The Theme: Demographic and Household Characteristics

Demographic characteristics and their relationship to hurricane evacuation decision-making have been extensively studied, usually through surveys or questionnaires. The relationships between the most common demographic characteristics and evacuation are briefly summarized below:

**Household income** has been shown to impact hurricane evacuation (Baker, 1979; Dash and Gladwin, 2007; Gladwin and Peacock, 1997; Hasan et al., 2011; Lazo et al., 2010; Zhang et al., 2004). Families with higher incomes are more likely to evacuate due to the fact that they have the financial resources to do so.

**Age** is another important factor that has been extensively studied (Aguirre, 1991; Arlikatti et al., 2006; Baker, 1979; Baker, 1991; Burnside et al., 2007; Dash and Gladwin, 2007; Gladwin and Peacock, 1997; Heath et al., 2001; Huang et al., 2012; Lazo et al., 2010; Zhang et al., 2004). Older residents and the elderly are shown to be less likely to evacuate due to lack of mobility or necessary resources.

**Household size** also impacts hurricane evacuation decision-making (Arlikatti et al., 2006; Baker, 1991; Gladwin and Peacock, 1997; Hasan et al., 2011; Zhang et al., 2004). The impact of
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household size is generally mixed between studies, though some do mention how larger households may be less likely to evacuate due to the increased amount of resources needed to evacuate.

**Household ownership:** The majority of the research also indicates that those who own homes are less likely to evacuate as opposed to those that rent because they have more incentive to protect their own property.

**Gender** has been extensively studied (Aguirre, 1991; Arlikatti et al., 2006; Baker, 1979; Dash and Gladwin, 2007; Dow and Cutter, 1998; Gladwin and Peacock, 1997; Huang et al., 2012; Murray-Tuite and Wolshon, 2013; Riad et al., 1999; Whitehead et al., 2000; Zhang et al., 2004). The majority of the research claims, with high certainty, that women are more likely to evacuate than men as women have higher risk perception prior to deciding to evacuate than men.

**Households with pets** have also recently been studied in this context (Baker, 1991; Brackenridge et al., 2012; Heath et al., 2001; Murray-Tuite and Wolshon, 2013; Whitehead et al., 2000). Those households with pets or attachments to pets are less likely to evacuate due to the lack of locations that accept and can care for pets; as well as the cost associated with evacuating pets.

**Households with children** are important to consider when evaluating evacuation decision-making (Baker, 1979; Baker, 1991; Fischer et al., 1995; Gladwin and Peacock, 1997; Hasan et al., 2011; Heath et al., 2001). Households with children are more likely to evacuate, mostly due to the drive to protect the children. However, it is important to note that this statement generally relates to households with younger children. Studies that included households with older children or teenagers often provided inconsistent effects on hurricane evacuation.

**Education** has also been studied (Baker, 1979; Baker, 1991; Dow and Cutter, 1998; Heath et al., 2001; Riad et al., 1999; Whitehead et al., 2000; Zhang et al., 2004). The research shows no clear relationship between this variable and evacuation-decision making at any level of formal education.

**Housing or dwelling type** generally impacts evacuation decision-making (Hasan et al., 2011; Horney et al., 2010; Whitehead et al., 2000). Individuals residing in mobile homes are more likely to evacuate from an approaching hurricane. Those residing in single family households are less likely to evacuate.

**Length of residence** also impacts evacuation decisions (Arlikatti et al., 2006; Baker, 1979; Baker, 1991; Gladwin and Peacock, 1997; Lazo et al., 2010; Zhang et al., 2004). Typically, those that have lived in an area longer are more likely to stay behind, while newer residents are more likely to evacuate.

It is important to note that each of the conclusions relating to the variables listed above are generally supported by the evacuation literature. Sociodemographic characteristics are difficult to
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analyze collectively due to the fact that each study has different ways of operationally defining them. For example, income can be subdivided into different income levels, yet these levels can change depending on the specific study. This makes studying demographic variables and their influence on hurricane evacuation extremely difficult. Generally speaking, there is not enough consistency to confidently claim how most of these demographic characteristics impact hurricane evacuation. It is important to stress that these statements are generalizations of the literature, and these variables are not mutually exclusive. This adds an extra complication to the understanding of these variables and their influence on hurricane evacuation.

THEME: Perceived Storm Characteristics

- Hurricane intensity brought up frequently - defined via hurricane category (wind speed).
- Stronger hurricanes resulted in increased hurricane evacuation.
- Multiple ways in which perceived storm characteristics defined - makes it hard to compare, though intensity is common throughout almost all studies.

Perceived storm characteristics have been shown to have a substantial influence on hurricane evacuation decision-making (Arlikatti et al., 2006; Baker, 1979; Baker, 1991; Burnside et al., 2006; Dow and Cutter, 1998; Dow and Cutter, 2000; Huang et al., 2012; Lazo et al., 2010; Lazo et al., 2015; Lindell et al., 2005; Martin et al., 2017; Urbina et al., 2003; Whitehead et al., 2000). However, it was found that perceived storm characteristics were defined differently between studies. A majority of the studies defined perceived storm characteristics via the intensity or severity of the hurricane on the Saffir-Simpson scale. Therefore, perceived storm characteristics were based mostly on the hurricane’s wind intensity. Most studies showed that as the category of the storm increases, so does the likelihood of evacuation. This is due to increased personalization of the risk associated with the storm characteristics. It can be generally stated that perceiving hurricanes as more intense results in greater rates of evacuation. As previously mentioned, hurricane intensity was not the only way in which perceived storm characteristics were defined. Storm characteristics such as its location or expected forecast track were used to gage the storm characteristics in some studies (Baker, 1979; Baker, 1991; Burnside et al., 2006; Dow and Cutter, 1998; Dow and Cutter, 2000; Huang et al., 2012; Lazo et al., 2015). An individual’s “storm savvy” was also mentioned, corresponding to individual characteristics such as how early one becomes aware of the hurricane or how long one monitors the storm, though these were not shown to have significant relationships with hurricane evacuation in a majority of the research. A person’s confidence in the weather forecast can also impact perceived notions of the storm characteristics, though the knowledge of
its impact is limited. Overall, perceived storm characteristics as defined by hurricane category and intensity were shown to most influence hurricane evacuation most.

THEME: Perceived Evacuation Impediments

- All perceived evacuation impediments lead to lower likelihood of evacuation.
- Transportation concerns frequently mentioned.
- Fear of looting/protecting property frequently mentioned.
- Caring for pets frequently mentioned.
- Affordability frequently mentioned.

Perceived evacuations impediments are defined as barriers that factors into an individual or family’s decision not to evacuate. There are some common themes that arise when analyzing perceived evacuation impediments within the overall research. These themes include the fear of looting or protecting property, being able to financially afford to evacuate, the overall lack of resources (both socially and economically), caring for pets, and having transportation concerns (Aguirre, 1991; Arlikatti et al., 2006; Baker, 1991; Bateman and Edwards, 1992; Burnside, 2006; Chen et al., 2006; Dash and Gladwin, 2007; Dash and Morrow, 2000; Dow and Cutter, 2000; Dash and Peacock, 1997; Farmer et al., 2017; Heath et al., 2001; Huang et al., 2012; Lazo et al., 2010; Lindell et al., 2005; Riad et al., 2009; Cutter and Smith, 2009). Thus, particular attention should be given to these subjects. A majority of the research that investigates perceived evacuation impediments discusses individuals’ fears of looting or urge to protect their property from the approaching hurricane. These fears often reduce the likelihood of evacuation. Financial affordability is also another evacuation impediment for many individuals. Evacuation is described as a financially stressful action that tends to decrease the likelihood of evacuation. Lack of resources includes the same economic stressor, but also includes lack of social resources such as family or friends. For example, individuals without close friends or family who live outside the affected area may be less likely to evacuate, as they don’t know where to evacuate to. Therefore, having access to such economic and social resources generally increases the likelihood of evacuation. The care of pets is another growing concern in the literature. Being physically able to evacuate with a pet is difficult, and thus reduces the chances of evacuation. Concern about whether shelters will accept pets is also common, and further reduces the likelihood of evacuation. Finally, transportation concerns were discussed frequently. Households are becoming more concerned about traffic jams on evacuation routes. Maintaining consistent traffic flow is important to promoting evacuation. It is important to note that although many articles find these issues to be of concern, there are some
empirical studies that do not find that these impediments statistically influence evacuation decision-making. As such, the extent of the influence of these impediments on actual hurricane evacuation is still debatable.

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**THEME: Official Warning**

- The focus should be on the source, reliability, and receipt of or access to warning information.
- Warning is a social process: more information, more consistency, more reliability, and more personalization = more protective action.
- Media and public officials are generally more important to consider than family members, though this is not supported in every study. Each study ranks order of most important source different.
- Voluntary vs mandatory evacuation orders and hurricane watches and warnings help with evacuation, but alone do not spur protective action.

Generally, receiving official warning information about a hurricane increases the likelihood of evacuation (Aguirre, 1991; Arlikatti et al., 2006; Baker, 1979; Baker, 1991; Bowser et al., 2015; Burnside et al., 2007; Dash and Gladwin, 2007; Dow and Cutter, 1998; Dow and Cutter, 2000; Fischer et al., 1995; Gladwin and Peacock, 1997; Hasan et al., 2011; Huang et al., 2012; Lindell et al., 2005; Martin et al., 2017; Murray-Tuite and Wolshon, 2013; Sorensen, 1991; Whitehead et al., 2000; Widener et al., 2012; Zhang et al., 2004). The majority of the studies in this literature review support the idea that receiving or accessing warning information is important for evacuation decision-making. The research also indicates that the source providing warning information is also important. Many individuals receive and rely heavily on news media for warning information, such as television networks and radio stations, although some segments of the population are more likely to rely on community or local groups (DeYoung et al., 2016a). Additionally, some studies found that having public officials personally disseminate warning information door-to-door can also substantially increase the likelihood of evacuation, though the impact of media sources seems to be more important. Notification of warning messages from family members of friends is also important, though most of the research suggests protective action is more likely taken if it is disseminated by public officials or members of the media.

Evacuation is more likely when there are multiple sources of consistent warning information and individuals can confirm the warning information. This emphasizes the idea of warning as a social process. In other words, individuals must first obtain the warning information. They will then
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process, confirm, and personalize the information before deciding whether or not to take protective action. There are numerous factors that impact the reliability of the overall warning message. The clearer and more frequent a warning message, the more likely it is to spur protective action. The issuance of hurricane watches and warnings, as well as voluntary and mandatory evacuation orders also increases the likelihood of evacuation. Personalizing the warning message is most essential to promoting evacuation decisions.

THEME: Hurricane Experience

• Hurricane experience is measured in many different ways and can lead to inconsistent results.
• “Crying wolf” and false alarm topics often introduced or discussed in relation to hurricane experience.

Previous hurricane experience has been frequently discussed in the literature relating to hurricane evacuation decision-making (Arlikatti et al., 2006; Baker, 1979; Baker, 1991; Bowser and Cutter, 2015; Burnside et al., 2007; Burnside et al., 2007; Chen et al., 2006; Dash and Gladwin, 2007; Dow and Cutter, 1998; Dow and Cutter, 2000; Fischer et al., 1995; Gladwin and Peacock, 1997; Hasan et al., 2011; Horney et al., 2010; Huang et al., 2012; Hunt et al., 2012; Lazo et al., 2015; Lindell et al., 2005; Riad et al., 1999, Sadri et al., 2017; Serulle and Cirillo, 2017; Urbina and Wolshon, 2003; Zhang et al., 2004). However, the influence of previous hurricane experience on future evacuation is inconsistent. Part of this inconsistency is due to the different ways in which hurricane experience is defined. For example, some define hurricane experience as whether or not a hurricane has struck the respondent’s area before (and if so, how many and to what severity). Some define it with respect to the damage a prior hurricane has caused to a specific individual or household. Others simply ask in broad categories how familiar an individual or household are with hurricane conditions, or whether or not a household has evacuated before. The timing of prior experience is also variable (e.g. whether it be in the last year, 5 years, 10 years, etc. Most of the research conclusions state that prior experience is not strongly related or simply not related at all to future evacuation, but it is variable. The subjects of the “cry wolf” effect and false alarms were also frequently mentioned. Generally, it was noted that both of these subjects had little influence on hurricane evacuation behavior, though consistently poor evacuation experiences will result in lower evacuation rates in future scenarios. What is interesting to note is the fact that in a majority of these studies, individuals’ prior hurricane evacuation behavior is often consistent with their future evacuation behavior. In other words, a majority of individuals who evacuated for a hurricane
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Before are more likely to evacuate again and vice versa. Again, this a generalized statement and it is important to note that the influence of prior hurricane experience on evacuation behavior is variable.

THEME: Expected Personal Impacts

• The safety of a house was a major recurring theme. Those who considered their homes safe were much less likely to evacuate.

• Expected personal impacts in terms of their effect on safety was mentioned often. Individuals are more likely to evacuate if they view a great risk to themselves or family members.

• Some studies evaluated wind vs flooding risk potential - of these, more people evacuated if they felt threatened by flooding more than wind, but they were also more likely to evacuate for higher category hurricanes.

• Personalization of risk directly relates to expected personal impacts.

The expected personal impacts of an approaching hurricane are important factors to consider when analyzing hurricane evacuation decision-making (Aguirre, 1991; Arlikatti et al., 2006; Baker, 1979; Baker, 1991; Burnside et al., 2007; Dash and Gladwin, 2007; Dow and Cutter, 1998; Dow and Cutter, 2000; Gladwin and Peacock, 1997; Horney et al., 2010; Huang et al., 2012; Lazo et al., 2010; Riad et al., 1999; Whitehead et al., 2000; Zhang et al., 2004). Most of the literature associated expected personal impacts with the concept of personalization. In fact, many studies cite that the personalization of potential risks is the most important factor to influence hurricane evacuation decision. However, the ways in which these expected personal impacts are defined are different depending on the particular study. Most studies utilize coded survey or open-ended interview question to assess this variable. In the majority of the research, risk and expected personal impacts are assessed based on the safety and sturdiness of the respondent’s housing structure. The construction materials of the roof and walls are often studied in relation to how a household interprets their risk. The consensus is that if residents believe their house is safe, they are less likely to evacuate. Conversely, housing structures deemed unsafe will promote evacuation. Those that live in mobile homes will also evacuate. The influence of wind and flooding is also noted. More studies emphasize the risk of flooding (mostly by storm surge) to be more significant in influencing evacuation, yet people are also more likely to evacuate for a higher category hurricane, a measurement that reflects wind speed, not risk of storm surge or inland flooding (DeYoung et al., 2016b). That being said, the threat or wind damage to a roof or structures has also been shown.
in some studies to significantly promote evacuation (DeYoung et al., 2016b). The personalization of harm to one’s self or household has a substantial influence on hurricane evacuation.

THEME: Environmental and Social Cues

- Environmental and social cues are all defined differently but both are important to influencing evacuation. The level of influence is inconsistent and usually cannot be compared.
- Actions in neighborhoods influence evacuation decisions.
- Social networks are important in influencing evacuation as long there is a high number of social network connections.
- Social and environmental cues positively influence hurricane evacuation; however, it becomes more convoluted when specifically looking at individual cues (e.g. track vs strength vs landfall location or family size vs. how many times they talked to family vs. watching friends evacuate, etc.).

Environmental and social cues are variables that have been investigated due to their impact on hurricane evacuation decision-making (Aguirre, 1991; Arlikatti et al., 2006; Baker, 1979; Baker, 1991; Burnside et al., 2007; Dash and Gladwin, 2007; Dow and Cutter, 1998; Dow and Cutter, 2000; Fischer et al., 1995; Hasan et al., 2011; Horney et al., 2010; Huang et al., 2012; Lindell et al., 2005; Murray-Tuite and Wolshon, 2013; Riad et al., 1999; Sadri et al., 2017; Serulle and Cirillo, 2017; Whitehead et al., 2000; Widener et al., 2012). Environmental cues are defined as characteristics about the hurricane itself, such as its intensity, location, track, etc. Social cues are those that involve the influence of friends, family, community, social network, shelter-type, etc. on hurricane evacuation. Both environmental and social cues positively influence hurricane evacuation, though the impact of individual variables within these two broad categories are inconsistent and debatable. Surveys and questionnaires were the most common methodologies used to investigate these variables. Some studies found that hurricane characteristics such as severity and landfall location have a strong influence on the hurricane evacuation decision. For example, the stronger the storm and the closer the forecasted landfall is to an individual, the greater the evacuation potential. Generally, individuals contact friends and family before the approach of a hurricane. These social connections greatly influence hurricane evacuation decisions and typically increases in social networking align with greater evacuation. In addition, a majority of individuals who do choose to evacuate choose to stay with family or friends. A large part of the literature also mentions that the actions within the neighborhood greatly impact evacuation decision-making.
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For example, individuals are more likely to evacuate themselves if they see others in the neighborhood evacuating as well. There is no real consensus whether environmental cues or social cues are more likely to persuade individuals to evacuate, possibly due to the multiple ways in which each of these categories are defined, but it can generally be stated that both cues do increase the likelihood of hurricane evacuation.

Theme: Unnecessary Evacuation

- Shadow evacuation most common theme - impacts perceived evacuation impediments which then can impact overall evacuation decision-making.
- False alarm or cry wolf also mention - most studies show it is not as important as most think.

Previous unnecessary hurricane evacuation is defined as when an individual or family unit evacuates, though is not advised to do so. Though not as researched as other topics, previous unnecessary evacuation still plays a role in future hurricane evacuation decision-making. The majority of the studies that mention unnecessary evacuation discuss the recurring theme of shadow evacuation, which is the evacuation of individuals who are not necessarily in “risk areas” or zones subjected to voluntary or mandatory evacuation orders. Shadow evacuation has been shown to have negative impacts on those attempting to evacuate from mandatory or high-risk regions. There are concerns for increasing traffic jams and other disruptions of traffic patterns due to shadow evacuation, possibly leading to a lower likelihood of evacuation (Bowser and Cutter, 2015; Dash and Morrow, 2000; Gladwin and Peacock, 1997; Huang et al., 2012). The “cry wolf” or “false alarm” effect has also been discussed in relation to unnecessary hurricane evacuation, with most studies in this review generally stating that these factors do not have a substantial influence on hurricane evacuation decisions (Bowser and Cutter, 2015; Dow and Cutter, 2000). Thus, it is important to understand the increasing concern for unnecessary evacuation, or specifically, shadow evacuation, and its effect on individuals.
Coastal proximity is an important factor within the Protective Action Decision Model (PADM) that has substantial influence on hurricane evacuation behavior. Coastal proximity was generally defined via distance (typically in miles) from the coast of the ocean or other large body of water or measured via geographic risk areas along certain coastal sections. The majority of the studies analyzed in this literature review conclude that the closer an individual is to the coast or large body of water, the more likely he or she is to evacuate (Baker, 1979; Baker, 1991; Bowser and Cutter, 2015; Chen et al., 2006; Dash and Morrow, 2000; Dash and Cutter, 2000; Gladwin and Peacock, 1997; Huang et al., 2012; Martín et al., 2017; Sadri et al., 2017; Sorensen, 1991; Widener et al., 2012; Zhang, 2004). The extent to which this variable influences hurricane evacuation is mixed depending on the specific study. However, a majority of the studies agree that evacuations along the coast are generally done well. Locations exposed to open bodies of water are more likely to encourage evacuation behavior. Yet there is often significant threat to inland areas near tributaries. Recent research suggests those living inland are less likely to personalize warnings to evacuate (Davidson et al., 2019).