ADDRESSING EMERGENCY PREPAREDNESS INEQUALITY AT AN INDIVIDUAL SCALE: A CASE STUDY OF HURRICANE HARVEY

BY

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THESIS

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ABSTRACT

With the rise of the Anthropocene and man-made climate change, extreme weather events like ultra-destructive hurricanes are predicted to become more frequent and increasingly devastating. Hurricane Harvey was an event through which inequalities in emergency preparedness on an individual scale can be observed.

Data was collected through online surveys and measured the exposure of the individual to Hurricane Harvey, individual disruption to normalcy due to Hurricane Harvey, preparedness actions taken and their justification and also collected demographic information. Individuals in Houston who were impacted by Hurricane Harvey altered their emergency preparedness by acquiring relevant information and purchasing items to have on hand in case of emergency. Inequalities exist between income groups and racial/ethnic groups who reside within the same geographic region, with higher income and White non-Hispanic populations taking less emergency preparedness actions than low-income minority groups, largely because most participants who fell into the high-income majority category had already taken said emergency preparedness actions prior to Hurricane Harvey and therefore did not need to do so afterwards to prepare for the next major event. Low income and minority individuals took more emergency preparedness actions after Hurricane Harvey, but often low-cost ones. In all categories, and in all emergency preparedness actions, a vast majority of participants who did not take an action did not do so because they did not think these actions were necessary. This notion highlights the individual choices and opinions of people who are in an area that will likely be impacted by another major storm event, and why individual scale is important to address when searching for answers about where to begin changing a population’s emergency preparedness.
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# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>CHAPTER</th>
<th>TITLE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>THEORETICAL OVERVIEW</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td>CASE STUDY</td>
<td>13</td>
</tr>
<tr>
<td>4</td>
<td>METHODS</td>
<td>16</td>
</tr>
<tr>
<td>5</td>
<td>RESULTS</td>
<td>21</td>
</tr>
<tr>
<td>6</td>
<td>ANALYSIS</td>
<td>32</td>
</tr>
<tr>
<td>7</td>
<td>DISCUSSION</td>
<td>37</td>
</tr>
<tr>
<td>8</td>
<td>CONCLUSIONS AND LIMITATIONS</td>
<td>45</td>
</tr>
<tr>
<td></td>
<td>REFERENCES</td>
<td>49</td>
</tr>
<tr>
<td></td>
<td>APPENDIX: MAPS AND SURVEY QUESTIONS</td>
<td>55</td>
</tr>
</tbody>
</table>
CHAPTER 1: INTRODUCTION

Introduction

With the rise of the Anthropocene and man-made climate change, extreme weather events like ultra-destructive hurricanes are predicted to become more frequent and increasingly devastating. Since the 1980s, substantial increases in most measures of Atlantic hurricane activity have been observed, including increases in the intensity, duration, frequency and high wind speed of these storms (Bender et al 2010). The destructive nature of these weather events is a cause for concern for the growing population of coastal areas in the United States. According to a 2018 report from the United States Census Bureau, over 94 million people live in counties directly adjacent to the Atlantic Ocean, Pacific Ocean, or Gulf of Mexico. Of those 94 million, nearly 60 million live in the path of hurricanes, which leaves them exposed to varied levels of potential impact (US Census Bureau, 2018). The fallout from these events and the subsequent flooding affects the populations of these areas unevenly, with racial minorities and low-income populations historically bearing a disproportionate amount of risk and damage (Pulido, L. 2017).

In 2017, the four hurricanes that made landfall in the United States and the subsequent devastation caused by high winds, rain, and storm surges caused over 200 billion dollars’ worth of damage and led to the death of over 3,000 people (Craig 2018). As storms continue to get stronger and more frequent, more people from all backgrounds will be exposed to potential financial, physical and emotional damage.

Recent research on climate change adaptation analyzes how best to prepare vulnerable populations to mitigate the impacts of severe weather events. The concept of preparedness emphasizes the potential negative impacts of these events and the actions required by individuals
for mitigation. Preparedness is a measurement of the ability to mitigate the negative consequences of a disaster. In the case of recurrent ultra-destructive hurricanes, and for the purpose of this project, preparedness will be analyzed as a result of adaptation to a changing environment. In this context, the changing environment can be seen as a state of altered normalcy, where resources normally available are not accessible (electricity, water, etc.) and the physical environment has been disrupted (damage to buildings, inaccessibility of roads, etc.), as seen in areas affected by hurricanes. Throughout the literature surrounding this issue, there is a focus on communities, cities, or states as being sites of adaptation, and these are the scales that are used to measure resilience and preparedness and to determine necessary policy changes needed to increase these factors at the given scale (Fekete, A. et. Al. 2010) (Wisner, B., Luce, H.R. 1993.) Prior research does not focus on the individual scale of adaptation to an ultra-destructive hurricane threat; ignoring the individuals’ influence on the larger systems they are part of may overlook the actual sources of vulnerability, which may be caused by ineffective administrative solutions, as much as the storms themselves.

In this thesis, I will seek to understand human adaptation at an individual scale in the face of ultra-destructive hurricanes to better prepare for these events in the future and help reduce inequalities in preparedness and vulnerability to damage. I will do so by answering the following questions, 1) How do individuals alter their emergency preparedness after living through an ultra-destructive hurricane? 2) What inequalities exist in terms of these alterations across demographic groups within the same geographic region? To answer these questions, the case study uses a mixed methods approach to collect and analyze data on types of emergency preparedness actions taken by individuals who fit into a larger demographic category as well as why those actions were taken or not taken.
Hurricane Harvey, which made landfall in Texas on Friday, August 25th, 2017, was one of the most destructive tropical cyclones on record, a title it shares with 2005’s Hurricane Katrina (FEMA, 2018). Hurricane Harvey inflicted an estimated $125 billion dollars’ worth of damage along the Gulf Coast and most of this damage can be attributed to the unprecedented amount of flooding that occurred in the Houston, Texas area and much of southeast Texas (Zirogiannis, N. et al 2018). The slow movement of Hurricane Harvey once it made landfall caused a record amount of rain to fall on Harris County, where the city of Houston is located. This resulted in the rapid development of flash flooding that caused catastrophic drainage issues and river flooding (National Oceanic and Atmospheric Administration. 2017). During and after the storm, over 30% of Harris County was flooded. An estimated 209,422 homes in Houston were damaged, with half of the housing victims being renters, and 82 lives were lost (Fox, K. 2018) (Moravec, E. 2017). Climate scientists have since agreed that the uncharacteristically strong nature of Hurricane Harvey was due to anthropogenic climate change and estimated that rainfall from the hurricane was 38% higher than it would have been had there been no man-made changes to the climate (Trenberth et al. 2018.)

I chose to focus this project on the city of Houston due to its racial/ethnic diversity and inequality, as well as its geographic location near the Gulf Coast of the United States. Houston is one of the most racially/ethically diverse cities in the nation (refer to section 3 for racial/ethnic breakdown) and has a long history of both racial/ethnic inequality and income inequality, and these inequalities usually go hand in hand along majority/minority lines (Emerson, M. et. al. 2011). In Houston, the poverty rate is 20.6% (with 13% being the national average) and the poverty rate gap between White/Caucasian and Black/African American Houston residents is 16.4% (Olin, A. 2020). Additionally, I was born in Houston and lived most of my life in the area
and therefore have seen firsthand the destruction that is caused when hurricanes make landfall in this area. As a native Texan, I have always known the importance of hurricane preparedness and have witnessed the struggle that results from these storms when proper emergency preparedness actions have not been taken.
CHAPTER 2: THEORETICAL OVERVIEW

The proposed research is located within the climate change body of research and integrates concepts from the broader literatures of political ecology, sustainability, and inequalities of capitalism. One of the themes that is used from this wide range of literature is natural hazard and risk vulnerability and how the patterns of racial and financial inequality are amplified in natural hazard scenarios. With man-made climate change, natural hazards are occurring at an increasing rate, furthering vulnerability. Another theme that is pulled from the literature is the resilience of a social system or a population through the measurement of adaptive capacity and the factors that help and hinder resiliency.

Natural Hazard Risk & Vulnerability

Within the research surrounding natural disasters like hurricanes and the populations these events affect, distinct patterns of differences in both risk and vulnerability have been observed in terms of likelihood of exposure to the risks associated with a natural disaster. Patterns of inequality have also been observed in terms of the amount of damage inflicted from a natural disaster, and these inequalities have been identified using the concept of social vulnerability. Since the emergence of vulnerability in disaster discourse, disasters triggered by natural hazards have been seen as unnatural occurrences that are brought about by a confluence of societal factors along with the natural hazards themselves (Westen et al 2009). These societal factors include historical patterns that are the result of larger systems of oppression, inequality and racism. The vulnerable populations in these areas are made up largely of people who historically have no voice and are largely ignored on the individual scale (Dercon, 2002).
According to S. Cutter’s 2008 article, social vulnerability identifies sensitive populations that may be less likely to respond to, cope with, or recover from natural disasters like an ultra-destructive hurricane. At the county scale, two major factors that increased the vulnerability of the area were racial/ethnic demographics and socioeconomic status (Cutter and Finch, 2008).

In 2017, the real household median income for Hispanic (all races) and Black households was $16,000 less than the average real household median income for all households in the United States, leaving these minority populations in a state of economic vulnerability pre-disaster (Fontenot et al 2018). Economic vulnerability and economic resilience, interacting with the natural hazard itself and the exposure of populations and physical assets, are considered to be critical determinants of the resulting disaster damages and losses. Indeed, disasters are largely influenced by economic forces, so that “the very occurrence of disasters is an economic event” (Cavallo 2011). Economic vulnerability and the ability to bounce back are not only directly related to disaster damages and losses but are also directly related to race/ethnicity due to the links between race/ethnicity and lower than average incomes. As such, patterns of race/ethnicity as a large determining factor in the damages and losses from a natural disaster can be observed, with Hispanic and Black households bearing an unequal amount of risk to damage.

These patterns of inequality have been observed in the aftermath of natural disasters, and vulnerable populations are only identified in the wake of a storm; however, these patterns can be used to predict similar patterns for future disasters. Resilience is defined within the natural hazards literature as the ability of an actor to cope with or adapt to hazard stress. It is a product of the degree of planned preparation undertaken in the light of a potential hazard, and of spontaneous or premeditated adjustments made in response to felt hazard (Pelling 2007). One of the main gaps in past research is the scale at which inequality is measured. The observed patterns
have only been analyzed from a household scale or larger and fail to take into consideration how these patterns manifest themselves in the individual, and in the actions of the individual aimed towards emergency preparedness. Similarly, the inequalities that exist in exposure and the reasons for them are the same reasons people are less likely to be prepared, including education, income, age, gender, etc. (Cutter 1995). This thesis uses the aforementioned establishments as well as gaps as a justification for looking at preparedness and inequality in preparedness, because if the reasons for the negative effect are not fully understood, it can never be solved. Furthermore, a large part of the inequality seen in risk and vulnerability is measured after-the-fact, when factors like preparedness are already too intertwined into a problem to analyze it on an individual scale as well as in hindsight.

**Adaptive Capacity**

Recent literature has highlighted the linkages and multi-scalar processes that exist between environment and society, and the importance of understanding the resiliency that is a result of these interactions (Chhetri et al 2012). Within the broader context of vulnerability, resiliency refers to the magnitude of a disturbance that can be absorbed by a socioecological system before a system radically changes to a different state (Folke 2006). Adaptive capacity assesses the potential for a socio-ecological system to cope with challenges presented by climate change by increasing the resiliency of a socioecological system (Adger 2006, Wagner et al. 2014).

This is an important concept because it outlines how climate change adaptation can be/is measured as part of a system. Within the separate measurements of that system and their interdependence on one another to adapt successfully, the role of the individual as an important
factor becomes apparent. The four aspects that are used to measure adaptive capacity are all dependent on the individual playing a specific role in that system. These four aspects that are considered key elements in measuring the ability of a system to adapt are resources, knowledge, institutions, and innovation of technology.

**Resources** are universally noted as determinant factors in a system’s ability to adapt (Chapin et al 2006). The availability and accessibility of resources within a system is important to the ability to adapt; however, within a system it is each individual who has or does not have resources. The individual scale of analysis is important when considering this pillar of adaptive capacity because resources are a function of institutional arrangements and knowledge and if the institutional arrangements determine that a set of individuals within a system do not have access to a certain resource, the system as a whole will lack that resource to a certain degree that is variably dependent on the system in question.

**Knowledge** and understanding of past events have been shown to improve processes for anticipating and dealing with future extreme events (Pelling 2011). When looking at adaptation from a systemic level, it is noted that information alone about an event does not guarantee a desirable outcome due to social and cultural perceptions of the meaning of the information relayed (Adger et al 2005). These social and cultural perceptions exist as a consequence of the actions and mindsets of individuals, who are both influenced by and are influencers of their culture as practitioners of it. Fragmented perceptions of risk can inhibit communication and actions aimed at preparedness among local, regional and federal agencies as well as informal institutions, consequently affecting their willingness to invest in preparedness increasing actions. These perceptions of risk are filtered by individual lenses and framed as a result of personal experiences (Wagner et al 2014). Additionally, knowledge gaps between individuals can lead to
a failure of a system to act in its best interest when faced with a disaster situation (Moser and Ekstrom 2010). Therefore, when addressing the ability of a system to adapt and measures that should be taken to increase that adaptive capacity, the individual scale of analysis is important to understanding the motivations for knowledge interpretation and actions taken or not taken due to that knowledge. These actions taken or not taken on an individual scale collectively create the body of knowledge a system possesses.

Institutions play a critical role in adaptive capacity, because institutions influence the distribution and occurrence of social vulnerability (Næss et al 2005). Institutions also rely on the existing knowledge of a system, and an institution lacking knowledge leads to the poor use of existing resources and diminishes the adaptive capacity of a system (Moser, S. C. 2010). Since formal and informal institutions are both reliant on and influencers of knowledge and resources, in order to analyze the failings of an institution within a system, how the institution manifests itself on the individual scale is important due to the individuals influence on both the knowledge and resources that the institution relies on.

The innovation of new technologies depends on the sensitivity of institutions to progressively adapt to climate change (Wagner et al 2014). Institutionalized research is key for producing new technologies that increase a systems preparedness and adaptability. It is “the product of constant interaction and feedback between social space (where individuals interact) and organizational space mediated by infrastructure individuals and institutions” (Wagner et al 2014, North 2017). Innovation to increase a systems adaptive capacity relies on institutionalized research; institutions rely on the existing knowledge of a system which is made of and influenced by individuals within the system. Institutions and thereby innovation also rely on resources and thereby rely on the individual who is with or without access to a given resource. Within the four
pillars of measuring adaptive capacity, each pillar is dependent on the other within a functioning system. Systems are made of a collective of individuals, which is why researching at the individual scale is vital to understanding where a system’s adaptive capacity can be improved.

**Practice Theory**

Widely accepted theories of social behavior, on which many emergency preparedness policies have been built, present individuals as beings that always behave in a logical, linear and predictable manner. These theories do not take into consideration the everyday practices of individuals, and the things that influence them and their choices regarding preparedness and perceived level of preparedness. Instead, already established policy and academic definitions of preparedness have formed the starting point for studies of preparedness (Heidenstrøm and Kvarnlöf. 2017). This top-down approach to preparedness is heavily biased towards official and policy-oriented definitions and fails to take into consideration that individuals do not exist in a social vacuum, and surrounding context can override cognitive models of assumed behavior (Stern 2000). As such, a large part of the research on preparedness does not consider the everyday life practices in which individuals who prepare operate.

Practice theory is not one unified theory, rather it is a range of efforts. Practice refers to the taken for granted doings of everyday people in ordinary life (Hargreaves, T. 2011). In practice theory, individuals are seen as practitioners that are performing the practices, and they are also able to change and redefine them (Shove et al 2012). These are elements that constitute a practice: meaning (our engagements and beliefs), materials (products, technologies), and competences (embodied skills, knowledge) (Heidenstrøm and Kvarnlöf. 2017). By exploring the interconnections between these elements, one can gain a deeper understanding of type and level
of preparedness, or to what degree individuals are able to absorb disruption while still carrying on with their daily lives (Trentmann 2009). Here, individuals are understood not as mere recipients of support from a system or institution but as active agents that both contribute to that system and work through an event by activating and mobilizing competencies, resources and materials, and construct and reconstruct meanings around events and the levels of preparedness required to move through them.

A practice is never a unit separated from other practices, it is always intertwined, and its elements are included in many different practices that are part of a larger context in which they are performed (Warde, 2005). The practice of preparedness is intertwined within the larger context of the system an individual is part of, and the skills required in the practice of preparedness are dependent on the larger set it is part of. The larger context in which preparedness is performed dictates the extent of skill with which the individual practices it, and this determines how prepared they are (Masten 2011). So, if the larger context is systematically influenced by institutions that perpetuate inequality, the skills with which preparedness is practiced and therefore the extent of preparedness itself will be inherently unequal. Institutions and social systems affect individuals and individuals collectively perpetuate and redesign and recreate the institutions and social systems that they are part of. As such, looking at the individual scale is important when analyzing inequality, particularly in inequalities in emergency preparedness, because the individual is where the system both manifests itself and is the starting point from which it can be mitigated.

To review, the most important points of the literature gathered for the purposes of this thesis are that the two major factors that increase the vulnerability of an area to damage from a natural disaster are racial/ethnic demographics and socioeconomic status (Cutter and Finch,
disasters are largely influenced by economic forces, so that “the very occurrence of disasters is an economic event” (Cavallo 2011). Economic vulnerability and resiliency are directly related to race/ethnicity due to the links between race/ethnicity and lower average incomes. A system’s resiliency is based on its adaptive capacity, which can be measured through analysis of four interdependent pillars. Systems are made of a collective of individuals, who have personal agency and actively make choices, which is why researching at the individual scale is vital to understanding where a system’s adaptive capacity can be improved. An understanding of the everyday practices of the individuals within the system should be sought out in order to pinpoint what areas of the four pillars of adaptive capacity are lacking, so that they can be altered in order to decrease an areas vulnerability to natural hazards.
CHAPTER 3: CASE STUDY

Hurricane Harvey and Houston

The city of Houston, located in the southeastern area of Texas, is the fourth largest city in the United States, with a population of 2.313 million people. Houston is also one of the most racially diverse cities in the United States (Table 1).

Table 1: 2017 Houston racial demographics

<table>
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<tr>
<th>Race</th>
<th>Percentage</th>
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<tr>
<td>Non-Hispanic White</td>
<td>37.8%</td>
</tr>
<tr>
<td>Hispanic (all races)</td>
<td>36.3%</td>
</tr>
<tr>
<td>African American</td>
<td>16.8%</td>
</tr>
<tr>
<td>Asian</td>
<td>7.2%</td>
</tr>
<tr>
<td>Other</td>
<td>1.9%</td>
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This research uses Hurricane Harvey as the ultra-destructive event after which individuals altered their emergency preparedness. This research uses the city of Houston as the geographic area in which to analyze the differences in alterations to emergency preparedness between demographic groups.

This event and location were chosen for the following reasons:

1) Recent nature of event: At the time this research occurred, it was a full two years since Hurricane Harvey made landfall. This timeframe is beneficial for several reasons, including the fact that the event was recent enough that individuals who experienced it will have a clear and reliable memory of it. However, the event was
also long enough ago that the immediate traumatic effects that such an event can have on an individual have likely been mitigated, some extent of recovery has been achieved, and individuals have had time to reflect on the event and the destabilizing effects it had on them. The event was also long enough ago that those individuals who would take future emergency preparedness actions as a direct consequence of Hurricane Harvey have likely already done so, and therefore their actions can be quantified. Additionally, those who permanently left the area as a consequence of Hurricane Harvey have likely already done so, and so the population that remains is likely to accept the risk of experiencing another ultra-destructive hurricane.

2) *Diversity in race/ethnicity and income:* The city of Houston has a large amount of diversity in both median household income and in race/ethnicity. As previously stated, Houston is one of the most racially diverse cities in the United States, and median household income can vary by neighborhood between $23,000 a year and over $250,000 a year. This makes it possible to determine the differential resilience demonstrated by these different groups within close proximity.

3) *Likelihood of similar events due to climate change:* Houston is listed as one of the five most vulnerable cities in the United States, because of its proximity to the Gulf of Mexico and the historic occurrence of hurricanes in that area, which are increasing in frequency, duration, and damage. Because of these facts, those who live in Houston are likely aware of their vulnerability to future events similar to Hurricane Harvey, and therefore understand that emergency preparedness practices are necessary.
**Research Questions and Hypotheses**

The discussion above of past research identifies a need for understanding human adaptation at an individual level in the face of ultra-destructive hurricanes so to better prepare for these events in the future and help reduce inequalities in preparedness and vulnerability. This will be done by answering the following research questions:

1) How do individuals alter their emergency preparedness after living through an ultra-destructive hurricane?

2) What inequalities exist in terms of these alterations across demographic groups within the same geographic region?

*Hypothesis #1:* Individuals took intentional actions to obtain additional resources and make emergency plans after Hurricane Harvey to increase their preparedness for the next extreme event.

*Hypothesis #2:* Individuals who are classified as part of minority or low-income populations took different actions aimed toward preparedness than those of high income or majority status because of a lack of resources or knowledge on how to be prepared.
CHAPTER 4: METHODS

This research takes a survey methods approach to understand adaptation and preparedness actions at an individual level and the factors that influence decisions regarding hurricane preparedness. This approach relies on individual, self-reported experiences regarding emergency preparedness and Hurricane Harvey, in the form of online surveys. This approach specifically addresses the self-reported actions taken by an individual and their explanation as to why those actions were or were not taken as a direct consequence of Hurricane Harvey. This approach also gathers self-reported demographic data to establish categorize respondents into groups for analysis.

Data Collection

Baseline establishment: Data collection was done in the form of an online survey (see Appendix). These online surveys established several variables necessary for the research. The survey first established that the participant met the basic requirements to be included in the study, such as being a current resident of Houston, Texas who is over the age of 18, and was living in Houston, Texas at the time of Hurricane Harvey and did not evacuate the city for the hurricane event. After establishing the basic requirements for participating in the study, the survey establishes what normal access the individual has to resources (such as water, electricity, housing, cell phone service, enough food to feed themselves, etc.) without the disruption of Hurricane Harvey. The survey then establishes the disruptions to normalcy the individual encountered after Hurricane Harvey by asking if they lost access to those normal resources directly after Hurricane Harvey using a yes/no format. After establishing the disruptions to
normalcy encountered after Hurricane Harvey, the survey addresses if these disruptions were attributed directly to Hurricane Harvey, or to other situations not directly related to Hurricane Harvey (such as ‘forgot to pay electricity bill’). The survey then establishes the amount of time each disruption persisted for until a renewed state of normalcy was restored.

*Perception of risk:* Following baseline and disruption to resources type questions, the survey then addresses the individual’s perception of risk by asking if the individual believes they are in danger of another hurricane, followed by asking whether the next hurricane will be stronger or weaker than Hurricane Harvey, and if the individual believes that it will cause as much disruption to the normalcy (normal access to resources) of the individual using a yes/no format. If the individual does believe that they are at risk of another hurricane and it will be disruptive, the survey asks if the individual feels the need to take preparedness actions for future events in preparation for the next hurricane in a yes/no format.

*Actions taken:* After establishing risk perception and the need for preparation, the survey then collects reported preparedness actions taken or not taken by individuals after Hurricane Harvey. The reported actions consist of a list of recommended preparedness actions based on the United States Federal Emergency Management Agency (FEMA) hurricane preparedness handbook as well as the researcher’s anticipated preparedness actions. The participants select which actions they took, as well as actions they did not take. As part of the research design, the actions on the list fit into broader categories of Obtained Additional Resources and Make Emergency Plans which reflect hypothesis #1: “Individuals took intentional actions to obtain additional resources and make emergency plans after Hurricane Harvey to increase their preparedness for the next extreme event.”
Reasons for actions: Following the reporting of preparedness actions taken or not taken, the motivations or reasons for the individual taking or not taking a preparedness action were addressed. Reasons were selected from a list of anticipated financial, knowledge or access reasons, and participants also had an ‘other’ option where they were able to describe the motivations for their choice. Participants who select ‘other’ option were manually coded according to their explanation.

Demographics: General demographic information about the participant was collected through the survey, including self-reported race/ethnicity, self-reported household income level, postal code and age range.

Open ended questions: To address the qualitative aspect of this research, optional open-ended questions were presented at the end of the survey, such as “Did you do anything else not listed in this survey to better prepare you for the next hurricane?”

Participant Inclusion

The following participant characteristics were required for this study: Participant must be eighteen years or older, must currently reside in Houston, Texas, must have access to the internet in order to complete the survey, must be able to read in English due to the formatting of the survey, and must complete the survey prior to established data collection deadline.

The specific demographics targeted in this research were individuals who currently reside in Houston, Texas, who lived in Houston, Texas during Hurricane Harvey. This research was specifically targeting areas with a high concentration of low-income individuals, areas with a high concentration of high-income individuals, areas with a high concentration of non-Hispanic white individuals and areas with a high concentration of individuals who identify as non-white.
By targeting these specific demographics, the research was able to collect data from a sample of individuals with diverse backgrounds, which was taken into account during the analysis of emergency preparedness actions taken or not taken.

**Recruitment and Selection**

Participants were recruited to the online survey one of two ways, by receiving a flyer distributed at local events containing a link to the online survey on it, or through announcements and electronic links distributed to specifically targeted geographically based social media groups. These social media groups were found through searching and finding group names indicating that they are Houston based and Houstonian centered groups. Flyers containing information about the survey, a link and a scannable QR code were distributed to interested individuals at a local festival for Houston residents. Those who received a flyer were incentivized to complete the online survey by being entered into a random drawing for a gift card upon completion of the online survey, and this was advertised on the post card itself. Those who became aware of the online survey through announcements made on targeted social media groups were given a hyperlink that led directly to the online survey. Those who become aware of the online survey through social media were also incentivized by being entered into the same drawing for a gift card, and this fact was advertised in the announcement containing the hyperlink on social media pages. Participants were instructed to complete the survey in its entirety and encouraged to share the link to the online survey to other potential participants who may have had different experiences. While distribution online was not affected by COVID-19, previously planned in-person distribution was limited due to the pandemic, and initial plans to distribute flyers in specifically targeted neighborhoods was not possible beyond a single local festival in late 2019.
Comparisons

After data collection, the data collected from the online survey was used to compare alterations in emergency preparedness actions taken as a result of Hurricane Harvey between different demographic groups. Individuals were grouped by low income (individuals who make less than or equal to $40,000 a year), middle income (individuals who make between $41,000 to $100,000), and high income (individuals who make $101,000 to $250,000 or more), as well as majority race/ethnicity (individuals who identify as non-Hispanic white) and minority race/ethnicity (individuals who do not identify as non-Hispanic white). Individuals were also grouped by disrupted or not disrupted by Hurricane Harvey based on the self-reported data. By comparing the emergency preparedness actions taken or not taken by individuals grouped by income, race/ethnicity and disruption, we are able to see if actions taken or not taken correlate to income or race, as well as reasons why actions were taken/not taken. By comparing income groups, we are able to determine the extent to which income encourages or inhibits emergency preparedness actions. By comparing racial/ethnic majority/minority, we are able to determine the extent to which emergency preparedness actions vary by majority or minority status. By comparing disturbed and undisturbed, the researcher will be able to create a control group from which further analysis can be based.
CHAPTER 5: RESULTS

Upon the completion of data collection, data was organized and coded using R statistical software. The statistical approach utilized a Chi square design, which determines whether or not there is a statistically significant relationship between two variables. The approach used the following groupings to compare against the survey questions: Low Income, Middle Income, High Income, Racial Majority, Racial Minority. This quantitative analysis served to establish if there is a connection between groups and actions taken or not taken, normalcy disturbed or not disturbed, and answers the following questions: Are these groups different in actions taken or not taken for future preparedness? What factors are the most important? Answering these questions establishes a basis for answering the first research question: 1) How do individuals alter their emergency preparedness after living through an ultra-destructive hurricane? Answering these questions also addresses the first hypothesis by establishing whether or not individuals took intentional actions to obtain additional resources and make emergency plans after Hurricane Harvey to increase their preparedness for the next extreme event.

For the second part of the analysis, qualitative analysis of the responses to the open-ended questions on the online survey (regarding why or why not an individual took a preparedness action) was coded and examined. This analysis serves to establish answers to the following questions: Why do different groups take different actions? Who is able to adapt and respond to climate change? Answering these questions will establish a basis for answering the second research question: 2) What inequalities exist in terms of these alterations across demographic groups within the same geographic region? Answering these questions also addresses the second hypothesis by establishing whether or not individuals who are classified as
part of minority or low-income populations took different actions aimed toward preparedness than those of high income or majority status because of a lack of resources or knowledge on how to be prepared.

**Survey results**

*Respondent income and race/ethnicity:*

After conclusion of the conduction of the online survey, the participant racial background resulted in 146 majority (white non-Hispanic) respondents and 54 minority (non-white) respondents. The racial/ethnic breakdown of participants are as follows:

**Table 2: Racial/ethnic demographics of survey respondents.**

<table>
<thead>
<tr>
<th>Racial/Ethnic Group</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>White (non-Hispanic)</td>
<td>146</td>
</tr>
<tr>
<td>Black/African American</td>
<td>12</td>
</tr>
<tr>
<td>Hispanic or Latinx</td>
<td>17</td>
</tr>
<tr>
<td>Asian</td>
<td>14</td>
</tr>
<tr>
<td>Other</td>
<td>11</td>
</tr>
</tbody>
</table>

After conclusion of the conduction of the online survey, the number of respondents grouped by income per year are as follows:

**Table 3: Income demographics of survey respondents.**

<table>
<thead>
<tr>
<th>Income Group</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Income ($≤$10,000 to $40,000)</td>
<td>22</td>
</tr>
<tr>
<td>Middle Income ($41,000 to $100,000)</td>
<td>68</td>
</tr>
<tr>
<td>High Income ($101,000 to $250,000+)</td>
<td>110</td>
</tr>
</tbody>
</table>

Due to the timing of this research, the original plan for both online and in-person data collection was not possible due to the COVID-19 pandemic. As such, participants were largely
recruited through online social media platforms, which can explain the respondent skew towards a high-income, White (non-Hispanic) population.

*Normalcy and disruption establishment:*

In the survey, base questions were asked to establish individual participants’ normal access to resources prior to Hurricane Harvey in order to determine disruption to normalcy as the result of Hurricane Harvey. Participants were asked if they normally had consistent access to each of the following:

- Clean, running water.
- Enough food to feed themselves.
- Electricity.
- Safe, undamaged housing.
- Heating and air conditioning.
- A working telephone/cellphone.

Following the establishment of normal access to resources, disruption to normalcy was determined by asking the same questions but posed in the light of access to resources directly after Hurricane Harvey (ex. Immediately after Hurricane Harvey, did you have access to clean, running water?). These questions were only posed to participants who said they had normal access to the resource in question. Following the disruptions of normalcy, cause was established to verify that the disruptions to normal access to resources were a result of the Hurricane Harvey storm event and not a non-related disruption (ex. “I forgot to pay my water bill”). All respondents who participated in the survey asserted that any disruption to their normal access to the aforementioned resources was a direct result of Hurricane Harvey.
Results of Chi square analysis on disruption to normalcy:

Table 4: Results of Chi square analysis in disruption to normalcy

<table>
<thead>
<tr>
<th>Immediately following Hurricane Harvey…</th>
<th>Race/ethnicity</th>
<th>Income</th>
</tr>
</thead>
<tbody>
<tr>
<td>Did you have consistent access to clean, running water?</td>
<td>p = 0.2436</td>
<td>p = 0.4622</td>
</tr>
<tr>
<td>Did you have consistent access to enough food to feed yourself?</td>
<td>p = 0.0498</td>
<td>p = 0.186</td>
</tr>
<tr>
<td>Did you have consistent access to electricity?</td>
<td>p = 0.1274</td>
<td>p = 0.0881</td>
</tr>
<tr>
<td>Did you have consistent access to safe, undamaged housing?</td>
<td>p = 0.5748</td>
<td>p = 0.003</td>
</tr>
<tr>
<td>Did you have consistent access to heating and air conditioning?</td>
<td>p = 0.1113</td>
<td>p = 0.1551</td>
</tr>
<tr>
<td>Did you have consistent access to a working telephone/cellphone?</td>
<td>p = 0.8981</td>
<td>p = 0.0519</td>
</tr>
</tbody>
</table>

*P values of significance are boldfaced.*

There is a difference between racial/ethnic majority/minority groups and whether or not there was disruption to consistent access to enough food to feed themselves immediately following Hurricane Harvey. White non-Hispanic respondents reported a higher level of
disruption to their normal ability to feed themselves immediately after Hurricane Harvey, while minority respondents did not report a significant disruption.

There are no differences between racial/ethnic majority/minority groups and whether or not there was a disruption to consistent access to clean running water, electricity, safe undamaged housing, heating and air conditioning, and a working telephone/cellphone.

There is a difference between income groups and access to safe, undamaged housing. Participants who reported the highest level of disturbance to their access to safe, undamaged housing fell into the middle-income group.

There are no differences between income groups and whether or not there was a disruption to consistent access to clean running water, electricity, heating and air conditioning, and a working telephone/cellphone. Although disruption to normal access to a working telephone/cellphone was very close to having a correlation between disruption and income, the p-value is greater than .05 and therefore is not considered significant enough to be included in this study. However, it is worth noting that while it is not being included as significant in this study, it may be a factor to consider in future research.

Risk Perception

Following the baseline establishment of normal access to resources and disturbance to normalcy due to Hurricane Harvey questions, questions were posed to ascertain the risk perception of the participants. Specifically, questions were posed in regards to another major hurricane event. The questions regarding hurricane strength, possible future disruption to normalcy, and need to prepare where only posed to respondents who answered “yes” to the first question posed. The questions were as follows:
- Do you believe you are in danger of being affected by another hurricane at any point in the near future?
- If so, do you think that the next hurricane will be stronger or weaker?
- Do you think the next hurricane will disrupt your normal access to resources?
- Do you feel the need to prepare for future hurricanes?

Table 5: Results of chi square analysis on risk perception.

<table>
<thead>
<tr>
<th></th>
<th>Race/Ethnicity</th>
<th>Income</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do you believe you are in danger of being affected by another hurricane at any point in the near future?</td>
<td>P = 0.9314</td>
<td>P = 0.4979</td>
</tr>
<tr>
<td>If so, do you think that the next hurricane will be stronger or weaker?</td>
<td>P = 0.1389</td>
<td>P = 0.4979</td>
</tr>
<tr>
<td>Do you think the next hurricane will disrupt your normal access to resources?</td>
<td>P = 0.5744</td>
<td>P = 0.427</td>
</tr>
<tr>
<td>Do you feel the need to prepare for future hurricanes?</td>
<td>P = 0.9475</td>
<td>P = 0.6683</td>
</tr>
</tbody>
</table>

There is not a difference between racial/ethnic minority/majority groups on any of the risk perception questions. There is also no difference between income groups on any of the risk perception questions.
Emergency preparedness actions taken post-Hurricane Harvey

After establishing how risk perception by race/ethnicity and income, questions were posed to participants regarding the emergency preparedness actions taken after and as a result of Hurricane Harvey. These actions specifically were included based on the Federal Emergency Management Agency emergency preparedness list as well as the researcher’s own anticipated actions. These questions were posed to all participants in the survey and were formatted in a yes/no manner. If participants answered “no” to any of the emergency preparedness actions questions, they were asked the follow up question of “Why not?” and were given a multiple choice options including “I had already done so prior to Harvey,” “I did not know how,” “I did not think I had to,” “I could not afford to” and “Other.” If the participants selected the “Other” option, they were prompted to complete a required fill in the blank explanation. The selected “Why not?” reasons and open-ended explanations will be addressed in the qualitative results section of this thesis.

Table 6: Results of chi square analysis on emergency preparedness actions.

<table>
<thead>
<tr>
<th>After Hurricane Harvey, did you….</th>
<th>Race/ethnicity</th>
<th>Income</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sign up for local weather alerts and warnings?</td>
<td>P = 0.5788</td>
<td>P = 0.309</td>
</tr>
<tr>
<td>Create a plan on how to communicate with family members if you lose power?</td>
<td>P = 0.6311</td>
<td>P = 0.2562</td>
</tr>
<tr>
<td>Create an emergency evacuation route?</td>
<td>P = 0.3775</td>
<td>P = 0.6656</td>
</tr>
</tbody>
</table>
### Table 6 continued.

<table>
<thead>
<tr>
<th>Item</th>
<th>Probability 1</th>
<th>Probability 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identify the closest emergency shelter location?</td>
<td>0.2591</td>
<td>0.0396</td>
</tr>
<tr>
<td>Create an important contact information list for family, school, work, doctors, etc. including phone numbers and email addresses?</td>
<td>0.7066</td>
<td>0.1898</td>
</tr>
<tr>
<td>Purchase an extra battery, portable charger, or battery pack for your cell phone?</td>
<td>0.8862</td>
<td>0.8444</td>
</tr>
<tr>
<td>Purchase a battery powered or hand crank radio?</td>
<td>0.1072</td>
<td>0.4515</td>
</tr>
<tr>
<td>Purchase extra batteries to have on hand in case of emergency?</td>
<td>0.2415</td>
<td>0.8717</td>
</tr>
<tr>
<td>Purchase a first aid kit specifically for emergencies?</td>
<td><strong>0.04969</strong></td>
<td>0.6479</td>
</tr>
<tr>
<td>Purchase a generator?</td>
<td>0.9112</td>
<td>0.08763</td>
</tr>
<tr>
<td>Purchase a flashlight specifically for emergencies?</td>
<td>0.2909</td>
<td>0.2092</td>
</tr>
<tr>
<td>Purchase a multi-purpose tool?</td>
<td>0.6854</td>
<td>0.3219</td>
</tr>
<tr>
<td>Purchase waterproof matches or a lighter in waterproof container?</td>
<td><strong>0.016</strong></td>
<td>0.2043</td>
</tr>
</tbody>
</table>
### Table 6 continued.

<table>
<thead>
<tr>
<th>Activity</th>
<th>P = 0.005</th>
<th>P = 0.26</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purchase a whistle?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Purchase a three-day supply of water specifically for emergencies?</td>
<td>P = 0.1949</td>
<td>P = 0.3185</td>
</tr>
<tr>
<td>Acquire copies of personal documents (medications list, proof of address, deed/lease to home, birth certificates, insurance policies) for use in case of emergencies?</td>
<td>P = 0.2169</td>
<td>P = 0.1359</td>
</tr>
<tr>
<td>Acquire extra cash for use in case of emergencies?</td>
<td>P = 0.3226</td>
<td>P = 0.0726</td>
</tr>
<tr>
<td>Purchase extra fuel for your car or generator specifically for emergencies?</td>
<td>P = 0.4626</td>
<td>P = 0.7208</td>
</tr>
<tr>
<td>Purchase flood insurance?</td>
<td>P = 0.6544</td>
<td>P = 0.56</td>
</tr>
<tr>
<td>Purchase storm shutters or temporary window covers for your home?</td>
<td>P = 0.5134</td>
<td>P = 0.6881</td>
</tr>
<tr>
<td>Purchase any type of water purification system?</td>
<td>P = 0.3695</td>
<td>P = 0.03008</td>
</tr>
<tr>
<td>Purchase canned or shelf stable food for emergencies?</td>
<td>P = 0.5077</td>
<td>P = 0.1789</td>
</tr>
</tbody>
</table>
Table 6 continued.

| Purchase sandbags to protect your home from flooding? | P = 0.8685 | P = 0.05 |

*P values of significance are boldfaced.*

There does not appear to be a correlation between race/ethnicity and identifying the closest emergency shelter location after Hurricane Harvey. There does appear to be a correlation between income and identifying the closest emergency shelter location after Hurricane Harvey. Respondents who fell into the “low income” category reported a significantly higher rate of identifying the closest emergency shelter location after Hurricane Harvey than the “middle income” and “high income” categories.

There does appear to be a correlation between race/ethnicity and the purchasing of a first aid kit specifically for emergencies after Hurricane Harvey. There was a higher rate of purchasing of first aid kits specifically for emergencies in minority populations. There does not appear to be a correlation between income and purchasing a first aid kit specifically for emergencies after Hurricane Harvey.

There does appear to be a correlation between race/ethnicity and purchasing waterproof matches or a lighter in waterproof container after Hurricane Harvey. A significantly higher rate of minority participants reported purchasing waterproof matches or a lighter in waterproof container after Hurricane Harvey. There does not appear to be a correlation between income and purchasing waterproof matches or a lighter in waterproof container after Hurricane Harvey.

There does appear to be a correlation between race/ethnicity and purchasing a whistle after Hurricane Harvey. A significantly higher rate of minority participants reported purchasing a
whistle after Hurricane Harvey. There does not appear to be a correlation between income and purchasing a whistle after Hurricane Harvey.

There does not appear to be a correlation between race/ethnicity and purchasing any type of water purification system after Hurricane Harvey. There does appear to be a correlation between income and purchasing any type of water purification system after Hurricane Harvey. A higher rate of water filtration system purchases was found in individuals who fell into the low-income category.

There does not appear to be a correlation between race/ethnicity and purchasing sandbags to protect from flooding after Hurricane Harvey. There does appear to be a correlation between income and purchasing sandbags to protect from flooding after Hurricane Harvey.
CHAPTER 6: ANALYSIS

Based on the quantitative results of the survey and the chi square analysis used to determine if there was a statistical correlation between race/ethnicity and income and disruption to normalcy as well as emergency preparedness actions taken or not taken after Hurricane Harvey, several connections can be seen between race/ethnicity and income and disruption to normalcy as well as emergency preparedness actions taken or not taken after Hurricane Harvey.

*Disruption to normalcy:*

In order to establish a baseline for analyzing the respondents’ answers to survey questions regarding emergency preparedness actions taken or not taken, questions regarding disruptions to respondents’ normal access to resources were posed to see if any of these disruptions were found at a higher rate in any racial/ethnic or income category. In regards to disruptions to normalcy, there were two major disruptions that had a significant correlation between disturbed or not disturbed normalcy and race/ethnicity and income. The first is a disruption to access to enough food to feed participants in the wake of Hurricane Harvey. There was a correlation between race/ethnicity and access to food: white non-Hispanic respondents reported a higher level of disruption to their normal access to enough food to feed themselves, with approximately 21% of respondents reporting that they did not have access to enough food to feed themselves immediately following Hurricane Harvey. This relates to the theme of natural hazards and risk vulnerability on which this study was built, verifying that there is indeed a difference between races/ethnicities and disruption to access to normal basic resources in the wake of a natural disaster (such as Hurricane Harvey).
The second result that found a significant correlation between race/ethnicity or income and disturbed or not disturbed access to normal resources was in regards to access to safe, undamaged housing. Respondents who fall into the middle income category reported a higher level of disruption to their normal access to safe, undamaged housing, with approximately 35% of respondents reporting that they did not have access to safe, undamaged housing immediately following Hurricane Harvey.

*Racial/ethnic correlations:*

The first emergency preparedness action question that resulted in a correlation between action taken or not taken and race/ethnicity was, “After Hurricane Harvey, did you purchase a first aid kit specifically for emergencies?” Here, 63% of respondents who fell into the racial/ethnic minority category did not purchase a first aid kit specifically for emergencies after Hurricane Harvey, in contrast to approximately 79% white non-Hispanic respondents who did not purchase a first aid kit specifically for emergencies after Hurricane Harvey. After analysis of the open-ended responses to the question as to why they did not purchase a first aid kit specifically for emergencies after Hurricane Harvey, survey results reveal that a high rate of white non-Hispanic respondents had already purchased a first aid kit specifically for emergencies prior to Hurricane Harvey. In addition, a high rate of racial/ethnic minority respondents also responded that they did not purchase a first aid kit specifically for emergencies because they had already done so prior to Hurricane Harvey; however, this does not change the fact that a difference can be seen between racial/ethnic majority/minority groups, with the minority population indicating a higher purchasing rate.

The second emergency preparedness action question that resulted in a correlation between action taken or not taken and race/ethnicity was, “After Hurricane Harvey, did you
purchase waterproof matches or a lighter in waterproof container?” 84% of respondents who fell into the racial/ethnic minority category did not purchase waterproof matches or a lighter in waterproof container after Hurricane Harvey in contrast to approximately 96% of respondents who fell into the White/non-Hispanic category did not purchase waterproof matches or a lighter in waterproof container after Hurricane Harvey. After analysis of the open-ended responses to the question as to why they did not purchase waterproof matches or a lighter in waterproof container after Hurricane Harvey, a high rate of both racial/ethnic minority and majority respondents did not think they needed to purchase waterproof matches after Hurricane Harvey. Despite the similarities between racial/ethnic minority and majority respondents' responses as to why they did not purchase waterproof matches or a lighter in waterproof container after Hurricane Harvey, there is still a 12% higher rate of minority respondents who purchased waterproof matches or a lighter in waterproof container after Hurricane Harvey versus respondents in the racial/ethnic majority category.

The third emergency preparedness action question in which responses differed by race/ethnicity was, “After Hurricane Harvey, did you purchase a whistle?” 87% of minority respondents did not purchase a whistle after Hurricane Harvey in contrast to approximately 99% of White, non-Hispanic respondents. Analysis of the open-ended responses showed that a high rate of racial/ethnic majority respondents had already purchased a whistle prior to Hurricane Harvey, and this is why they did not feel the need to purchase one after Hurricane Harvey. In contrast, a high rate of racial/ethnic minority respondents responded that they did not purchase a whistle after Hurricane Harvey because they did not think or know that they needed to. The higher rate of purchasing a whistle among minority respondents as well as the reasons expressed
for not purchasing one add to the evidence of a difference in regards to emergency preparedness actions in the wake of a natural disaster between racial/ethnic majority/minority populations.

*Income grouping correlations:*

The first emergency preparedness action that resulted in a correlation between action taken or not taken and income groupings is “After Hurricane Harvey, did you purchase any type of water purification system?” The survey indicated that 73% of individuals who fall into the low income category did not purchase any type of water purification system after Hurricane Harvey, 81% of middle income respondents did not purchase any type of water purification system after Hurricane Harvey, and 13% of high income respondents did not purchase any type of water purification system after Hurricane Harvey.

These results indicate a much higher rate of purchasing water purification systems by respondents in the high-income category versus the middle- and low-income categories. When asked why they did not purchase any type of water purification system after Hurricane Harvey, approximately 37% of participants explained they could not afford to do so, and 41% responded they did not think or know that they needed to. In the low-income category alone, 76% of respondents indicated that they could not afford to purchase a water purification system. In contrast, out of the 13% of high-income respondents who did not purchase a water purification system after Hurricane Harvey, 98% indicated that they had already purchased a water purification system prior to Hurricane Harvey. This finding shows that there is indeed a measurable difference between income groups when it comes to the ability to possess a water purification system, due to either financial or knowledge gaps. This finding supports both hypothesis one and two.
The second emergency preparedness action that resulted in a correlation between action taken or not taken and income grouping is “After Hurricane Harvey, did you purchase sandbags to protect your home from flooding?” 86% of low income respondents did not purchase sandbags to protect their home from flooding, approximately 96% of middle income respondents did not purchase sandbags to protect their home from flooding, and 97% of high income respondents did not purchase sandbags to protect their home from flooding. This result indicates a higher rate of sandbag purchasing by low-income respondents versus the middle- and high-income categories. When asked why they did not purchase sandbags, of the 96% of middle-income respondents who did not purchase sandbags to protect their homes from flooding after Hurricane Harvey, 68% of respondents indicated that they did not feel the need to, and of the 97% of high-income respondents, 72% indicated that they did not feel the need to. An interesting result of this particular emergency preparedness action and the answer to the question of why sandbags were not purchased is that 27% of all respondents in all income categories chose the fill-in-the-blank “Other” option where they could explain their reasons not to purchase sandbags because the given options of the multiple choice answers did not apply to them (e.g., affordability or awareness). After manually coding the open-ended responses, a large portion of respondents indicated that they either did not have the space to/were not willing to store them, or they did not think that having sandbags would effectively prevent their homes from flooding during the next hurricane event.
CHAPTER 7: DISCUSSION

Hurricanes are extremely destructive forces that are an increasing threat to cities located along the Gulf Coast of the United States. The devastation caused by these storms is manifested not only in the physical damage inflicted to the area, but also in the social systems of the area and the differences between how populations within the same affected area recover and in how these groups prepare for future hurricanes. This study focusing on Hurricane Harvey and the city of Houston illustrates the differences between how participants of different race/ethnicity and income groups were affected by Hurricane Harvey, and how they prepared for future storms after Hurricane Harvey.

The results of this study indicate that individuals within the city of Houston took intentional actions to obtain additional resources and make emergency plans after Hurricane Harvey to increase their preparedness for the next extreme event, confirming hypothesis one and answering the first research question (see page 15). The results of this study also indicate that individuals who are classified as part of minority or low-income populations took different actions aimed toward preparedness than those of high income or majority (White, non-Hispanic) status because of lack of resources or knowledge on how to be prepared, conforming hypothesis two and answering the second research question.

While middle income respondents had the highest rate of disruption to normalcy to access to safe, undamaged housing after Hurricane Harvey, they were also the income category with the highest rate of respondents that did not think that they needed to identify the closest emergency shelter after Hurricane Harvey, and the high-income group also had a high rate of not identifying the closest emergency shelter. The qualitative data that was collected by the survey
asking respondents why they did not take this emergency preparedness action indicated that this was because they had already done so prior to Hurricane Harvey. The low-income population of respondents had a 50% rate of not identifying the closest emergency shelter after Hurricane Harvey and the results of the qualitative answers indicate that approximately 36% of respondents who did not identify the closest emergency shelter did not do so because they did not know how. The contrast between high/middle and low-income respondents identifying emergency shelters after Hurricane Harvey is interesting because it also ties into emergency preparedness actions such as purchasing flood insurance, purchasing storm shutters, and buying sandbags to protect homes from flooding. I would like to focus specifically on the sandbags action, since the flood insurance and storm shutters analysis did not return with any difference between high/middle/low-income groups and taking or not taking that action. However, the “After Hurricane Harvey, did you purchase sandbags to protect your home from flooding?” question did. It indicated that a higher number of low-income individuals did in fact purchase sandbags to protect their homes from flooding, although they were the group that reported the least disruption to their normal access to safe, undamaged housing.

Interestingly, in the qualitative answers that were given for the sandbags question, a vast majority of high- and middle-income respondents chose to select the “other” option when asked why they did not purchase sandbags. When prompted with the opportunity to explain why, a trend was seen where participants indicated that they were not willing to store the sandbags. This is evidence to the fact that there is a difference between knowing that you should take an action in order to protect yourself and your property in the future and actually taking the action itself, which supports the prior research into adaptive capacity outlined in the literature review (see
and the social norms and priorities that influence an individual’s decision to take an action or not.

These social norms are priorities that tie into the themes within practice theory, with an emphasis on the meaning, materials, and competencies aspects of the theory. Meaning (or engagement and beliefs) is visible in the survey results by the high percentage in all racial/ethnic and income categories of explanations as to why the individual did not take an emergency preparedness action being that they did not feel the need to. The emphasis placed or not placed on the importance of emergency preparedness actions influences the willingness to take an action even if it is for their own benefit in the case of another major hurricane event. This is the case even for something as simple as having a three-day supply of water stored somewhere in their homes or an emergency evacuation plan.

Another aspect of practice theory identified and outlined in the literature review that can be applied to the survey results is materials. The everyday taken for granted practices of individuals when it comes to taking emergency preparedness actions is influenced by the ease of accessibility to the resources required to take a given emergency preparedness action. This can be seen in the survey results from low income and minority populations that explained why a participant did not take an action due to the inability to afford a particular physical resource. By placing emphasis on actively budgeting and saving specifically for a particular resource, or with additional financial assistance from emergency management agencies, the everyday practice of an individual to prepare themselves for the future can be changed so that the resource can be obtained.

Similarly, the third aspect of practice theory that can be applied to the survey results is competencies. In relation to this research, competencies can be applied as the knowledge and
skills required to increase the individual’s emergency preparedness. This ties into the responses that explained that an action was not taken because they did not know how, and an inequality that can be observed within this theme is the racial majority/minority population. If an individual does not know how to take an emergency preparedness action, they will not implement it, and it can also impact their willingness to emphasize the importance of preparedness, bringing us back to the meaning aspect of practice theory. Through increasing and reordering outreach and educational programs, emergency preparedness and management agencies can begin to change the inequality visible in this study; and through an understanding of the deficits found in each intertwining aspect of the practices of the affected population, a more effective policy for reducing emergency preparedness inequality can be formed.

My theory that could explain the differences in home protection actions and income groups is that people who had access to resources such as money prior to Hurricane Harvey and the damage it inflicted did not take home protection actions afterwards because they didn’t need to. People with higher incomes have a better chance of fully recovering from the next hurricane because of the larger amount of money they have and can spend more money on recovering from any damage inflicted upon their homes, making the process of recovering and returning to their state of normalcy easier. In contrast, people of low income already have so little, that they need to take steps to protect what they already have, because they do not have the financial ability to fully recover from the damage ensued by the next major hurricane event. It is worth noting that not all respondents were home owners and this is potentially an influencing factor on the results. This theory ties into and elaborates on the themes of inequality and economic resilience covered in existing research on natural hazards vulnerability, covered in the literature review section of this thesis.
Similar to home protection emergency preparedness actions, one of the results of the survey that showed dramatic differences in actions taken/not taken by low vs medium vs high income groups in regards to food and water security. There was no difference in income-specific disruption to normal access to enough food to feed themselves or clean running water, and there was also no income-based difference in purchasing canned or shelf stable food. However, there was a significant income-based difference in response to the emergency preparedness question, “After Hurricane Harvey, did you purchase any type of water purification system?” A very small number of high-income respondents did not purchase a water purification system after Hurricane Harvey, and based on survey results this is because they had already possessed one before Hurricane Harvey. Similar to home protection actions, this is further evidence to the theory that high income populations already had access to resources that minimized the disturbance to their lives prior to Hurricane Harvey due to their financial status. Since the high-income group had already taken this emergency preparedness action prior to Harvey, they didn’t need to after. In contrast, a much higher rate of low-income respondents did purchase a water purification system after Hurricane Harvey, indicating that unlike the high-income population, they did not possess one before the storm, and therefore had to take more actions to be prepared for the next one. It is likely that the low-income population did not possess a water purification system prior to Hurricane Harvey because they could not justify spending money on something that didn’t seem immediately necessary, and the aftermath of Harvey made the purchase justifiable, even on a small budget. To further support this notion, the low-income participants who reported that they did not purchase a water purification system after Harvey indicated that they didn’t because they could not afford to do so.
Although not observed in this study specifically, prior vulnerability studies have shown that Black/African Americans and Latinos bear an unequal level of risk to natural hazards due to historical factors. Following this theme, racial minority participants of this study took more emergency preparedness actions than those of racial majority status, which makes sense if you are part of a population that bears a higher level of risk. Exposure to hurricane risk can also vary geographically. Demographic groups have different residential geographies due to segregation, and this segregation increases their risk. An interesting finding of this study is that racial/ethnic minorities did not take major actions such as making a large purchase or creating extensive disaster plans and instead opted to take smaller, more immediately affordable, and somewhat unexpected preparedness actions after Hurricane Harvey such as purchasing waterproof lighters, whistles and first aid kits. I believe that this can be explained by the population and income geographics of the city of Houston.

Houston, Texas is one of the most geographically segregated cities in the United States, both by race and by income, and both of those factors go hand in hand with one another (see appendix). In 2017, less than 10% of the White population was in poverty across the nation, compared to 25% of the Black/African American population, 22% of the Hispanic/Latino population, and 12% of the Asian population. In Houston, the differences in the percentages are far greater (U.S Census Bureau, 2018). In the wake of Hurricane Harvey, the higher income white areas of the city were the first to receive emergency assistance from local and federal disaster agencies, taking precedent over the areas where most low income and minority residents reside. I believe that the reported emergency preparedness actions taken by racial/ethnic minorities in this study were a result of this uneven distribution of disaster relief, where after Hurricane Harvey minority participants realized that they would have to fend for themselves
with little assistance in the event of the next major hurricane event, and therefore needed to prepare.

Several correlations were not found in this study but were expected. First, no correlation was found between income or race/ethnicity and purchasing a generator after Hurricane Harvey, and second, no correlation was found between income or race/ethnicity and purchasing flood insurance after Hurricane Harvey. The absence of these correlations can most simply be explained by the notion that those who had the resources to prepare for a natural disaster prior to Hurricane Harvey did so, and therefore did not have to take them in order to prepare for the next hurricane. This idea is supported by the vast amount of survey responses that, when asked if an emergency preparedness action was taken after Hurricane Harvey, responded that the action was not taken because the participant had already done so prior to the storm.

During the course of this research, specifically through the distribution and analysis of the surveys, a trend emerged within the open-ended responses of some very negative views of emergency preparedness overall. Participants used the open-ended questions to express how they feel in passionate ways, often using colorful language, giving evidence to the fact that Hurricane Harvey is a very sensitive topic to those who were affected by it. This also sheds light on the fact that natural disasters are not simply physical events that happen within a geographic area, but they are social, economic and emotional ones that deeply impact lives even years after the event itself. This is why it is important to look at emergency preparedness from an individual scale, because each individual is impacted by the same disaster differently. Gaining an understanding of these differences is important in the effort to end emergency preparedness inequality, because individuals are where both the systems of inequality are manifested, and where they can begin to be changed.
Scale is a concept that is more convoluted than is addressed in this thesis, and certainly goes beyond the strict boundaries of the constructions portrayed here. The focus and structures of scales shown here in this research are based on the research that current emergency management policies are built upon, which is another way that these policies can be flawed. Additionally, when focusing on individual scale it is important to remember that individuals are not to be blamed for the failings of the system which they find themselves in. For the purposes of this research, individuals are seen as beings with both the agency to take the actions they choose to take and also as beings who are heavily influenced by the social and physical space they find themselves operating within and the constraints that exist within those spaces. Individuals are not to be blamed for not being prepared, as it is not the sole responsibility of each individual to do so.
In conclusion, this thesis was aimed at helping to understand human adaptation at an individual scale in the face of ultra-destructive hurricanes to better prepare for these events in the future and help reduce inequalities in preparedness and vulnerability to damage. This study did so by answering the following questions: 1) How do individuals alter their emergency preparedness after living through an ultra-destructive hurricane? 2) What inequalities exist in terms of these alterations across demographic groups within the same geographic region? To answer these questions, a case study used a mixed methods approach to collect and analyze data on types of emergency preparedness actions taken by individuals who fit into a larger demographic category as well as why those actions were taken or not taken. The theoretical framework was grounded in natural hazard and risk vulnerability, adaptive capacity, and practice theory. The literature on natural hazard and risk vulnerability establishes the existence of inequalities along racial and socioeconomic lines when it comes to vulnerability to a natural disaster. Adaptive capacity establishes the importance of the individual who exists within a larger system and how that larger system is dependent on the individual when it comes to climate change adaptation and ability to adapt. Practice theory establishes that practices of preparedness are interwoven into the everyday lives of individuals, who exist within a larger system but can alter the system by changing or redefining their practices. Practice theory also establishes that individuals are both influenced by and are influencers of the system they find themselves in, and that the individual scale is where inequality in preparedness can be observed, and also the scale at which it can be mitigated.
The case study for this thesis centers around Houston, Texas and the significant event of Hurricane Harvey that occurred there in 2017. The hypotheses are as follows:

H1: Individuals took intentional actions to obtain additional resources and make emergency plans after Hurricane Harvey to increase their preparedness for the next extreme event.

H2: Individuals who are classified as part of minority or low-income populations took different actions aimed toward preparedness than those of high income or majority status because of a lack of resources or knowledge on how to be prepared.

Data was collected through online surveys and measured the exposure of the individual to Hurricane Harvey, individual disruption to normalcy due to Hurricane Harvey, preparedness actions taken or not taken as a result and why, and also collected demographic information. Quantitative and qualitative analysis were conducted to answer the research questions. The findings are as follows:

Individuals in Houston who were impacted by Hurricane Harvey altered their emergency preparedness by acquiring relevant information and purchasing items to have on hand in case of emergency. Inequalities exist between income groups and racial/ethnic groups who reside within the same geographic region, with higher income and racial/ethnic majority populations taking less emergency preparedness actions than low-income minority groups, largely because most participants who fell into the high-income majority category had already taken said emergency preparedness actions prior to Hurricane Harvey and therefore did not need to do so afterwards to prepare for the next major event. Low income and minority individuals took more emergency preparedness actions after Hurricane Harvey, but often low-cost ones. In all categories, and in all
emergency preparedness actions, a vast majority of participants who did not take an action did not do so because they didn’t think that they needed to. This notion highlights the individual choices and opinions of people who are in an area that will likely be impacted by another major storm event, and why individual scale is important to address when searching for answers about where to begin changing a populations emergency preparedness. In this case, it is to make sure that individuals understand the importance of each emergency preparedness action and how it will benefit them in the future.

The limitations of this research include the small sample size which may not accurately represent the experiences of the entire population of Houston. Another limitation is the possible bias caused by the necessity of having to distribute the survey almost entirely online through social media channels due to the COVID-19 pandemic. Due to the channels of distribution, a disproportionate amount of middle or high income racial majority individuals were participants and therefore an accurate representation of the income and racial/ethnic makeup of the city of Houston in the participant pool was not achieved, which could bias the results of this study.

This research contributes to existing literature and research by closing the gaps regarding individual scale in climate change adaptation literature. This research emphasizes the importance of the individual scale in natural hazards and risk vulnerability literature and also serves to enhance understanding of the importance of the individual within the conceptual framework of adaptive capacity. In addition, this research further integrates practice theory into geographic research by using the theory as justification for analysis at an individual scale. This further integrates practice theory into human geographic, climate change and inequality literature. This research also contributes to the practice theory framework by analyzing how inequality affects an individual’s capacity to change their practices.
The broader implications of this research include an advancement in understanding climate change adaptation and the need for further exploration of inequality as a factor in adaptation. This research also serves to broaden the understanding of marginalized groups of people, the reasons for their marginalization and the effect it has on them. With the use of individual scale in this research, clarification on the sources of inequality in emergency preparedness occurred and can be addressed. This research also contributes to the understanding of emergency preparedness inequality and serves as a potential basis for policy change regarding emergency preparedness and management for vulnerable populations.
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APPENDIX: MAPS AND SURVEY QUESTIONS
Survey questions:

1. Did you live in Houston, Texas at the time of Hurricane Harvey?

   • Yes
   • No

2. Do you currently live in Houston, Texas?

   • Yes
   • No

3. Were you 18 years or older at the time of Hurricane Harvey?

   • Yes
   • No

4. Did you evacuate Houston for more than two weeks for Hurricane Harvey? (Did you leave Houston before the storm hit and stayed away for more than two weeks after the storm)

   • Yes
   • No

5. What was your zip code during the time of Hurricane Harvey?
6. Do you normally have consistent access to clean, running water?

- Yes
- No

7. Do you normally have consistent access to enough food to feed yourself?

- Yes
- No

8. Do you normally have consistent access to electricity?

- Yes
- No

9. Do you normally have consistent access to safe, undamaged housing?

- Yes
- No

10. Do you normally have consistent access to heating and air conditioning?

- Yes
- No

11. Do you normally have consistent access to a telephone?

- Yes
- No
12. Immediately after Hurricane Harvey, did you have consistent access to clean, running water in your home?

- Yes
- No

13. Was the disruption to your access to clean, running water a direct result of Hurricane Harvey or another reason?

- Yes, the disruption to my water was a direct result of Hurricane Harvey
- No, the disruption to my water was not a direct result of Hurricane Harvey

14. How long were you without access to a clean, running water in your home?

- 1-6 days
- 1-3 weeks
- 1-3 months
- More than three months

15. Immediately after Hurricane Harvey, did you have consistent access to enough food to feed yourself?

- Yes
- No
16. Was the disruption to your access to enough food to feed yourself a direct result of Hurricane Harvey or another reason?

- Yes, the disruption to my food was a direct result of Hurricane Harvey
- No, the disruption to my food was not a direct result of Hurricane Harvey

17. How long were you without access to enough food to feed yourself?

- 1-6 days
- 1-3 weeks
- 1-3 months
- More than three months

18. Immediately after Hurricane Harvey, did you have consistent access to electricity?

- Yes
- No

19. Was the disruption to your access to electricity a direct result of Hurricane Harvey or another reason?

- Yes, the disruption to my electricity was a direct result of Hurricane Harvey
- No, the disruption to my electricity was not a direct result of Hurricane Harvey
20. How long were you without access to electricity?

- 1-6 days
- 1-3 weeks
- 1-3 months
- More than three months

21. Immediately after Hurricane Harvey, did you have consistent access to safe, undamaged housing?

- Yes
- No

22. Was the disruption to your access to safe, undamaged housing a direct result of Hurricane Harvey or another reason?

- Yes, the disruption to my safe, undamaged housing was a direct result of Hurricane Harvey
- No, the disruption to my safe, undamaged housing was not a direct result of Hurricane Harvey

23. How long were you without access to safe, undamaged housing?

- 1-6 days
- 1-3 weeks
- 1-3 months
- More than three months
24. Immediately after Hurricane Harvey, did you have consistent access to heating and air conditioning?
   - Yes
   - No

25. Was the disruption to your access to heating and air conditioning a direct result of Hurricane Harvey or another reason?
   - Yes, the disruption to my heating and air conditioning was a direct result of Hurricane Harvey
   - No, the disruption to my heating and air conditioning was not a direct result of Hurricane Harvey

26. How long were you without access to heating and air conditioning?
   - 1-6 days
   - 1-3 weeks
   - 1-3 months
   - More than three months

27. Immediately after Hurricane Harvey, did you have consistent access to a telephone?
   - Yes
   - No
28. Was the disruption to your access to a telephone a direct result of Hurricane Harvey or another reason? (ex. forgot to pay phone bill)

- Yes, the disruption to my telephone was a direct result of Hurricane Harvey
- No, the disruption to my telephone was not a direct result of Hurricane Harvey

29. How long were you without access to a telephone?

- 1-6 days
- 1-3 weeks
- 1-3 months
- More than three months

30. Do you believe that you are in danger of being affected by another hurricane at any point in the future?

- Yes
- No

31. If so, do you think the hurricane will be stronger or weaker than Hurricane Harvey?

- I think it will be stronger
- I think it will be weaker
32. Do you think the next hurricane will disrupt your normal access to resources? (i.e. running water, food, electricity, housing, AC/heating, telephone?)

- Yes
- No

33. Do you feel the need to prepare for future hurricanes?

- Yes
- No

34. After Hurricane Harvey, did you sign up for local weather alerts and warnings?

- Yes
- No

35. Why not?

- I had already done so prior to Hurricane Harvey
- I did not know how
- I did not think I had to
- Other - please explain (required)

36. After Hurricane Harvey, did you create a plan on how to communicate with family members if you lose power?

- Yes
- No
37. Why not?

- I had already done so prior to Harvey
- I did not know how
- I did not think I had to
- Other - Please explain (Required)

38. After Hurricane Harvey, did you create an emergency evacuation route?

- Yes
- No

39. Why not?

- I had already done so prior to Hurricane Harvey
- I did not know how
- I did not think I needed to
- Other - Please explain (Required)

40. After Hurricane Harvey, did you identify the closest emergency shelter location?

- Yes
- No
41. Why not?

- I had already done so prior to Hurricane Harvey
- I did not know how
- I did not think I needed to
- Other - Please explain (Required)

42. After Hurricane Harvey, did you create an important contact information list for family, school, work, doctors, etc., including phone numbers and email addresses?

- Yes
- No

43. Why not?

- I had already done so prior to Hurricane Harvey
- I did not know how
- I did not think I needed to
- Other - Please explain (Required)

44. After Hurricane Harvey, did you purchase an extra battery, portable charger, or battery pack for your cell phone?

- Yes
- No
45. Why not?

- I had already done so prior to Hurricane Harvey
- I could not afford to do so
- I did not know I needed to
- Other - Please explain (Required)

46. After Hurricane Harvey, did you purchase a battery powered or hand-crank radio?

- Yes
- No

47. Why not?

- I had already done so prior to Hurricane Harvey
- I could not afford to do so
- I did not think I needed to
- Other - Please explain (Required)

48. After Hurricane Harvey, did you purchase extra batteries to have on hand in case of an emergency?

- Yes
- No
49. Why not?

- I had already done so prior to Hurricane Harvey
- I could not afford to do so
- I did not think I needed to
- Other - Please explain (Required)

50. After Hurricane Harvey, did you purchase a first aid kit specifically for emergencies?

- Yes
- No

51. Why not?

- I had already done so prior to Hurricane Harvey
- I could not afford to do so
- I did not think I needed to
- Other - Please explain (Required)

52. After Hurricane Harvey, did you purchase a generator?

- Yes
- No
53. Why not?

- I had already done so prior to Hurricane Harvey
- I could not afford to do so
- I did not think I needed to
- Other - Please explain (Required)

54. After Hurricane Harvey, did you purchase a flashlight specifically for emergencies?

- Yes
- No

55. Why not?

- I had already done so prior to Hurricane Harvey
- I could not afford to do so
- I did not think I needed to
- Other - Please explain (Required)

56. After Hurricane Harvey, did you purchase a multi-purpose tool?

- Yes
- No
57. Why not?

- I had already done so prior to Hurricane Harvey
- I could not afford to do so
- I did not think I needed to
- Other - Please explain (Required)

58. After Hurricane Harvey, did you purchase waterproof matches or a lighter in a waterproof container?

- Yes
- No

59. Why not?

- I had already done so prior to Hurricane Harvey
- I could not afford to do so
- I did not think I needed to
- Other - Please explain (Required)

60. After Hurricane Harvey, did you purchase a whistle?

- Yes
- No
61. Why not?

- I had already done so prior to Hurricane Harvey
- I could not afford to do so
- I did not think I needed to
- Other - Please explain (Required)

62. After Hurricane Harvey, did you purchase a three-day supply of water specifically for emergencies?

- Yes
- No

63. Why not?

- I had already done so prior to Hurricane Harvey
- I could not afford to do so
- I did not think I needed to
- Other - Please explain (Required)

64. After Hurricane Harvey, did you acquire copies of personal documents (medications list, proof of address, deed/lease to home, birth certificates, insurance policies) for use in case of emergencies?

- Yes
- No
65. Why not?

- I had already done so prior to Hurricane Harvey
- I did not think I needed to
- I did not know how
- Other - Please explain (Required)

66. After Hurricane Harvey, did you acquire extra cash to be used in case of emergencies?

- Yes
- No

67. Why not?

- I had already done so prior to Hurricane Harvey
- I could not afford to do so
- I did not think I needed to
- Other - Please explain (Required)

68. After Hurricane Harvey, did you purchase extra fuel for your car or generator specifically for emergencies?

- Yes
- No
69. Why Not?

- I had already done so prior to Hurricane Harvey
- I could not afford to do so
- I did not think I needed to
- Other - Please explain (Required)

70. After Hurricane Harvey, did you purchase flood insurance?

- Yes
- No

71. Why not?

- I had already done so prior to Hurricane Harvey
- I could not afford to do so
- I did not think I needed to
- Other - Please explain (Required)

72. After Hurricane Harvey, did you purchase storm shutters or temporary window covers for your home?

- Yes
- No
73. Why not?

- I had already done so prior to Hurricane Harvey
- I could not afford to do so
- I did not think I needed to
- Other - Please explain (Required)

74. After Hurricane Harvey, did you purchase any type of water purification equipment (filter, drops, etc.)?

- Yes
- No

75. Why not?

- I had already done so prior to Hurricane Harvey
- I could not afford to do so
- I did not think I needed to
- Other - Please explain (Required)

76. After Hurricane Harvey, did you purchase canned or shelf stable food for emergencies?

- Yes
- No
77. Why not?

- I had already done so prior to Hurricane Harvey
- I could not afford to do so
- I did not think I needed to
- Other - Please explain (Required)

78. After Hurricane Harvey, did you purchase sandbags to protect your home from flooding?

- Yes
- No

79. Why not?

- I had already done so prior to Hurricane Harvey
- I could not afford to do so
- I did not think I needed to
- Other - Please explain (Required)

80. Did you do anything else to better prepare yourself for the next hurricane? If so, please list them below. If not, continue to the next question.

81. Do you feel you were adequately prepared for Hurricane Harvey? If not, why? When complete, or if you do not wish to answer, please continue to the next question.

82. Is there anything else you would like to share about your preparations for future hurricanes? If not, please continue to the next page.
83. What is your household size?

84. What is your race/ethnicity?

85. What is your annual household income range? (before taxes)

86. What is your age?