his neighbors' homes were completely destroyed.[146] Steffovitch reported he spent an extra $12,500 for the concrete tile roof, which helped prevent the fire from engulfing his home.[147] While a $2,500 tax credit would not have covered the entire cost of the mitigation project, it would have provided for over 10 percent in savings and would perhaps encourage other people to implement such measures to mitigate potential damage. There are countless ways homes can be better fortified to withstand an array of natural disasters. While most of these homes would not have received disaster mitigation grants, under the proposed system, every homeowner would have been eligible for the $2,500 tax credit. This tax credit would also allow homeowners to be proactive in implementing disaster mitigation projects, in turn, saving even more money in the long term.[148]

VII. IMPROVE COMMUNICATION BEFORE, DURING, AND AFTER NATURAL DISASTERS

Clear communication before, during, and after natural disasters is necessary to make the United States more disaster resilient. In fact, "[e]ffective communications systems are critical and the failure of these systems can have catastrophic consequences."[149] Poor communication during a natural disaster can "cost needless deaths and increased human suffering."[150] One of the most notable communication blunders occurred during Hurricane Katrina, one of the most devastating natural disasters in the United States.[151] The lack of effective communication had dire consequences.[152]

35a/03_Fire-Resistant-Construction_web.pdf [https://perma.cc/CHN4-63RV] (last visited Mar. 9, 2020).

[145] *Id.*

[146] *Id.*

[147] *Id.*

[148] FEMA, *supra* note 129.

[149] HEATHER K. MEEDS, U.S. ARMY WAR C., COMMUNICATION CHALLENGES DURING INCIDENTS OF NATIONAL SIGNIFICANCE: A LESSON FROM HURRICANE KATRINA 9 (Mar. 15, 2006), https://pdfs.semanticscholar.org/d706/8ffc72a6c9245ac2bcb1f6afe6b4165167b3.pdf?_ga=2.248217287.1197514896.1580261844-1226448469.1580261844 [https://perma.cc/2E8K-ZD2U].

[150] *Id.*

[151] *Hurricane Katrina Worst in U.S. History*, HIST. (Nov. 29, 2005), https://www.history.com/topics/natural-disasters-and-environment/hurricane-katrina-worst-in-us-history-video [https://perma.cc/QG9G-79HG].

[152] *See* MEEDS, *supra* note 149, at 9.

For example, six rescue helicopters hovered over a single house, but "[i]f proper communications had been in place, only one helicopter would have been sent to that roof top and the other five would have been able to rescue other civilians."[153] While this is a single example of a communication mishap, when multiplied across a region during a natural disaster, the consequences can easily compound. As a result, it is critical that clear information disseminated from the government be broadcast before, during, and after a natural disaster.

A. Communication Before Natural Disasters

Effective communication before a natural disaster strikes is imperative and will often chart how the rest of the communication during a natural disaster will occur. Clear and organized information before a natural disaster strikes will allow more people to evacuate and allow the proper first responders and resources to be in place for rescue and relief efforts. Experts suggest, "[b]eing organized, thoughtful and flexible are key to helping everyone navigate the crisis."[154]

Specifically, "[g]overnment agencies should consider leveraging the [IoT] and other web-driven technologies to obtain timely and accurate data that can better inform decisions and actions."[155] In order to capitalize on these technological advances, human response teams will have to be in place and prepared to receive, analyze, and act upon the incoming information.[156] Sensors connected via the web can monitor water quality, smoke, humidity, pressure, and temperature.[157] For example, "[i]n the case of wildfires, sensors can detect how far and how fast [ ] the fire [is] spreading."[158] With this information, first responders and government personnel can communicate if residents need to evacuate, and if so, what the best route is to take.[159] To truly take advantage of the IoT capabilities, a strong infrastructure must be in place to allow the sensors to properly send signals.[160] Without a resilient infrastructure, the sensors would fail during natural

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[153] *Id.*
[154] Carey Kirkpatrick, *Houston And Harvey: Managing Communications In A Natural Disaster*, FORBES (Sept. 18, 2017), https://www.forbes.com/sites/forbesagencycouncil/2017/09/18/houston-and-harvey-managing-communications-in-a-natural-disaster/#6a031b7258e1 [https://perma.cc/5S7A-LRNG].
[155] Tremaine & Tuberson, *supra* note 122.
[156] *Id.*
[157] *Id.*
[158] *Id.*
[159] *Id.*
[160] *Id.*

disasters and would become useless. Officials should place multiple sensors in various locations to ensure that data will still be sent even if one sensor fails.[161]

Before chaos ensues, governments can ensure that they "know which communication channels work best to reach the affected citizens."[162] For example, if the community tends to be inhabited by older residents, the government should use radio, television, and newspapers to communicate instead of solely relying on social media.[163] Similarly, if the population predominantly speaks Spanish, then the government must ensure that communications are translated and broadcasted accordingly.

Local, state, and federal governments must organize and decide on how the various agencies will communicate with each other prior to the natural disaster. Each agency will likely have its own form of communication and protocol, and working out any possibility of miscommunication prior to the disaster will be beneficial and will help save lives. By working together, these government agencies can develop predetermined contingency plans, which will help allow all government agencies to effectively communicate in certain situations. For example, the government should decide on the method of communication if cell towers are out of service, prior to the natural disaster striking. Similarly, these government agencies should predetermine which agency will be responsible for communicating with its constituents. Sometimes in the midst of chaos, multiple government agencies might send out conflicting reports that only add to the confusion.

B. Communication During Natural Disasters

During natural disasters, the government should use data and information collected from the IoT, which "can help facilitate and expedite a local response during the disaster."[164] Because "[t]iming is everything in a disaster situation," state agencies must communicate as clearly and efficiently as possible during the natural disaster.[165] One of the most difficult problems that arises during natural disasters is that various agencies fail to properly communicate with one another.[166] Therefore, all local, state, and federal agencies should determine a single entity or a

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[161] *See* Tremaine & Tuberson, *supra* note 122.
[162] *Id.*
[163] *Id.*
[164] *Id.*
[165] *Id.*
[166] *Id.*

unified command to serve as the lead during the natural disaster. This protocol will ensure that all important information and communication passes to a single designated source, who in turn, will help to make certain that the various government agencies are being properly utilized.

Amidst the natural disaster and the surrounding chaos, governments must remain organized and flexible in order to properly communicate with other governmental agencies and their constituents.[167] Specifically, officials would be wise to complete status checks during the natural disaster to see how their communication is working and what could be done to improve it.

C. Communication After Natural Disasters

Once the natural disaster passes, it is important to recognize that the disaster is not over.[168] In fact, in many ways, it is just beginning. This is often the period when massive rescue and relief efforts are underway, and during the resulting chaos and uncertainty, communication is prone to be poor. Working on improving communication before and during the natural disaster will help to ensure that communication following a natural disaster is beneficial. As mentioned earlier, staging utility and communication company technicians and personnel in predetermined disaster prone areas will allow for any broken lines of communication to be quickly restored.[169] This will greatly assist in the recovery and relief operations as more people will be able to communicate with the proper authorities and each other.[170]

It is during this period that government entities should implement communication for long-term disaster relief.[171] While national news media will intensely focus on a natural disaster while it occurs, this media attention quickly fades in the days after the natural disaster passes.[172] As a result, many impacted victims and individuals subsequently become unaware of how to communicate that they are in need of long-term assistance.

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[167] *See* Kirkpatrick, *supra* note 154.
[168] *See* Aaron E. Carroll & Austin Frakt, *The Long-Term Health Consequences of Hurricane Harvey*, N.Y. TIMES (Aug. 31, 2017), https://www.nytimes.com/2017/08/31/upshot/the-long-term-health-consequences-of-hurricane-harvey.html [https://perma.cc/5R7M-PMDK].
[169] *See* McConnon, *supra* note 108.
[170] *Id.*
[171] *See generally* Labrador, *supra* note 34.
[172] *See* Joseph Scanlon, *Research about the Mass Media and Disaster: Never (Well Hardly Ever) The Twain Shall Meet*, *in* JOURNALISM: THEORY AND PRACTICE 233–69 (Joseph R. Detrani ed., 2011).

Therefore, governments need to ensure that impacted individuals know how to properly communicate with the appropriate agencies for immediate and long-term relief and assistance.

In the aftermath of natural disasters, government agencies should complete an after-action report and debrief how they viewed the success or the failure of the communication process before and during a natural disaster.[173] Studying and analyzing how various government agencies performed in response to a natural disaster will help determine what went well and what improvements need to be made.[174] Repeating communication errors and not learning from previous mistakes will only add to the destruction and pain left in the wake of a natural disaster.

To effectively debrief the communication that occurred, government agencies must converse with all stakeholders. Talking with community leaders, hospitals, insurance agencies, media outlets, and other government agencies will allow for a productive report and analysis of what communication successes and failures transpired. Furthermore, conducting a survey of how the sensors and the IoT performed will help government agencies tweak and begin to perfect the system that is in place.

CONCLUSION

There is no question that natural disasters will increase in number and destructiveness in the years and decades to come.[175] However, the fact is "[t]oo often governments and households fail to take adequate measures to reduce their vulnerability to common disasters, say, by elevating one's home after a storm surge to avoid future flooding or building weather-resistant infrastructure."[176] Anne Stauffer, director of broadband research and fiscal federalism at Pew Charitable Trusts, explains, "[t]he system is not prioritizing disaster investments that would reduce the need for disaster response and recovery."[177] While becoming resilient may seem overwhelming, the truth is that the mitigation work and investment in

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[173] *See* Laura N. Medford-Davis & G. Bobby Kapur, *Preparing for Effective Communications During Disasters: Lessons from a World Health Organization Quality Improvement Project*, 7 INT'L J. EMERGENCY MED. 15 (2014).

[174] *See, e.g.*, U.S. FIRE ADMIN., FEMA, OPERATIONAL LESSONS LEARNED IN DISASTER RESPONSE (June 2015), https://www.usfa.fema.gov/downloads/pdf/publications/operational_lessons_learned_in_disaster_response.pdf [https://perma.cc/UM7E-NH24] (examining after-action reviews of the U.S. Fire Administration's response to major disasters over the past decade).

[175] MEEDS, *supra* note 149, at 14.

[176] Labrador, *supra* note 34.

[177] *Id.*

disaster resiliency will no doubt pay off in terms of lives saved, total damage inflicted, and cost to the American people. In fact, "[a]ccording to the National Institute of Building Sciences, every dollar spent on mitigation saves the U.S. government an average of $6 in recovery costs."[178]

There are numerous improvements and investments that the United States government can undertake to make America more disaster resilient. Specifically, the United States government should initially focus on three main areas in order to ensure the strongest return on investment. First, the government must invest in the nation's infrastructure. Without upgrading America's dilapidated infrastructure, the power and increasing strength of natural disasters will continue to inflict incredible destruction and devastation. Second, the United States government should eliminate their disaster mitigation grants and replace them with $2,500 mitigation project tax credits to make the process more efficient, easy, and available to a greater number of citizens. Small investments by a great number of American homeowners and other individuals will have tremendous benefits that will save money, lives, and help the country rebound after natural disasters. Third, communication must be greatly improved before, during, and after natural disasters in order to more efficiently and effectively distribute resources and provide aid to those who need it the most. Taking a proactive, rather than a reactive, approach will initially be more laborious but will have greater long-term effects and benefits for the American people.

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[178] *Id.*