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Building Community Resiliency Against Disasters

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Building Community Resiliency Against Disasters

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Abstract

Disasters impact people in many different places around the world. The impact to communities by disasters is shaped by their constructed vulnerability. The goal of this research project was to better understand how the vulnerability and resiliency of different communities was shaped at six different sites across the U.S. and to construct a collection of best practices to raise the resiliency of populations and locations in the face of many different forms of possible disasters in the future. These concepts and conclusions were drawn from internet research of the chosen sites. Phase 1 of the research determined noteworthy sites and gathered details and data on each site to guide recommendations. Phase 2 gathered information by interviewing individuals with credible and meaningful insights to add to the research data. The sites chosen had disaster events that happened recently or were still occurring during the research in order to better understand the current issues disasters pose and to generate more creative and applicable solutions to these issues. Researching these sites provided a better understanding regarding the best ways to interact with vulnerable communities and raise their resiliency against disasters. It was found that if vulnerable communities had better access to resources, infrastructure, and decision-making agency, and locations had sustainable electricity sources that could operate through extreme weather, they would be more resilient to disasters. Politics plays a large role in shaping vulnerability and resiliency, particularly in how policies determine who has access to resources, power distribution, what disaster response occurs, and how disasters are perceived, showing that these specific areas of resiliency are important to focus on, but to be effective, they need support from the political realm. If these proposed recommendations are implemented, communities will be better able to withstand disruptive forces from the environment and mitigate harm, or possibly even fully prevent disasters from occurring.

Introduction

A disaster is a collision between human society and forces of the surrounding environment that creates harm and disruption to human life and societies. It was estimated that disasters, in the United States in the year 2021 created a record $306 billion in damages (Consortium for Ocean Leadership, 2019). This damage included:

> Physical damage to residential, commercial, and government or municipal buildings, material assets within a building, time element losses like business interruption, vehicles and boats, offshore energy platforms, public infrastructure like roads, bridges, and buildings, agricultural assets like crops, livestock, and timber, and disaster restoration and wildfire suppression costs (National Centers for Environmental Information (NCEI), 2022).

The term natural disaster is misleading because it implies that a force of nature or the environment is acting alone without human involvement and that the disaster is inevitable. Disasters are defined by how they impact and harm people and the places they live (Pierre-Louis, 2021). If a hurricane forms in the middle of the ocean and doesn't collide with any human societies, it is just a storm. A disaster occurs when these forces of the environment collide with human societies, causing damage and harm, such as when Hurricane Katrina hit New Orleans in 2005, flooding the city and killing almost 2,000 people (US Department of Commerce, 2022). The damage and harm is not solely determined by if forces of the environment collide with human societies, but specifically how those societies and people there are affected, whether or not societies are able to protect against the damage, resulting in effective disaster mitigation or societal collapse (Smith, 2020). Together, the forces of human society and the environment around humans generate and define disasters. Human-caused climate change is another variable

shaping disasters that has and will continue to impact the severity of weather events. The environmental forces which collide with human society to create disasters are becoming stronger and more frequent as global temperatures increase drastically (U.S. Geological Survey, n.d.). Over time, these forces of the environment will only become more powerful as the atmospheric temperature grows warmer (US EPA, n.d.). Disasters are defined by how they impact human societies and by how human behavior has affected the climate, making the forces leading to disasters more powerful. As climate change and disasters continue, the focus then needs to be on the human societies and structures that are harmed when forces of the environment hit them.

To understand the impact that disasters have on human societies, we must consider vulnerability and resiliency. The harm communities experience due to a force of the environment is influenced by the constructed vulnerability or resiliency of those populations, which affect the ways in which a disaster does or does not occur. Vulnerability is the collection of forces and variables that amplify harm in the case of a disrupting event (NCDP, 2020). A group's vulnerability is influenced by access to resources, social and economic factors, and location in relation to surrounding structures and hazards. In New Orleans, for example, people with access to cars, bank accounts, and family members had a much higher chance of getting out of the city before Katrina hit, which raised their resiliency (Smith, 2020). Resiliency is the collection of social forces and variables that reduce or prevent harm in the case of a disrupting event (GSDRC, 2016). Resiliency focuses on providing resources, protection, and agency so that when something like a hurricane occurs, they are not harmed, and their lives are minimally disturbed. In the case of Hurricane Katrina in New Orleans, due to historic inequality, black communities lived in areas most prone to flooding and they had fewer resources, mobility, and network

support (Smith, 2020). The black population in New Orleans had little to no access to these important resources, crucial to reducing harm from such events and building up resiliency.

Vulnerability and resiliency of communities are socially constructed, meaning that it is shaped largely by social factors. A social construction is something that exists in the world as a result of human interaction and an agreement among people that it exists (Bainbridge, 2022). Disasters originate from socially constructed conditions that are not linked to force such as hurricanes or tornadoes but are instead tied to the vulnerability and resiliency that exists among people within societies (Blaikie et al., 1994). When events like hurricanes occur, these conditions present themselves in the form of amplified harm. These are the parts of someone's social positioning which affect where they live, how much money they have, how they are treated in society, or how much harm they are susceptible to.

Two of the most influential social factors regarding disasters are race and economic status. Environmental racism is a term used to describe the systemic harm that racial minorities suffer from due to damage caused by disasters (Beech, 2020). These minoritized and marginalized communities are more frequently located close to sources of harm or system failures, they have fewer resources to survive during and recover after a disaster occurs, and they often receive worse treatment and less help in times of need (Environmental Justice and Environmental racism, n.d.; Frank, 2021). Racial communities affected by a disaster are less likely to be accepted into buyout programs so they can leave a vulnerable area and receive less money from the government to rebuild after a disaster occurs (Frank, 2021; Hersher, 2019). A 2018 study conducted by James Elliot, a Rice University sociologist, showed that white people living in counties that experienced significant damage during a disaster had an increase in their personal wealth, while Black, Hispanic, and Asian people living in counties that experienced

significant damage from disasters lost wealth (Frank, 2021). Insurance payouts and government support funds were the reason the white people had an increase in wealth, while other racial groups received much less money.

By studying the events of different disasters and understanding the vulnerability of the locations and the communities there, how can more resilient cities be built and what ideas and solutions can be proposed to decision makers so that they can implement policies and programs to support and protect the local communities? Disasters exploit the inequalities of vulnerable populations. Analyzing disaster locations along with population data provides deeper understanding of the vulnerability and resiliency present at each location. These data consisting of articles and documents describing the disasters and demographic data about those affected provides insights into how to make communities more resilient in order to reduce and hopefully fully prevent harm from occurring when more events from climate change inevitably occur. Each disaster site has a combination of distinct and similar traits in comparison to other sites. Environmental forces are different in some ways; they can come in the form of hurricanes, droughts, forest fires, floods, and many others. Populations and locations are also different. They can have different socioeconomic, political, and geographical demographics. Vulnerable populations being affected the most and environmental forces caused by climate change colliding with human spheres are what connect disaster sites. Through studying how the differences and similarities between sites led to disaster situations, a set of guidelines was formulated for application to a wide variety of locations while also meeting the precise and specific needs at individual disaster sites. In order to answer this question, disaster site information and open-ended semi structured interview transcripts were reviewed, coded,, and analyzed.

Methods

Phase 1 of the study consisted of researching recent disasters and identifying sites with robust data. Early in the research, there were multiple sites being considered, with a focus on disasters which had happened in the last few years or that were happening currently. Four or five sites stood out in terms of their scale and impact as well as the diversity of disasters between the sites. A total of six sites were decided upon: 1) the flooding in Detroit in the summer of 2021; 2) the Lake Mead-Hoover Dam drought of 2021 and 2022; 3) the Kentucky tornadoes in December of 2021; 4) the Texas electricity outage in February of 2021; 5) Hurricane Ida which struck in 2021; and 6) the New Mexico wildfires which started in April of 2022. These were chosen because they had all occurred recently, they were located across the United States in different areas, and they were all different types of disasters both in the extreme weather event that led to the disaster and in how people were affected. News articles, scholarly research, and Federal Emergency Management Agency (FEMA) documents were reviewed. These sources provided information about when the disaster started, which areas were affected, and the resulting damage. If the disaster was still ongoing, more recent articles provided information about how people were responding and what actions were being considered in the present time.

To better understand the constructed vulnerability and resiliency at each site, data, consisting of news articles and FEMA documents, were collected by conducting internet research. The continued phase 1 research included online news articles, governmental and other organizational websites, and academic articles and papers which provided a large amount of information about the disaster sites chosen for this research project. These resources provided timelines, resource statistics, vulnerability and resiliency points of interest, and information on affected communities. From this research, a group of resiliency categories were developed, which were strengthening electrical systems, building up community resiliency through ideal

federal, state, and local relationships, and deciding whether to rebuild or relocate after a disaster occurs.

Phase 2 research was conducted to obtain data from individuals connected to and knowledgeable about the disaster sites chosen for this research and building disaster resiliency. These people participated in open-ended, semi-structured interviews ranging from 25 to 50 minutes, focusing on questions about their experiences with disaster sites, disaster resiliency initiatives, how to better engage with disaster vulnerability, and barriers to making that happen. Interviews were audio recorded and then transcribed. The transcriptions were then coded following the recommended categories developed through the phase 1 research, acknowledging if sections of the interviews fell into those categories or if there were important vulnerability and resiliency topics that were not emphasized before the interview section of the research.

Demographics on each of the locations were also collected to gain a better understanding of the communities affected at each site and to see if any connections could be drawn among the different populations. The five demographic categories chosen were political affiliation, religious affiliation, age, race and ethnicity, and poverty level. These categories provided information about how the vulnerability and resiliency of populations were shaped at each of the disaster sites, specifically age, racial identity, and poverty level. These data were gathered to see if certain demographics influence how people were affected and if specific populations were disproportionately affected. Political and religious affiliation were gathered with the goal of understanding why certain policies did or did not exist before the disaster occurred and what the responses and actions after the event were at each of the sites. Along with the articles and documents detailing the events of the disasters at each site, this information helped create a better

understanding of the vulnerability of each site and the communities there, as well as possible solutions to build resiliency at each site against future disasters.

Case Studies

Some broader conclusions could be drawn when the data from five sites were aggregated and analyzed. The vulnerability of communities was constructed through a lack of access to necessary resources and infrastructure, a systemic reliance on the federal government to resolve all disaster problem, and an inability for communities to guide decision-making regarding actions that affect them. Additionally, location vulnerability was constructed by electricity systems failing in extreme weather and the inexistence of sustainable electricity sources. One other idea that was important to consider was rebuilding or relocating after a disaster occurs, with the interviews in particular not seeing importance in significant relocation now, but possibly in the future. The interview section of the research also pointed to politics having a large influence in the form of policymaking, the distribution of action-taking power, perceptions and responses to disasters, resource distribution, and public perceptions of the disasters.

Now that I've stated what the research showed, I'm going to unpack what data I collected and used to come to the conclusion of my resiliency categories and my reasoning behind them. To build resiliency against constructed vulnerabilities, local community agency and access to resources without financial burden were critical to building community resiliency. Additionally, when governments and local communities reinforce electrical systems against extreme weather events and introduce sustainable electricity sources within electrical systems, they help protect electrical grids, water access, and communication lines. These resiliency goals will be very difficult to achieve if political spheres, meaning local members of government, policies, and resource allocation are not supportive of them. Currently, local, state, and federal

political members have great influence over whether or not resiliency actions are discussed and implemented, where resources are directed to, and which groups or organizations have agentive capabilities.

It is also important for communities to have access to resources and be able to make decisions themselves. Electrical systems need to have sustainable electricity sources at their foundation and other resources such as water and internet or other forms of communication need to be available, or those systems will collapse. Within this research, there is a strong influence of politics affecting vulnerability and resiliency actions. Policies, access to resources, power distribution, and disaster response and perception are all connected to politics within and area, showing that, currently, politics greatly affect disaster resiliency actions. Rebuilding or relocating after a disaster needs to be considered as well. There has been some temporary relocation, but no significant permanent relocation efforts regarding these disaster sites. This decision may not be made currently, but it is very possible that it will need to be made in the coming decades.

Demographics Information

The vulnerability of communities and individuals is partially informed by their social identity. Racial minorities and people living in poverty are more vulnerable to harm from disasters than white communities and people with wealth and resources (Smith, 2020). The information in this chart (see Appendix A, Table 1) came from the disaster sites in the research project. The different demographics categories were collected to better understand which communities were more vulnerable among the sites. This information was also gathered to determine if religious and political views were correlated to the decisions that were or were not

made at each site. Communities that consisted of higher racial minorities and high poverty rates were more likely to have vulnerable communities (see Appendix A, Table 1).

The key demographics for better understanding vulnerability are racial and economic demographics, because high percentage black populations tend to correlate with high poverty rates (see Appendix A, Table 1). These demographics helped point to who had more access to resources and assistance and who faced more barriers and had less mobility and support within society. This information didn't solely determine who would experience more harm and struggle from the studied disasters, or disaster overall, but it was a predicator of which communities consistently encounter more struggle and hardship in disasters.

Detroit Flooding

Serious flooding in Detroit occurred during the summer of 2021. Heavy rain and flooding came in June, July, and August. The flooding was caused due to the excessive rain having nowhere to drain (Thompson et al., 2021). This led to neighborhood streets, highways, and houses being flooded in multiple feet of water. People couldn't reach their cars in the street which were either halfway submerged in water or had been pushed away to another location by the water. Debris covered all roads from neighborhood streets to highways. Many people couldn't leave their homes due to the height of the water and the inability to access transportation. The flooding also knocked electricity out to many parts of the Detroit area.

The city's electrical grid collapsed during the severe flooding. In August there were around 13,000 reported electrical outages post-flooding with an estimated 140,000 consumers without electricity (Thompson et al., 2021). This was due to the storm and flooding itself taking out parts of the electric grid as well as trees knocking over electrical lines. Anyone who could

drive was doing so in flooded roads where most if not all stoplights and streetlights were out. The threshold for water that Detroit can handle is said to be 2 inches within a single event (Thompson et al., 2021). Anything above that starts to create serious problems. Detroit experienced 15.28 inches of rainfall through that summer while one single storm in July recorded 2.20 inches of rainfall and a group of storms in August recorded 2.73 inches of rainfall (Hicks, 2021)

There were two main water pump centers which were supposed to drain water out of the Detroit area and reduce the risk and harm of flooding: Freud and Conner Creek (MacDonald, 2021). Each pump center contained seven pumps (MacDonald, 2021). During the flooding in August, which was the most severe event, pumps were down at both stations due to electrical outage issues: only three out of seven were working at Freud and only five out of seven were working at Conner Creek (MacDonald, 2021). The electricity problems were due to inconsistent service by the provider at the time, Detroit's Public Lighting Department (Dickson, 2022). During the flooding in June, key pump stations on the eastside failed due to electrical outages (MacDonald, 2021). The failure of these pump stations was believed to have played a role in the damage and harm caused by the severe rain and flooding, but it was not the only factor at play (MacDonald, 2021). Experts said that the failure of the pump stations increased the depth and duration of the flooding in residential areas, but there would have been flood damage to the basements of houses either way (MacDonald, 2021). The Great Lakes Water Authority (GLWA) claimed that the flood system "is working as designed and is in dry weather conditions, and currently has capacity to handle the expected flows into the system. In anticipation of the severe weather, GLWA has staffed accordingly" (Thompson et al., 2021). GLWA released this statement following criticism regarding the severe flooding in August. GLWA did later

acknowledge the electricity failure at the key pump stations but said no more about the August flooding (MacDonald, 2021).

Figure 1

Conner Creek Pump Station

Dado, N. (2021). *Why Detroit keeps flooding: Inside look at Conner Creek Pump Station* [Photograph]. Click On Detroit. https://www.clickondetroit.com/news/local/2021/08/30/an-inside-look-at-conner-creek-pump-station-and-why-flooding-continues-in-detroit/

The harm to Detroit residents did not stop at the flooding events. Following the flooding in June, metro Detroit experienced a hike in water prices. Almost all areas experienced water price increases above 1.5% and some reached close to 10% following the June flooding (Dickson, 2021). Highland Park is only raising its fixed base rate by 1.5% (Dickson, 2021).

Speaking on this, Highland Park Mayor Hubert Yopp said, “You’ve got to think about the residents you’re taking that money from… (A price hike) is not what our community needs” (Dickson, 2021). Highland Park was a rare case, and many other places implemented higher price hikes. The spokesperson for Detroit Water and Sewage Department, Bryan Peckinpaugh, explained the water price increases by saying that the increase is “based on the annual volume to manage and treat the stormwater and pay down the debt on the nine wet weather treatment facilities" (Dickson, 2021). Detroit residents had to pay for water repairs due to the flooding and then had to pay more because the water system couldn’t handle the rainfall, adding onto the harm they experienced.

Lake Mead-Hoover Dam Drought

Lake Mead was formed when the Hoover Dam was constructed within Nevada and Arizona in 1936 (Bureau of Reclamation, n.d.). The Colorado River feeds Lake Mead, which then flows through the Hoover Dam. The water of Lake Mead has continued to reach concerning levels as evaporation rates increase as temperatures rise due to climate change (Center for Science Education, n.d.). In June 2021, the water in the lake was recorded at 1071.56 feet, its lowest level yet, dropping 140 feet over the last 20 years (Yetikyel, 2021). By May 7th of 2022, Lake Mead reached just below 1054 feet (Los Angeles Times, 2022). The declination of the water level of Lake Mead was found to be directly connected to rising temperatures due to climate change (Los Angeles Times, 2022). The water level dropped so low that a body in a barrel was discovered at the bottom of Lake Mead (Press, 2022).

The declining water level of Lake Mead led to reduced electricity generation by the Hoover Dam, which Lake Mead flows through. With Lake Mead at full capacity, the Hoover Dam can produce 2,074 megawatts of electricity, which is enough electricity for about one

million residents, sending it to Arizona, California, Nevada, Colorado, Nebraska, New Mexico, Utah, and Wyoming, though the majority of the electricity goes to Arizona, California, and Nevada (Yost, 2021; Jenkinson, 2021). At full capacity, the Hoover Dam services about two percent of the populations of those three main states receiving its electricity (U.S. Census Bureau quickfacts: United States, n.d.). Due to the declining water levels, however, the dam was only producing electricity at 66% efficiency, requiring substitutional electricity generation for hundreds of thousands of people (Yost, 2021). This reduction in hydroelectricity created issues for the electric grid in this area. According to John Moura of the North American Electric Reliability Corporation (NERC), when electricity consumption was at its highest, or as the solar generation output was reduced closer to the evening hours, there were vulnerable points arising with the lower hydroelectricity generation (Yost, 2021). The NERC put California in the 'high risk' category for electricity outages during the summer as the electricity consumption increased and the Lake Mead water level was expected to lower further (Yost, 2021).

To slow the declining water levels, Arizona, California, Colorado, New Mexico, Nevada, Utah, and Wyoming attempted to reduce water consumption from Lake Mead and the Colorado River (Snider, 2022). In August of 2021, the federal government issued a water shortage declaration on the Colorado river (City of Las Vegas, n.d.). Lake Mead supplied electricity and water to 25 million people (Yetikyel, 2021) and 4.5 million acres of farmland used the Colorado River for agriculture (Yetikyel, 2021). These water cuts to prevent further loss of water to Lake Mead affected millions of people in many ways. Las Vegas obtained 90% of its drinking water from Lake Mead (Yetikyel, 2021). States were attempting to refill Lake Mead through these water cuts. As of May in 2022, California had stored 1.3 million acre-feet in Mead, and planned to take out about 250,000 acre-feet of that water this year to help with the current drought (Los

Angeles Times, 2022). Customers were also being asked to increase water conservation in 2022 (Los Angeles Times, 2022). Despite these efforts, it was expected that more water will be taken out of the Colorado River and Lake Mead because it was so dry this year (Los Angeles Times, 2022). The drought in this area and water scarcity were also amplified by wildfires that were occurring in the West (Yetikyel, 2021). Water was needed to fight fires which are worse in times of drought, but water was also a scarce resource when the drought was happening, which made the situation much more difficult to handle. California didn't even have enough water to meet the demands of six million people living in the State Water Project dependent areas (Elam, 2022). These water cuts were made with the hope of increasing water supply in the future, but the water needs of people in the present time weren't being met while the cuts are occurring.

Money was being paid to residents of Arizona to reduce their water use in attempt to refill the Lake Mead reservoirs. In an interview with Tom Buschatzke, Director of the Arizona Department of Water Resources, he discussed water cuts stating,

> "…in the short term, we probably got to pay people. In the long term, paying people forever is not sustainable. Even $4 billion, which is a crazy big number, amount of money probably won't last forever. What we don't want and I stated this publicly in various places, we don't want an outcome in which we've created these temporary reductions of use through payment, the money runs out and you don't have a permanent solution" (T. Buschatzke, personal communication, October 5, 2022.

It came up in multiple interviews that paying money to fix or stall a situation from getting worse will cause more issues to arise, and that acting before a problem occurs is the only way to stop or prevent it. Buschatzke also discussed the decline in hydroelectricity production from the dams by saying,

> "The grid is certainly weaker because of it. Glen Canyon Dam is a key infrastructure component... So if you have a brownout or a blackout on the grid, and you got to start it up again. Hydro power is one of those things that gets the grid, gets the electrons moving again. That's a huge concern for all of us. We know that the cost of power across the grid has gone up because of the reduction again, hydropower generation" (T. Buschatzke, personal communication, October 5, 2022).

Current solutions to pay people are temporary and expensive. Eventually the money will run out and there will be even less water and electricity generation to work with to create effective solutions. People will have less drinking water and there won't be water for the large agriculture economy in this area. People will have less air conditioning or none at all. If sustainable and impactful solutions are not acted upon soon, entire societies living on the Hoover Dam-Lake Mead system could collapse.

Kentucky Tornadoes

Kentucky experienced an outbreak of tornadoes at the end of 2021. Tornadoes are unusual in cooler months such as November or December, but as the temperature increased due to climate change, the conditions were becoming more fitting for tornadoes (Person & Orr, 2021). Hundreds of thousands of people were without electricity due to these tornadoes and nearly 99,000 of them, the most in any of the states affected, were in Kentucky (Person & Orr, 2021). It was estimated that the tornadoes destroyed at least one thousand homes in Kentucky (Robertson & Rojas, 2022). The entire structure damage in Kentucky was calculated at fifteen thousand buildings and that came from an early report. That number was expected to be higher after later reports were conducted (Robertson & Rojas, 2022). The tornadoes also caused at least 57 deaths and over 500 injuries in Kentucky (US Department of Commerce, 2022).

The Federal Emergency Management Agency (FEMA) came under scrutiny for its inadequate response to the tornadoes in Kentucky. 11,800 people in Kentucky who were affected by the tornadoes requested assistance from FEMA within the first six weeks after the tornadoes hit, but only 14% of them were approved aid (Ryan, 2022). Over 4,300 people were deemed as ineligible for housing assistance after the tornado because they missed or couldn't be contacted for an inspection, according to FEMA data (Ryan, 2022). Almost 200 of these applicants were turned down because those individuals could not verify their identity or address, or that they owned the damaged property (Ryan, 2022). 3,000 people from Kentucky's requests for aid were denied because they had insurance coverage (Ryan, 2022). After being denied aid, FEMA directed some people to take out a small business loan (Ryan, 2022). FEMA did provide tens of millions of dollars in support, but there were many cases where people did not receive the aid they needed.

The preparation prior to the tornadoes and the response afterward were important to note. In response to the destruction of an Amazon warehouse where nobody was killed in the collapse, the governor or Kentucky said it would be: "the Christmas miracle we hope for," referring to no deaths occurring, but not commenting on the harm to people that could have been caused in that situation (Robertson & Rojas, 2022). There was little focus on why the destruction happened and most of the attention was claiming influence beyond human reach. The preparation and response protocol to tornadoes in Kentucky also reflected this belief. According to the state of Kentucky's mitigations plan, nothing was considered safe when a tornado struck and it was claimed that not much could be done (Ryan, 2021). The plan specifically stated that "any area in the county is as vulnerable as another and the events are completely random and unpredictable" (Ryan, 2021). Kentucky had no plan of prevention and was not attempting to put one into place. The current

understanding of the tornadoes by those in positions of power in Kentucky was that they are unpredictable, and that vulnerability was unforeseeable. This then led to no actions being taken to build prevention or mitigation. According to University of Kentucky Hazard Mitigation Grants Program and National Weather Service, the warning system for tornadoes in Kentucky was stated as:

> "rather than consider the probability of the conditions becoming right for a severe thunderstorm or tornado given a state of nature, it might be more informative to consider the probability of a severe thunderstorm or tornado occurring given that the conditions already are present" (Kentucky Emergency Management, n.d.).

Kentucky Emergency Management agency designed the warning system to release a warning after the conditions were right for a tornado to form, rather than anticipating the possibility of one forming and putting out warning before it struck.

In an interview conducted with Simone Domingue, a postdoctoral research fellow at Oklahoma University, she explained the difficulty that communities currently have with recovering from disasters and building their own resiliency. "So there's… cases where I think a lot of communities know what they need. And so a lot of that… decision making, and planning can happen at a local level. But they also need access to resources and need access to entities that can coordinate and have authority to do things because… communities, they may have no power to do certain things" (S. Domingue). This concept of communities knowing their needs but requiring resources to act came up in multiple interviews.

People within FEMA hold a different perspective on FEMA's responsibilities and agenda. In an interview with Meghan Luke, the Branch Chief for the Communications and

Culture Branch at FEMA, she explained the struggles that FEMA faces due to its actual purpose and capability not matching public perceptions and expectations:

> "I think what is confusing to the general public is the role we provide during a response. We are not a first responder. We are there to support the state with emergency management support and coordinate the federal response of the disaster. The state is in charge of making certain decisions during an operational response, but we can provide federal assets, such as our federal urban search and rescue teams, and manage the federal response" (M. Luke, personal communication, October 1, 2022).

The expectation for FEMA to swoop in and solve everything after a disaster is unrealistic; that's not FEMA's purpose. Luke dove into FEMA's role and obstacles further by saying, "The biggest challenge is coordination and cross-collaboration. During a disaster, as you can imagine, there's a lot of coordination with a lot of federal, state, nonprofits, and local partners that are all getting situational awareness of what's going on on the ground" (M. Luke, personal communication, October 1, 2022). The barriers existing within communication among many groups and varying scales of operation came up in multiple interviews.

Texas Electricity Outage

Texas had a serious electricity outage in February of 2021 following a winter storm. The massive outages came from a combination of the storm itself and the electrical grid system in the state of Texas. The Texas electrical system, which ran on natural gas, did not have the infrastructure to keep each part the grid stable and running in low temperatures with snow and ice, causing less natural gas extraction and, therefore, less electricity production (Cai et al., 2022). Organizations overseeing the grid did not prepare a proper response in case strain was put

on the grid (Cai et al., 2022). As the electricity production faltered, the electrical grid collapsed upon itself. This disaster was not a single event, but instead was a buildup, starting almost two decades before the actual electrical system failure.

In the early 2000's, Texas deregulated the electricity market, which made it easier to electrify the production of natural gas (Douglas, 2021). This created a dual reliance on electricity and natural gas creating a loop electrical system rather than a chain system. If either natural gas or electricity faltered, the other was likely to fail as well. Each part of the system was managed by a different entity. The Texas Railroad Commission supervised natural gas production while the electricity grid was managed by the Public Utility Commission and the Electric Reliability Council of Texas (ERCOT). At the beginning of the system, natural gas is produced, it is then sent to electrical plants as well as gas processing plants (Cai et al., 2022). The electrical plants produce electricity that is sent through the grid to people's homes and other buildings, as well as to the gas processing plants to run them (Cai et al., 2022) The gas processing plants send gas to local gas companies (Cai et al., 2022). If natural gas production falters at the beginning of the system, electricity production lessens and then the whole electrical grid system is at risk.

When the winter storm hit in February of 2021, the cold and other effects of the storm disrupted natural gas and electricity production that flowed through the electrical grid in Texas. Natural gas wells were unable to produce as much natural gas because of freezing conditions from the storm (Cai et al., 2022). The storm also hindered natural gas producers from delivering the gas to the electrical plants, which needed it to produce electricity (Cai et al., 2022). More than 9,000 megawatts of electrical outages were caused by electrical plants not getting enough natural gas, which is enough to electricity roughly 1.5 million homes (Douglas, 2021; Green Energy Institute, 2014). At this point, there was less electricity available than there was demand,

so the ERCOT ordered utility companies to make electricity cuts or else a large blackout would occur, which would crush the entire natural gas and electricity systems (Cai et al., 2022). An additional 20,000 megawatts of electricity were ordered to be cut offline by ERCOT (Douglas, 2021).

Some of the buildings that shut down when the electricity was cut off were natural gas facilities (Douglas, 2021). Once the electricity was cut to them, they couldn't produce any more natural gas which meant that electrical plants weren't producing as much electricity. Through the attempt of lowering electricity demand to stabilize the grid, electricity and gas supply were decreased which made the grid more unstable rather than stable. These natural gas facilities were cut off from electricity because they weren't on the critical structure list for buildings in the system that were the most important (Douglas, 2021). Only 35 of the critical structures were natural gas facilities that deliver fuel to electricity plants (Douglas, 2021). During legislative hearings, the natural gas companies said they didn't fill out the appropriate forms because they either didn't know the form ensured their electricity would be kept on or they didn't know the form existed (Douglas, 2021). After the storm and outages, and additional 168 natural gas facilities were added to the critical facilities list (Douglas, 2021).

In an interview with Mitchell Ferman, a journalist with the Texas Tribune, he provided insight into the issues leading up to the storm. According to him, a significant number of power plants, "weren't properly weatherized, like prepared for extreme winter weather, same with the gas sites, the natural gas… producers were also not prepared for this kind of weather" (M. Ferman, personal communication, September 28, 2022). Many interviewees noted that electrical systems were not prepared for extreme weather caused by climate change. Ferman also discussed

the issues with Texas agendas and how that affected the set up and operation of the electrical grid:

> "Texas has long championed this approach of… cheap power first, reliability second. And so… the market signals to power generators that… when there's enough supply, then they don't need to be online, because then they won't be making money. And so that's how the market has gone for 20 plus years. And it's like mostly been fine… until it wasn't" (M. Ferman, personal communication, September 28, 2022).

The electrical grid is tied into the Texas economy and political sphere, shaping how it operates and what the priorities are, cheap electricity over system reliability. Ferman also discussed how politics played a large role in this event: "immediately… the Governor was… trying to clamp down so he basically started getting super involved to a point where… a politician never has done before. And he really was controlling… ERCOT's public communications. He was controlling… information that was released publicly about the grid… really getting in the weeds with grid stuff. That was pretty unprecedented. He was getting involved in the CEO search for ERCOT like… it's not even a state agency. Like I said, you know, it's like removed. And so that part is really important... the politics really… has influenced stuff here" (M. Ferman, personal communication, September 28, 2022). Ferman spoke directly on the targeting of renewable electricity, by people such as Governor Abbott, even though it was not the problem, by saying "They were like proposing legislation to target renewables, like they were trying to a big part of this whole thing is that in Texas, oil and gas is massive. It's a huge, you know, it's intertwined with the state's economy tightly and the industry funds a lot of political campaigns" (M. Ferman, personal communication, September 28, 2022). Texas government members were trying to blame renewable electricity sources and use the failure of

natural gas as a reason to continue using fossil fuels. The way that Texas operated before the storm and how its leaders responded after the storm were greatly driven by political values and governmental power structures within the state.

Hurricane Ida

Hurricane Ida struck Louisiana and Mississippi as well as some northeastern parts of the United States in 2021. Hurricane Ida was identified 48 hours before genesis (National Hurricane Center Tropical Cyclone Report: Hurricane Ida, 2021). It was moved to a medium category 24 hours before genesis and up to a high category storm 6 hours before genesis (National Hurricane Center Tropical Cyclone Report: Hurricane Ida, 2021). Ida formed near the end of August and struck Louisiana on August 29th (US Department of Commerce, 2022). It reached category 4 status, the second strongest category, quickly with winds reaching up to 150 miles per hour (US Department of Commerce, 2022). Hurricane Ida's storm surged reached up to heights of 12 feet (Bittle, 2021).

After Hurricane Katrina, the federal government spent $14.5 billion to enhance the storm surge and flooding protection around New Orleans (Jiménez et al., 2022). This included a 130-mile-long ring around the city that stood 30 feet high with goals of protecting New Orleans from any storm surge and flooding that could come from a possible hurricane in the future (Jiménez et al., 2022). These protection systems held strong against Hurricane Ida, through which New Orleans experienced minimal damage or harm, especially compared to the onslaught that Hurricane Katrina unleashed on the city 16 years earlier (Jiménez et al., 2022). Some streets were flooded however, and more than a million people were left without electricity (Jiménez et al., 2022). The areas around New Orleans experienced much greater damage. One of the most notable cases during and after Hurricane Ida was the town of Lafitte, just south of New Orleans.

The town had seven-foot-tall surge walls which were ineffective against the twelve-foot-tall storm surge of Hurricane Ida (Bittle, 2021). Almost the entire city was swallowed with water. Much of the focus after Hurricane Ida was on New Orleans rather than areas around the city which had less protection. John Bel Edwards, the Governor of Louisiana, stated that "If there's a silver lining, and today it's kind of hard to see that, it is that our levee systems really did perform extremely well" (Jiménez et al., 2022). Some claim that the worst damage had been averted due to the existing flood walls around New Orleans (Bittle, 2021).

There were many points of failure in the hurricane prevention and response system that faltered or collapsed in the case of Hurricane Ida. The storm was only identified as a possible serious problem six hours before it formed, leaving a small window for action before it struck (National Hurricane Center Tropical Cyclone Report: Hurricane Ida, 2021). Many walls built to protect areas from hurricanes were also overestimated in their ability to hold off storm surges. Engineers assumed that seven-foot-tall walls in places such as Lafitte would be enough to hold of the hurricane but estimations of the ability of the protection system were far beyond its actual ability (Bittle, 2021). The threat of hurricanes would only grow as sea levels continued to rise (Bittle, 2021). The city of New Orleans and the area around it were sinking into the Gulf of Mexico, which would only make things worse over time (Bittle, 2021).

In an interview performed with Sarah Babcock, Chief Administrative Assistant at Jefferson Parish, she discussed how to effectively build community resiliency:

> "…if we could raise wages, then people can afford cars to evacuate themselves, right?... if we could reduce gun violence, we would have fewer people handicapped to evacuate, right? If we could, you know, provide safe and affordable housing for people… then maybe their house can withstand a storm, or there would be housing for people to move

> into right and so I think it's really important often emergency management lives this totally separate life than those day to day struggles of people who are living in poverty and we need to… combine this and one of our arguments about improving people's lives needs to be that we're spending billions and billions of dollars to rescue them in an emergency right?" (S. Babcock, personal communication, September 16, 2022).

Community needs should be met at all times, and if that's done, people will be more resilient. Babcock further discusses the struggles for people who don't have resources and social networks as well as showing the financial benefit to building resiliency:

> "Because those of us who can afford safe and affordable housing and who have a car and have family connections and friends and support networks outside of our neighborhood, we don't often need the same level of support that the people who are going to be living in a FEMA trailer for three years are going to have and so we need to focus on… fixing the rest of this right…We don't have money to give people to raise wages, but we're spending that money it's just on the back end, in the most expensive way to spend that money" (S. Babcock, September 16, 2022).

The benefit of spending money on resiliency rather than on cleaning up a disaster was brought up in multiple interviews.

New Mexico Wildfire

New Mexico was battling wildfires that were believed to have started on April 6 of 2022 (BBC News, 2022). They were believed to have started from a preventative fire initiated by the U.S. Forest Service which then grew out of control (BBC News, 2022). Two fires grew out of this prescribed burn: the Hermits Peak Fire and the Calf Canyon Fire (BBC News, 2022). They

joined other active fires and burned more than 250,000 acres of forest (BBC News, 2022). As of May 2022, wildfires had burned 78% more acres than the 10-year average (The White House, 2022). Electricity and internet had been out for many in the area of the fires making it difficult for people to keep updated on what was happening and to make contact for help (Nott, 2022).

Both the Hermits Peak Fire and the Calf Canyon Fire were believed to have started from a prescribed burn by the U.S. Forest service which took place on April 6th (BBC News, 2022). It grew out of control and continued to burn until it spread hundreds of thousands of acres (BBC News, 2022). Many were concerned and critical as to why the burn occurred in a very dry season for fires in the western United States. The Governor of New Mexico, Michelle Lujan Grisham, said "It's negligent to consider a prescribed burn in the windy season in a state that is under an extreme drought warning" (U.S. News: A World Report, 2022). Governor Lujan Grisham was pushing for the federal government to accept significant liability for the fires that had occurred (U.S. News: A World Report, 2022). In response to these actions by Governor Lujan Grisham, U.S. Forest officials claimed that the prescribed burn occurred in acceptable weather conditions but did not released documents on the prescribed fire (U.S. News: A World Report, 2022).

Wind conditions also caused issues. Since the fires started, winds reached up to speeds of 50 miles per hour (Environmental News, 2022). It is likely that high wind speeds played a role in the prescribed burns getting out of control and turning into raging forest fires (BBC News, 2022). As the fires grew larger, the wind played a more impactful role in helping it spread and burn more land. Early in May of 2022, the fires jumped a highway, most likely due to high winds blowing them over to the other side (Environmental News, 2022). The winds also affected the ability of New Mexico to fight the fires. With winds getting as high as 50 miles per hour, helicopters and aircraft couldn't be sent into the air to make dumping runs on the fires

(NBCUniversal News Group, 2022). This required all firefighting to occur on the ground and greatly inhibited firefighters from building in fire breaks and gaining ground on the fires (Environmental News, 2022). The New Mexico National Guard hauled in over 100,000 gallons of water to firefighters on the ground (Nott, 2022).

Conclusions and Recommendations

Research in phases 1 and 2 showed the vulnerability of communities to disasters was constructed through an inability to access important resources and infrastructure, a weak network between federal and local governments and organizations, the inability of communities to make decisions that impact them, and location vulnerability being constructed by unsustainable electricity systems that collapse under stress. Phase 2 research, which brought in interview data, revealed a fourth category, underscoring the influence that both federal and local policies have to either enable or restrict disaster resilience actions to be taken.

There were three categories of interest among these six sites that increased the vulnerability of the populations to a disaster during phase 1 research. The first category was the electrical problems that occurred at every single disaster site in the research project. This involved electricity production falters or failures and collapses of electrical grids. These problems came from the placement of electrical systems, how they were designed and implemented, and the sources that were used to generate electricity. The second category was the failure of city leaders and local and state governments to understand that extreme weather is the new normal in the current and future states of climate change and as such, we must build up communities and locations accordingly. Cities and decision makers were unprepared for the possibility of disasters and how to manage and support the community before, during, and after they occurred. This led to large amounts of pressure being put on FEMA and the federal

government as a whole to contain, cleanup, and rebuild every single disaster and location. FEMA and the federal government are necessary, but a better connection and relationship needs to be built with local communities and organizations to involve them so that FEMA's resources and infrastructure are being utilized, but it isn't being spread too thin. The third category of interest was the issue of intranational climate refugees, which are people who must move to somewhere else within their own country because of their current location being unlivable due to a disaster or other event influenced by climate change (Podesta, 2022). Responses to disasters assumed that places affected would soon be inhabitable by the communities who lived there post-disaster. There are some places that were unlivable for a very long period of time, some of them being over a year and possibly reaching closer to 2 years and then the recovery and rebuild time needs to be considered (Wildfire actions, 2022). FEMA at times provides temporary housing for up to 18 months, but that is not consistent across every disaster (FEMA.gov, n.d.). Response plans did not account for that time component, and many people had to pay for temporary housing on their own and had to move far away. Other places were rebuilt only to just be hit again by another disaster. This discussion isn't happening much now, but it is likely to become a significant discussion topic within a few decades. I will expand on these three categories of interest below.

The first category of interest, which focuses on electricity, has opportunities for changes and improvements to raise the resiliency of the communities located at each site, and other vulnerable sites outside of this project. One change is to move utilities underground. Moving utilities underground protects electrical grids from being disrupted or shut down by weather events (McNabb, 2022). There is more stability to electrical systems because moving utilities underground protects them against every possible disaster. Pacific Gas & Electric (PG&E) has announced plans to bury 10,000 miles of electrical lines in wildfire-prone areas of California

(McNabb, 2022). Wildfires, hurricanes, tornadoes, and snow and ice storms all strike electrical lines when they are above ground. Moving them underground will protect them within fortified tunnels which are more resistant to these types of weather events (McNabb, 2022). It is expensive and difficult to move electrical lines underground, meaning that it is not to solution for all locations or disaster events, but there are places where it can be extremely beneficial. A second change would be to switch electricity production to sustainable resources that aren't dependent on one another, rather than producing electricity from depleting, unstable, or inconsistent sources. Sustainable resources, such as solar or wind electricity, are much more reliable and stable compared to hydroelectricity in drought-prone areas or fossil fuels. Following the Texas power outage, "A federal study actually found that renewable sources outperformed fossil fuel production during the incident…"(Ballinger et al., 2022). In the midst of a serious snowstorm, renewable energy was able to produce more energy and stay more resilient than fossil fuels. Creating a system that doesn't have sources reliant on one another will also make electrical systems more stable; if one electricity source falters, the another will be able to make up for it, rather than requiring each one to be performing perfectly to keep the other sources from failing. This is confirmed by the University of Calgary's Energy Education website where it says: "Having a diverse energy mix is usually considered an important part of energy security, having multiple sources allows a country to continue without disruption if one source of energy fails" (Energy diversification, n.d.). If energy diversity is important for a country, it is also important for any location vulnerable to experiencing a disaster.

Fossil fuels contribute to climate change which makes disasters worse, and water is a depleting and rare resource. Switching away from fossil fuels will help prevent the global temperature from rising, making weather events stronger and more frequent. Renewable

electricity is also more resilient against disasters than fossil fuels (The optimist daily, 2022). Transitioning to renewable electricity will not just assist in decreasing the worsening of climate change, it will also make electricity sources and electrical systems more resilient. If electricity generation is based upon stable and independent sources, electricity systems would be much more resilient in the face of extreme weather events. A study published in 2022 found that using 100 percent renewable energy and renewable energy battery storage would eliminate blackouts in variable weather (Jacobson et al., 2022). Renewable energy has been found to both be better at keeping the energy system stable and to prevent blackouts from occurring in variable weather.

The second category of interest, focused on preparation and response by cities and communities, can be improved by implementing and emphasizing local and state level disaster preparation and response. Every site within this study had some form of a climate action plan in place, but they were not far along with acting on them. The next step is to implement that plan in an effective way. The Detroit climate action plan acknowledged equitability and resiliency but didn't specifically talk about empowering communities to be involved in resiliency work (Sustainability action agenda, n.d.). Nevada mentioned working with communities to raise resiliency, but didn't mention the scale of work, which was important in the case of the Hoover Dam drought (Climate Action NV, 2020; Clark County, n.d.). Arizona mentioned working with Native American tribes, but there was not mention of resiliency or working with other communities (Maurer, n.d.). Kentucky discussed inclusion and working with communities, but there was not a specific focus on resiliency (Ky Conservation Committee, n.d.). Texas had no mention of resiliency in its climate action plan (Environmental policy in Texas, n.d.). The state also put in a law that prevents any cities from banning natural gas as a fuel source (Douglas, 2021). Louisiana's climate action plan mentioned accountability as well as collaboration and

partnership but was not specific in how those would be achieved (Climate initiatives task force, n.d.). Mississippi's climate action plan contained little to no involvement with communities and no mention of resiliency (MDEQ, n.d.). New Mexico did have an entire section on climate resiliency, identified vulnerable parts of the state, and focused on working with communities (New Mexico Climate Action Plan, 2022). These climate action plans are important to acknowledge because most of them do not fully discuss or act upon understanding vulnerability and building up resiliency through working with local communities. If these plans, which are supposed to guide resiliency efforts, have little to no mention of resiliency or working with communities, it is likely that efforts will be limited if not failing. One specific climate plan to note is that of Texas, which does not mention resiliency and even works to maintain fossil fuels as main energy sources. Climate action plans do not determine the success or failure of resiliency efforts, but they do reveal and help build the foundation for these actions to be taken and achieved. A solid climate action plan with mentions of resiliency and working with communities shows that a location is thinking seriously about these problems and trying to make positive changes.

Local organizations and offices focused on climate action and disaster response need to be present at vulnerable locations. Local offices and organizations are better able to work at local scales, which allow for collaboration with communities and being able to identify small details that larger organizations, such as FEMA, may miss. The advantage that FEMA has comes in its financial, technological, and logistical resources and expertise, so if local disaster preparation and response organizations were provided resources from organizations such as FEMA, local organizations would be better equipped to help the communities near them, resulting in a decreased burden on FEMA. As climate change makes extreme weather more common, there

will be disasters occurring in many places, and communities and locations need to be built to withstand them. The local community level allows for preparations to be made where they are most needed, because local organizations would have that local knowledge, and because they are already at the site, the response would be much more effective rather than waiting for FEMA to arrive. The local level allows for preparation and effective planning in the places where it is needed most (GovPilot, n.d.). Local leaders and community members are already on the ground and connected when a disaster occurs. This allows them to better assess the needs of the community and location both during and after the disaster occurred to improve recovery (GovPilot, n.d.).

Social justice and equity will be better achieved through a synergistic network between federal and local organizations and communities. Many of the disaster sites had high racial minority populations, especially of African Americans, and high poverty rates (Appendix A). People and organizations working within a city or state are more connected to these issues and can better act with them in mind, in comparison to a federal--level organization. Local connections and roots strengthen ideas of social justice and is a better scale at which to act upon those values. In Detroit, 78.33% of the population was Black or African American, Louisiana's was 31.4% and Mississippi's was 36.3% (Appendix A). The disaster locations had poverty rates ranging from 12.5% to 33.2%, all higher than the national average, which is 11.4% (Appendix A, Bureau, 2022). These communities and individuals had fewer resources to prepare and recover from disasters. At sites such as Detroit, Louisiana, and Mississippi, the African American populations were disproportionately affected by the disasters (Beech, 2020). Each of these communities is vulnerable and affected in a different way based upon where they are located and the social factors that shape their vulnerability or resiliency. Large organizations such as FEMA,

struggle to understand and best act upon the needs of all the communities they work with across the United States, but they have the resources and infrastructure that local communities don't. The local level organizations at each site are best equipped and capable to understand the needs and vulnerability of the specific community located there, but need help from FEMA to support and raise the resiliency of those populations against possible disasters. If partnerships between FEMA and local communities are built, communities can voice their needs and play a role in building their own resiliency, but FEMA can also use it's resources and infrastructure more efficiently and provide its expertise to guide local communities on the right path.

The third category of interest considers intranational climate refugees and the ways in which a disaster affects where and how people live, as well as for how long. Climate refugees are usually considered as having to move from one country to another, but it is likely that intranational climate refugees will be just as much of an issue. There will be some places that will become unlivable for a certain period after a disaster, during which people would need temporary housing in new different locations (Wildfire actions, 2022). There are also some places that will no longer be livable at all, and entire communities will need to be relocated. Orrin Pilkey, a geoscientist scholar at Duke University, has been pushing for structures and communities to be pushed back from shorelines, relocating them to less vulnerable locations (Falling into the ocean, 2019). This could be an option for different communities depending on the disaster they are faced with. The decision in this case is whether to rebuild or relocate. The decision should be made on a disaster to disaster and community to community basis. Entire cities such as New Orleans can be relocated, but it would take large amounts of time and resources to physically move skyscrapers that could be spend elsewhere (Peter, 2021). During that city relocation period, individuals living there would be forced to create a new life

somewhere else and responsibility would be put on them, rather than on organizations which are supposed to be supporting those individuals. Smaller communities affected by fires that have been burning for multiple years may benefit more from relocation rather than waiting for the fires to go out near their homes. Both options need to be considered and acted upon in the right moments. Neither is the correct choice on its own, and both will be required to protect communities properly.

The interviews in phase 2 research confirmed the importance of two of these resiliency categories of interest while also pointing toward another category that was not proposed in the phase 1 section of the research. One resiliency category that was confirmed in the interviews was importance of making electrical systems more resilient. The two most prevalent proposals through the interviews were to transition to sustainable electricity systems that could remain stable and adapt to the change climates caused by global warming and to weatherize electrical systems, making them more resilient when faced with extreme weather. The second resiliency category that was confirmed through the interviews was community empowerment. It was emphasized in multiple interviews that communities know their own needs better than anyone else. What they need is the resources, power, and social space to build up their own resiliency to prevent a disaster, rather than relying on organizations such as FEMA to come in and help after the damage has already been done. The category of rebuilding versus relocating did not come up in the interviews frequently enough to be significant. This concept not coming up in the interviews, while being significant in phase 1 research, means that discussions regarding rebuilding versus relocating are not happening now, but they are very likely to occur in the coming decades. A third category of importance raised by multiple interviewees was the potential for support or harm that the political sphere at federal, state, and local levels has on

policies affecting resiliency and vulnerability of communities and locations, the resources communities have access to, the power those communities can act with, and what perceptions and responses there are to disasters. State and federal government policies, such as those with FEMA, are focused on reacting to disasters, and then rebuilding. That needs to shift to resources being channeled through to communities so that they can build their own resiliency, proactively mitigating harm from disasters rather than responding after disasters occur. State and federal governments need to be putting forth the resources to transition electricity systems to become more sustainable and resilient against extreme weather. The political decisions made surrounding disasters has a large impact on the vulnerability and resiliency of communities and locations, influencing the agency and scale of resiliency efforts within these areas.

A transition and focus on sustainable sources will make electrical systems more resilient. Preparation and action on local and community levels and understanding the problem of intranational climate refugees will help involve the right people in decision making and actions regarding resiliency. These are all necessary to create more resilient locations and communities against current and future weather events and possible disasters. Each of these recommendation highlights weaknesses among a diverse group of disaster sites and proposes solutions that can be applied and carried at multiple different locations. By implementing these findings and recommendations, disasters can be mitigated, protecting communities, and possibly completely prevented moving forward.

Future Research

Disasters are defined by how they impact and harm vulnerable communities and locations. This research revealed that the vulnerability of communities and locations to disasters was shaped through a lack of resources and networks, electricity systems based on unsustainable

sources and sources that can falter simultaneously, and that policies and political responses are influential in shaping disaster response and either supporting or restricting resiliency efforts. Phase 1 of this research, which involved analyzing journal articles and government documents, revealed that making electricity systems more resilient and building networks of local community members, state organizations, and federal organizations will make communities and locations more resilient. Phase 2 of this research, derived from interviews with people connected to the disaster sites, reemphasized these two points, while also revealing how influential policies and the political realm at federal and state levels can be for resiliency efforts, either assisting or working against them. An area that came up in phase 1 research, but not in phase 2 was the idea of rebuilding or relocating after a disaster. Since it did not come up in the interviews, this may not be a serious discussion currently among people working with disasters, but it may become more prevalent in the coming years. By better understanding the constructed vulnerability of these disaster sites, and putting together categories for building resiliency, the damage and harm caused from potential future disasters could be lessened, and possibly prevented entirely.

While this research has provided themes and recommendation, further research is required to glean feedback from those directly involved or impacted by the disaster. Three recommendations include conducting more interviews, the inclusion of more sites, and applying these recommendations to an additional site. Conducting more interviews would help provide more information about what happened and the chosen disaster sites and how communities were affected. People's experiences and perspectives hold a lot of value and insight into harms and experiences during and after disasters strike. Obtaining more of those experiences would strengthen recommendations of how to build resiliency of local populations. The second direction this research could take is to study more disaster sites. This could be locations that

experienced similar types of weather events to those studied in this project, or different types of disasters entirely. More information both in terms of different disasters and being able to draw comparisons and differences between similar sites will strengthen recommendations to raise the resiliency of communities. The last direction of this research that could be taken is to apply these findings and recommendations to a specific site, such as Indianapolis, and work with decisionmakers to implement these recommendations at a live location to raise the resiliency in the current moment and going forward. Taking these concepts and recommendations from this research and using them to better understand one location and make it more resilient based upon its needs and the needs of the population there will put these ideas into action.

Appendix A

Demographics Data Table 1

Disaster Site Demographics Information	Race	Poverty Rate	Climate Action Plan?	Resiliency or Vulnerability Mentioned?
Detroit Flooding 2021	78.33% Black or African American, 14.70% White, 6.97% other	33.20%	Yes.	Yes.
Lake Mead-Hoover Dam Drought 2021-2022	**AZ**: 60.4% White and 4.7% Black **NV**: 51.2% White and 9.8% Black	**AZ**: 12.8% **NV**: 12.5%	**AZ**: Yes. **NV**: Yes	**AZ**: No. **NV**: Yes.
Kentucky Tornadoes 2021	82.4% White and 8% Black	14.90%	Yes.	No.
Texas Power Outage 2021	50.1% White and 12.2% Black	13.40%	Yes.	No.
Hurricane Ida 2021	**LA**: 57.1% White and 31.4% Black **MS**: 56.0% White and 36.6% Black	**LA**: 17.8% **MS**: 18.7%	**LA**: Yes. **MS**: Yes.	**LA**: No. **MS**: No.
New Mexico Wildfire 2022	51% White and 2.2% Black	16.80%	Yes.	Yes.

Note. Data for Detroit political information is from *The six political states of Michigan,* by Weigel, 2020. Data for Detroit religious information is from Pew Research Center, by Pew Research Center's Religion & Public Life Project, 2022. Data for Detroit age information is from Detroit, Michigan population 2022, by Detroit, Michigan Population 2022 (Demographics,

Maps, Graphs), n.d. Data for Detroit racial information is from Detroit, Michigan population 2022, by Detroit, Michigan Population 2022 (Demographics, Maps, Graphs), n.d. Data for Detroit poverty information is from U.S. Census Bureau quickfacts, by U.S. Census Bureau quickfacts: Detroit City, Michigan, n.d. Data for Detroit climate action plan and resiliency and vulnerability information are from *Sustainability action agenda* by City of Detroit, n.d. Data for Lake Mead-Hoover Dam political information is from Politics & Voting in Las Vegas, Nevada by Politics & voting in Las Vegas, Nevada, n.d. and *Arizona still feels red as voters embrace a conservative shade of blue* by Schwarz, D. H., 2022. Data for Lake Mead-Hoover Dam religious information is from Pew Research Center, by Pew Research Center's Religion & Public Life Project, 2022. Data for Lake Mead-Hoover Dam age information is from *Arizona demographic statistics* by Infoplease, n.d., and *Nevada demographic statistics* by Infoplease, n.d. Data for Lake Mead-Hoover Dam racial information is from *mtgis* by Story map series, n.d. Data for Lake Mead-Hoover Dam poverty information is from United States Census Bureau by Saipe. n.d. Data for Lake Mead-Hoover Dam climate action plan and resiliency and vulnerability information are from *Arizona's Climate Change Action Plan* by Maurer, K., n.d. and *Introduction* by Climate Action NV, 2020. Data for Kentucky Tornadoes political information is from *Politics & voting in Kentucky* by Politics & Voting in Kentucky, n.d. Data for Kentucky Tornadoes religious information is from Pew Research Center, by Pew Research Center's Religion & Public Life Project, 2022. Data for Kentucky Tornadoes age information is from Bureau, U. S. C. by United States Census Bureau, n.d. Data for Kentucky Tornadoes racial information is from *mtgis* by Story map series, n.d. Data for Kentucky Tornadoes poverty information is from United States Census Bureau by Saipe. n.d. Data for Kentucky climate action plan and resiliency and vulnerability information are from *Climate action* by Ky Conservation Committee, n.d. Data for

Texas Electricity Outage political information is from *Politics & voting in Kentucky* by Politics & Voting in Kentucky, n.d. Data for Texas Electricity Outage religious information is from Pew Research Center, by Pew Research Center's Religion & Public Life Project, 2022. Data for Texas Electricity Outage age information is from Bureau, U. S. C. by United States Census Bureau, n.d. Data for Texas Electricity Outage racial information is from *mtgis* by Story map series, n.d. Data for Texas Electricity Outage poverty information is from United States Census Bureau by Saipe. n.d. Data for Texas Electricity Outage climate action plan and resiliency and vulnerability information are from *Ballotpedia* by Environmental policy in Texas. n.d. Data for Hurricane Ida political information is from *Politics & voting in Louisiana* by Politics & Voting in Louisiana, n.d. and *Politics & voting in Mississippi* by Politics & Voting in Mississippi, n.d. Data for Hurricane Ida religious information is from Pew Research Center, by Pew Research Center's Religion & Public Life Project, 2022. Data for Hurricane Ida age information is from Bureau, U. S. C. by United States Census Bureau, n.d. Data for Hurricane Ida racial information is from *mtgis* by Story map series, n.d. Data for Hurricane Ida poverty information is from United States Census Bureau by Saipe. n.d. Data for Hurricane Ida climate action plan and resiliency and vulnerability information are from *Official Seal of the State of Louisiana* by Climate initiatives task force, n.d. and *Protecting* by MDEQ, n.d. Data for New Mexico Wildfire political information is from *Politics & voting in New Mexico* by Politics & Voting in New Mexico, n.d. Data for New Mexico Wildfire religious information is from Pew Research Center, by Pew Research Center's Religion & Public Life Project, 2022. Data for New Mexico Wildfire age information is from Bureau, U. S. C. by United States Census Bureau, n.d. Data for New Mexico Wildfire racial information is from *mtgis* by Story map series, n.d. Data for New Mexico Wildfire poverty information is from United States Census Bureau by Saipe. n.d. Data for New

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