Guidelines, Recommendations, and Toolkits for Flood Communication and Awareness, TWDB Contract # 2201792659

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Executive Summary:

The Texas Water Development Board (TWDB) Flood Priority Research Project aims to conduct research based on evidence to enhance the public's awareness of flood risks and decision-making in Texas. Part 1 of this project researched and pinpointed four critical end-user groups, determining their flood information needs and the nature of their flood-related decisions. These high-impact, broad-reach priority groups are:

1) People who predominately speak Spanish, because 28.7% of Texans speak Spanish at home and they are often missed in flood warnings and messages.
2) New Texans moving into Flash Flood Alley (the part of the state where most are relocating), because they bring their expectations about flooding with them, which are often not applicable to Texas.
3) Young males 18-35, who account for the largest percentage of flood deaths by driving through flood waters.
4) Older adults with disabilities, who are a growing demographic in Texas and need to prioritize planning for floods and potential evacuations.

In addition to Part 1, additional research and fieldwork allowed the creation of the following additional deliverables:

- Part 2 devises an outreach campaign plan, tapping into specific media, themes, and messaging for outreach. It also encompasses focus group sessions to assess the feasibility of the materials generated and a state-wide survey designed to better understand the needs of the four prioritized end-user groups.
- Part 3 crafts a comprehensive communication campaign toolkit. This includes messages, graphics, and communication materials for a general Texas audience as well as for our four prioritized end-users. It also outlines strategies for the efficient distribution of the outreach content.
- Part 4 delineates the evaluation metrics to measure the efficacy of the state's flood awareness and communication endeavors.
- Part 5 bolsters the accessibility and efficacy of the developed flood-related outreach materials. It discerns the right stakeholders capable of conveying TWDB's messages to the four priority end-user groups.

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Part 1: Literature Review and Target End-User Identification

1   Part 1 Overview

The first section of this report delves into the research literature in risk and health communication, pinpointing crucial factors that guided our selection of specific audiences for this project. It is pivotal to understand that an overly broad approach to raising flood awareness and communicating flood risk will likely impede effectively reaching any particular end-user group. Consequently, we lay out an evidence-backed blueprint of our strategy to identify the most suitable audiences for targeted outreach.

The literature review encompassed the nuances of audience needs regarding flood information, varied flood risks, and indicators of vulnerability. From this analysis, we distilled two fundamental categories of risk: safety and property. A prime region that emerged as a hotspot for both these risks is Flash Flood Alley. Spanning 16 counties in the heart of Texas, this zone not only bears significant flood risk but also is absorbing the state's highest influx of newcomers. Additionally, our research on linguistic requirements in Texas, combined with prevalent practices in risk campaigns, informed our recommendation to disseminate messages in both English and Spanish, catering to all the prioritized end-user groups.

We selected the four priority end-users based on extensive research. We scrutinized historical flood risks, juxtaposing them against factors of social vulnerability. By delving into academic and market literature we were able to pinpoint best practices in flood awareness targeted to varied audiences. Our selection of the four priority groups was influenced by understanding the distinct needs of various groups, along with the myriad flood-related decisions they face. Subsequently, we interviewed 31 key stakeholders and 35 potential end-users. The key stakeholders comprised flood modeling experts, Federal Emergency Management Agency (FEMA) representatives, emergency management officials, a county judge, a State of Texas Emergency Assistance Registry (STEAR) program representative, an individual from the Harris County Modeling, Assessment and Awareness Project (MAAPnext), and several personnel from the National Oceanic and Atmospheric Administration/National Weather Service (NOAA/NWS).

2   Approach to Defining Audiences for Flood Awareness Messages

Most prior flood risk communication research has focused on warnings and actions during floods (e.g., Rahn et al., 2020; Wood et al., 2018) and unfortunately, the U.S. and other places around the world have very little research on how governmental organizations can motivate community members to mitigate and prepare for floods. While FEMA is currently developing messages to motivate people to better understand their flood risk and purchase flood insurance (e.g., https://www.floodsmart.gov/), only a few countries have researched how to communicate better around flooding. Australia has dedicated the most research to understanding flood education by evaluating their flood-safety programs and assessing how to better communicate with their audience (e.g., Arbon et al., 2016; Duffy, n.d.; Gissing et al., 2016; Hamilton et al., 2018a; Nieland & Mustag, 2016; Teo et al., 2019). In the U.S. — with the exception of Turn Around Don't Drown® (TADD; a program launched in Texas in 2003 and housed at the National Weather Service) — there have been few flood-protective messages disseminated in the U.S., and reviews of the industry and academic literature reveal that almost none of them have been

evaluated formally. Therefore, it is important to realize that this TWDB-UT collaborative research effort will be an important step in the direction needed to shift the flood awareness perceptions of Texans and help them make informed decisions around how to mitigate and prepare for floods.

2.1 Guiding Principles From Research

Considering the dearth of flood-specific messaging research it is important to turn to the related bodies of research on health communication and risk communication to guide our choices in this deliverable on audience focus. Health and risk communication are helpful because both fields focus on prevention and behavior change — which are highly relevant to this project. They also have well-developed theories that explain how people make decisions and interpret messages. Finally, there are decades of collected empirical data that help us understand people's attitudes, behaviors, and beliefs and the actions they may or may not take related to health and safety.

These are empirical findings from health and risk messaging that apply to the current project:

1) Messages must have a level of personal relevance if the goal is to change behavior (e.g., Lustria et al., 2013), such as raising awareness of flood risk. This is a fundamental empirical finding used to justify selecting specific audiences and tailoring or targeting messages for each group (see section 2.2 for a detailed discussion of these concepts).
2) The population in Texas is not uniform and considering the lack of success with other country-wide efforts, like Germany (Osberghaus & Hinrichs, 2021), it will be difficult to find a single message that motivates different types of Texans to action.
3) Efforts to deliver messages to individuals are expensive (think about corporate advertising dollars spent) and most of them never reach their audience. This is because people can become overloaded with messages, and they simply ignore messages they do not find immediately relevant to them — often called selective attention (Treisman, 1969).
4) The type of media used to send messages really matters. In some places, traditional media — such as television (e.g., weather forecasters) — and community groups (e.g., religious organizations, homeowners' associations) are still some of the most effective ways to reach specific audiences (Ryan et al., 2020). However, other audiences (e.g., young adults) may be better reached through social media and the use of social influencers because that is how they consume many forms of information (Kostygina et al., 2020).
5) Trust and credibility of the source delivering the message is vital, and these perceptions have changed recently (Balog-Way et al., 2020). The rise of mis- and dis-information makes people question some sources and blindly trust others. There has also been a politicization of science. Since the 1970s, public trust in science has declined among conservatives and people who frequent church (Gauchat, 2012). There are other demographic groups that historically and currently have lower levels of trust in science including women, non-White people, individuals with lower family income, and people located in the southern part of the U.S. (Gauchat, 2012). These demographic differences are relevant for the current project.
6) Risk communication must be treated as an ongoing process if we are to accomplish lasting outcomes (Balog-Way et al., 2020; Kasperson, 2014).

7) People need to know what to do, and not just become aware of their flood risk. This is related to self-efficacy (i.e., belief they can perform what is recommended) and response efficacy (i.e., belief that if they perform the action, it will work), and could be helpful in achieving collective efficacy (i.e., belief that one's group is capable of organizing and helping achieve the goal; Babcicky & Seebauer, 2020). These factors need to be considered in this project.

2.2   Understanding the Value of Message Targeting and Message Tailoring

Since the 1990's, scholars have demonstrated that targeted and tailored messages are more effective than generic messages that try to reach too many different audiences (Kreuter et al., 1999; Skinner et al., 1999). When trying to reach audiences with messages, it is important to balance that reach with the budget (or anticipated budget) required for that reach. In recent published studies on getting Californians to reduce their water consumption during a drought, researchers found that increased media coverage aligned with people's conservation behavior changes (Quesnel & Ajami, 2017). However, paid media coverage is expensive because water-related messaging must compete with general for-profit advertising and well-funded nonprofit and government campaigns. For example, in Year 1 of the Centers for Disease Control and Prevention's (CDC) "Tips from Former Smokers" national advertising campaign, they spent $54 million and estimated that they got 100,000 people to quit smoking (CDC, 2013). FEMA also had recent mass media campaigns, like their current campaign for free and low-cost flood preparedness options (FEMA, 2022), but they partnered with iHeartMedia, and this research team could not find how much they spent or if the campaign has had any direct impacts to date.

Trends show the potentially important role that nonprofit organizations can play in disseminating campaign messages, especially when they are partnering with government-initiated efforts. Among X (formerly called Twitter) users who posted tweets about the "Tips from Former Smokers" campaign, individuals and nonprofit organizations (e.g., American Academy of Pediatrics, American Lung Association) posted 696 tweets (39.0%) and 526 tweets (29.5%), respectively, compared to government and for-profit organizations (271 tweets (15.1%) and 247 tweets (13.8%) respectively; Chung, 2016). Similarly, half of all YouTube Public Service Announcements (PSAs) between 2006 and 2015 spotlighting the global water crisis originated from nonprofit organizations, while the other half of PSAs were from for-profit (23.58%) and government bodies (26.42%; Krajewski et al., 2019).

In health communication research (which shares many similarities with flood risk research), there are three primary ways used to customize health messages to meet specific audiences.

1) Message targeting, a form of group message: customizing messages for "shared characteristics of population subgroups, such as lifestyle factors like recent college graduates in emerging careers in small cities" (Schmid et al., 2008, p. 32). This is based on advertising principles of audience segmentation.
2) Message tailoring, an individual message: fit messages to individual characteristics. For example, tailoring messages to people depending on their level of concern about flooding would entail sending different messages to those with higher levels of concern than those with lower levels. Identifying those individual characteristics can be very difficult and the typical approach is to survey individuals and immediately follow with a message tailored

to what was found in the survey. It is possible that with generative artificial intelligent approaches, tailoring may become easier in the future (cite).
3) Combination of targeting and tailoring approaches

Tailoring messages typically costs more than targeting messages because you are identifying characteristics of individuals (e.g., the specific personality factors that motivate them to seek flood information or change their flood preparedness behaviors) and the message is then tailored for that individual.

2.3   Social Norms and Perception of Risk Probability as Behavior Change Motivators

One way to determine the right approach to use is to identify variables — e.g., social norms, values, knowledge — that predict the desired behavior (Slater, 2007). Fortunately, our UT team has previously conducted a Texas-wide survey of these types of variables (Stephens et al., 2023), and in that study, we found the combination of social norms (i.e., behaviors people perceive as common) with flood risk probability was the primary driver of how people in both flood-prone and less flood-prone areas decide to seek flood risk information. This suggests that 1) if a resident knows their family or community thinks it's important to seek flood risk information, they will also be more motivated to search for flood information, and 2) if a resident knows their probability (i.e., likelihood) of experiencing a flood is high, they will experience more negative emotions around flooding, and this in turn increases their motivation to seek flood information. What we do not know from this study are the more nuanced individual factors and beliefs that drive people to seek flood risk information. See Stephens et al. (2023) for the full details of this study.

Furthermore, recent research (i.e., Lim et al., 2022) studied more nuanced forms of social norms that include both descriptive and injunctive norms. Descriptive norms describe how common a behavior is in a social group, and injunctive norms describe whether the behavior is considered desirable by the group. Prior research in disaster risk contexts has shown that messages using descriptive norms are not enough to prompt homeowners to become more prepared for floods (Mol et al., 2021). The study by Lim et al. (2022) also employed injunctive social norms, which proved more effective in moving people to action. The authors tested the impact of referring to the weather forecasters (and neighbors) as relevant social groups who recommended installing water barriers (or purchasing flood insurance), and they combined this with a message indicating social disapproval. Below is a copy of the message they used that significantly impacted mitigation intentions:

> "All of your local weather forecasters agree that everyone living in hurricane-prone areas should install water barriers. Because if you don't, your damaged home can harm others' homes and lower your community's property values" (Lim et al., 2022, p. 6).

It is important to realize that their study, like many flood mitigation studies, combined two different mitigation behaviors: flood insurance and installing water barriers. Studies of these behaviors often find different motivators for each type of desired mitigation behavior, so it will be important for us to separate these mitigation behaviors. It is also important to carefully consider how to discuss the types of desired flood awareness and what is needed to help people feel like their actions will have a positive outcome (also called response efficacy).

2.4   Prior Relevant Research by the UT-Austin Team

A major deliverable in the UT-Austin Team's prior project with TWDB (2021-2022) was a literature review that resulted in identifying the audience factors that influence flood education and communication programs (see Figure 2.1) and the creation of a resource for local flood officials.

Figure 2.1 Model of Audience Factors Influencing Flood Education & Communication
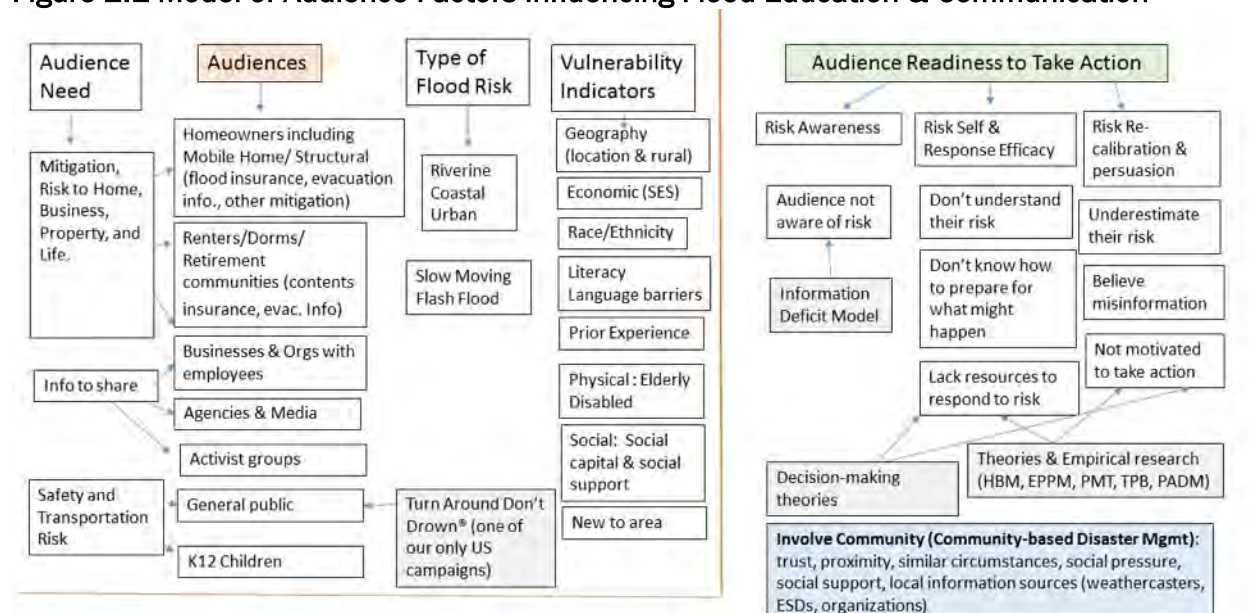
Figure Information: This model summarizes audience groups and their needs for flood information, types of flood risk, vulnerability indicators, as well as the theoretical and empirical findings used to understand how to help audiences become more aware of their flood risks and motivate them to take protective action. *Source: Stephens, K. K., Carlson, N., Robertson, B. W., Tich, K., & Sibi, T. (2020). Technical memorandum 1: Literature review and target audience research. The University of Texas at Austin.*

While this model was developed for educational efforts, it is also helpful in the current project on audience identification for raising flood awareness. Needs to mitigate risk to home, business, property, and life are shared by three audiences: Homeowners, Renters, and Businesses/Organizations. Needs for safety and transportation are distributed among the general public and school-aged children. They also used literature to identify types of flood risk, vulnerability indicators, and relied on risk-communication research to identify variables that influence audience decisions to take action. Note that involving the community in flood-risk actions — e.g., having them provide input at community meetings — offers many advantages. These include increasing trust, identifying issues relevant to their location, identifying access to social resources, and encouraging them to access local information sources such as weather forecasters.

3   Research Approach

The literature review and end-user target-audience research used the following process.

3.1   Website Review

We reviewed the following websites and included relevant resources identified here, as well as through market research in Table 6.1.

- U.S. Resources: Center for Disease Control and Prevention (CDC), United States Environmental Protection Agency (EPA), Federal Emergency Management Agency (FEMA), National Flood Insurance Program (NFIP), National Oceanic and Atmospheric Administration (NOAA), United States Geological Survey (USGS), United States Army Corps of Engineers (USACE), and National Weather Service (NWS).

- Texas Resources: Texas General Land Office (GLO), Texas Division of Emergency Management (TDEM), Texas Water Development Board (TWDB), Texas Department of Transportation (TxDOT), Texas State Soil & Water Conservation Board (TSSWCB), Texas Geographic Information Office (TxGIO, formally known as Texas Natural Resources Information System, or TNRIS), Texas Commission on Environmental Quality (TCEQ), Galveston Bay Estuary Program, Texas A&M AgriLife Extension (including Texas Community Watershed Partners), Texas Sea Grant College Program, Harris County Flood Control District, and several Councils of Governments (COGs, including the Houston-Galveston Area Council) as well as major cities that will be explored more fully in Part 2 of this report.

3.2   Searched Databases

We found academic articles using the following databases: Elsevier ScienceDirect, Taylor and Francis, ProQuest, EBSCOhost, Health Research Premium Collection, Wiley Online Library, Springer Link, and Google Scholar.

Search words included: best practices in flood awareness education; best practices in flood communication; flood awareness campaigns; flood risk; flood risk communication; natural hazards risk communication; risk communication theory; behavior change and floods; decision making and disasters; disaster preparedness and flood; disaster preparedness; communication and tornados; communication and hurricanes; communication and fires; communication and lightening; communication and earthquakes; communication and weather safety; urban flooding; flash flooding; citizen science and floods; resilience and natural disasters (had to be selective); social vulnerability and floods; Latina/o/e/Mexican Americans and flood preparedness; race and ethnicity and floods; older adults and floods; climate change and flood preparedness; homeowners and floods; mitigation and floods, insurance and floods; floods and young adults; and flood awareness and college students.

3.3   Identified Systematic Reviews

In addition to finding over 80 key articles related to our current project on flood risk awareness and communication, we also identified systematic literature reviews. The findings from these appear in section 5 where we organize this literature and synthesize the conclusions. The article citations appear in the extended bibliography at the end of this report.

3.4   Searched Social Media

Examining the social media landscape helps to better understand how this communication medium may contribute to recommendations that apply to all parts of this report. We captured how different stakeholders such as cities, counties, businesses, and public officials share flood information on social media. We collected social media during September of 2022, which was National Preparedness Month, and during Texas Flood Awareness Week in May of 2023. Our team also collected data during California's Tropical Storm Hilary in August 2023, Florida's Hurricane Idalia in August 2023, and during Hurricane/Post-Tropical Cyclone Lee in September 2023. The analyses did not employ any specific analytical or review tools. Instead, we thoroughly examined content from various social media platforms such as X (formerly called Twitter), Instagram, LinkedIn, and Facebook by using word searches ("flood awareness week", "Hilary", "Idalia", "Lee") as the events happened. These analyses appear in Part 2 of this report.

3.5   Conducted Interviews With Key Informants

We used our contacts as well as the list of key informants shared by the Texas Water Development Board to interview people who have expertise on flood models, datasets, and/or visualization. Our goal was to learn more about methods and approaches that can assist selected end-users in their flood decision-making. We contacted a total of 26 people and secured 1-hour in-depth interviews with 13 individuals. The interviewees' affiliations include the following:

- Harte Research Institute at Texas A&M University-Corpus Christi,
- Coastal Bend Bays & Estuaries Program,
- Galveston Bay Estuary Program (a program of the Texas Commission on Environmental Quality (TCEQ)),
- Adaptation International,
- National Weather Service (NWS) Forecast Office Houston/Galveston, TX,
- Virginia Tech Flood experts,
- Texas Floodplain Management Association (TFMA),
- National Weather Service-West Gulf River Forecast Center (NWS-WGRFC),
- Harris County Flood Control District,
- Public policy consulting firm based in Texas,
- Institute for a Disaster Resilient Texas (IDRT),
- Texas Realtors/Texas Real Estate Commission, and
- Texas A&M AgriLife Extension Community Health and Resource Management (CHARM)

Additionally, we interviewed two fire chiefs, three emergency management coordinators, one Floodplain Administrator, a county judge, a group of three FEMA representatives, six people from NOAA/NWS, a representative from TDEM's STEAR program, and a representative from Harris County's MAAPnext program.

The interview questions asked the flood experts to identify current flood messaging, discuss challenges when disseminating messages, and describe flood-related products that help individuals understand flooding. See Table 3.1 for a list of the interview takeaways.

Table 3.1 Key Takeaways From Interviews With Stakeholders

Key Interview Takeaways
• Experts know flood-related information because of their job position/role
• Personal impact of flooding is most important for the average person
• Current flood messaging is limited at both the state and national level
• More messaging is needed to reach vulnerable populations
• Flood terminology is confusing (e.g., 100-year flood, stormwater, wastewater)
• Maps are most requested by flood experts
• Maps need to be tailored to communities
• Maps need more data to inform potential impact
• Maps can speak across populations
• Users need to understand their area or maps are confusing
• New people to areas are vulnerable
• FEMA floodplains/zones are confusing
• Understanding culture for messaging is important
• Flooding is continuous – messaging should be too
• Having information available through mobile phones is needed
• Must tell people what they can do about their flood risk if you raise their awareness

We heard very similar takeaways from the flood experts and more public interfacing stakeholders we interviewed. These findings confirm what the research in this report found: there are not many options for the public to understand their flood risk, and there is inadequate messaging, especially in Texas.

3.6   Identified Media Platforms & Themes/Messages)

We identified local, regional, state, university, federal, international, and organizational entities with flood education programs. We focused on neighboring states and countries that share similar flood-related issues (e.g., coastal, flash flood) as Texas. Note that examples are included in the current report in section 6.

3.7   Searched Flood Awareness Education and Communication Outreach Efforts

We investigated whether current flood awareness education/communication outreach efforts (such as Turn Around Don't Drown®) had been formally evaluated because these evaluations could substantiate a claim of best practices. We include these findings in section 6 of this report.

3.8   Searched Mobile Apps That Focus on Flood Awareness, Information, and Education

We compiled a list of available mobile apps that are used for flood awareness, information, and education, including flood safety and housing floodplain mobile apps. Some are useful for flooding only and others encompass a range of disasters. Some apps are tailored for students and have a stronger academic orientation. Others provide specific information about floods. For example, they allow users to monitor water levels and receive alerts when facing an imminent risk of flood. The apps listed below are the most salient according to blog posts reviewing the best apps from a variety of sources, including NOAA and FEMA. After a simple search on Google, we found the most frequently recommended apps are the FEMA Mobile and The

Weather Channel apps. This could be because the former is based on National Weather Service alerts and the latter allows users to know weather changes every 15 minutes. See Table 3.2 for a list of education-specific apps and Table 3.3 for a list of flood safety and awareness apps.

Table 3.2 Education-Specific Mobile Apps for the Public and First Responders

App	Description
American Red Cross by the American Red Cross	Tracks potential tropical storms and hurricanes and sends notifications. It can notify one's contacts that they are safe during a storm. It also provides general advice for what to do before a flood.[1]
Data in the Classroom by the National Oceanic Atmospheric Administration (NOAA)	Students from middle to high school use ocean data produced in real-time to explore environmental issues, learn, and develop problem-solving skills. The app provides quizzes, animations, and datasets with activities about coral bleaching, El Niño, water quality, and ocean acidification.[2]
Help Kids Cope by the National Child Traumatic Stress Network	Parents find advice on how to talk to their kids about disasters and how to support them through sheltering-in-place, evacuating to a designated shelter, or reuniting with family after a disaster. It can be used to explain flooding to children.[3]
mPING App by NOAA, the University of Oklahoma, and the Cooperative Institute for Mesoscale Meteorological Studies	Students can be citizen scientists by helping NOAA's National Severe Storms Laboratory collect public weather reports. The agency then uses the data to fine-tune its forecasts and develop new technologies and techniques.[2]
PFA Mobile by the U.S. Department of Veteran Affairs	Helps first responders review guidelines and assess their skills at providing psychological first response.[3]
RealEarth™ Satellite App Suite by the University of Wisconsin	Group of apps for middle and high school students. They provide access to NOAA's real-time imagery and weather data. The WxApp shows current weather conditions in any given location. The GOES app allows them to see imagery from satellites GOES East and GOES West.[2]
SAHMSA (Substance Abuse and Mental Health Services Administration) Disaster Mobile App	For first responders to learn pre-deployment preparation, on-the-ground assistance, and post-deployment resources. Users can learn tips on helping survivors cope and find local behavioral health services. It includes self-care support.[4]
Stop Disasters! by the United Nations	The United Nations Office for Disaster Risk Reduction (UNDRR) created a game to simulate the risks posed by tsunamis, hurricanes, wildfires, earthquakes, and floods. Strategies players use include building schools, hospitals, or houses.[5]

Table Information: A list of education-specific apps for first responders, parents, and children/adolescents. *Sources:*
[1]https://www.redcross.org/get-help/how-to-prepare-for-emergencies/mobile-apps.html
[2]https://www.nesdis.noaa.gov/about/k-12-education/mobile-friendly-educational-resources
[3]https://www.nctsn.org/what-is-child-trauma/trauma-types/disasters/flood-resources
[4]https://store.samhsa.gov/product/samhsa-disaster
[5]https://www.stopdisastersgame.org

Table 3.3 Flood Safety and Awareness Mobile Apps for Organizations and Individuals

App	Description
AccuWeather by Accu Weather	Allows access to daily forecasts and radar images.[1]
Alert FM by Global Security Systems	Allows emergency management officials to create and send alerts to groups about NWS weather watches and warnings, evacuation instructions, and homeland security notices.[2]
Clime (formerly known as NOAA Weather Radar Live)	An interactive map showing the risk of flooding and other extreme weather conditions. Includes push notifications when an alert is issued for floods, tornados, and other weather events.[3]
DisasterAlert by Pacific Disaster Center	Provides users with critical hazard alerts and information. It offers near real-time updates about 18 different types of natural hazards around the globe.[4]
FEMA Mobile APP	Allows users to receive real-time NWS alerts, locate emergency shelters, and prepare for hazards.[5]
FloodAlert by SOBOS GmbH	Provides real-time information about water levels, weather forecasts, and evacuation routes. Also gives flood warning alerts.[5]
Flood Maps & ZDs by Ikonetics	Helps create the Standard Flood Hazard Determination Form (SFHDF) for Mac using FEMA-based maps.[6]
Floodwatch by D5G Technology	Tracks all the rivers across the U.S. to highlight how water levels are changing over a 24-hour period and provides data for the past 7 days.[7]
Flood Zone Map by Qvyshitf LLC	Displays a printable map that shows the flood-prone areas near a given street address. Identifies flood zones after a rainstorm, tropical storm, or hurricane.[8]
In-telligent by In-telligent Properties LLC	Receives NWS alerts with an audible tone and notifies users of lightning in the area. It also provides notifications on local emergencies, such as a bomb threat.[9]
Land id by Land id	Enables discovering of extensive private parcel data and the creation of shareable and interactive maps. It provides access to FEMA's Digital Flood Insurance Rate Maps. [10]
My Flood Risk by HKV ljin in water	Provides information about flood zones and flood protection measures.[11]
MyWARN by Weather Apps LLC	Offers severe weather watches and warnings based on specific locations as issued by the NWS.[2]
Ping4alerts! by Ping 4 Inc.	Provides severe weather alerts. It can also be used by public safety agencies to send detailed emergency alerts to people in a specific location.[2]
Pin2Flood by the University of Texas at Austin & Texas Division of Emergency Management (TDEM)	Pin2Flood is a TDEM-controlled product, developed by UT Austin (with FEMA funds), that allows official emergency responders to drop a pin indicating water and see which structures and roads are at risk. The product is based on a HAND model, and it can also be used for pre-planning[12]
RiverCast by Juggernaut Technology Inc.	Provides river level forecasts and alerts.[13]

StormShield by E.W. Scripps Company	Provides alerts for tornadoes, hurricanes, floods, thunderstorms, winter storms, and other weather events via voice and push notification.[2]
StormWatch+ by Cirrus Weather Solutions LLC	This app provides radar, NWS forecasts, and severe weather alerts.[2]
The Weather Channel by The Weather Channel Interactive	Informs of weather changes every 15 minutes. Contains maps, wind speed reports, rain forecasts, and live radar.[14]
USGS flood inundation mapper by the United States Geological Survey (USGS)	Shows where flooding may occur in the community's local stream or river. The USGS works with communities to identify an appropriate stream section, gather the data to model where flooding will likely occur, and verify that the maps produced are scientifically sound.[15]
WeatherBug by GroundTruth	Users can access radar, forecasts, and severe weather alerts.[16]
WeatherUSA by Weather USA	Users can access current weather data and forecasts via their webpage and app.[17]
WunderStation by Weather Underground LLC	It allows users to connect to their personal weather stations, receive alerts via SMS or email, and stream NOAA Weather Radio via a desktop browser.[18]

Table Information: A list of flood safety and awareness apps to identify areas prone to flooding, monitor weather conditions, and receive alerts. *Sources:*

[1]*https://www.accuweather.com*

[2]*https://www.weather.gov/enterprise/sw-alerts-app-1e*

[3]*https://www.lifewire.com/best-flood-apps-4771113*

[4]*https://play.google.com/store/apps/details?id=disasterAlert.PDC&hl=en_US&gl=US&pli=1*

[5]*https://www.thetechedvocate.org/the-5-best-flood-apps-of-2023/*

[6]*https://apps.apple.com/us/app/flood-maps-zds/id908554933*

[7]*https://www.floodwatchapp.com/*

[8]*https://play.google.com/store/apps/details?id=com.rmtheis.flood&hl=en_US*

[9]*https://play.google.com/store/apps/details?id=com.sca.in_telligent&hl=en*

[10]*https://play.google.com/store/apps/details?id=com.mapright.android&hl=en_US*

[11]*https://apps.apple.com/ie/app/my-flood-risk/id1261855282*

[12]*https://gis.tdem.texas.gov/portal/apps/storymaps/stories/72f0ec81a7654da688518f486122abed*

[13]*https://www.rivercastapp.com*

[14]*https://apps.apple.com/us/app/weather-the-weather-channel/id295646461*

[15]*https://fim.wim.usgs.gov/fim/, https://www.usgs.gov/mission-areas/water-resources/science/flood-inundation-mapping-fim-program*

[16]*https://www.weatherbug.com*

[17]*https://www.weatherusa.net/services/mobile*

[18]*https://wu-next-ibm.wunderground.com/wunderstation*

4 Demographic and Social Vulnerability Overview

4.1 Searched Databases and Interviewed Key Informants

We searched through the following databases — CDC, NOAA, NWS, Migration Policy Institute, United States Census Bureau, Texas Demographic Center, TxDOT, and the Texas Department of State Health Services (DSHS) — to identify demographic characteristics in the state that informed our selection of prioritized end-user groups. TDEM official, Seth Christensen, directed us to the NOAA database as the most comprehensive available source of information on flood-related casualties. Based on this claim, TxDOT was not consulted.

When we realized the NOAA data was incomplete in places, we contacted NOAA's Greg Waller and University of Texas at San Antonio Professor Hatim Sharif, a civil engineer who has conducted extensive research on human casualties associated with natural hazards. Both sources noted that the NOAA Storm Events Database draws from NWS and news media reports, which reliably report on storm-related fatalities but not injuries. Because there is no reliable source for comprehensive flood-related statistics, we restrict our reporting here to fatalities. We then reviewed property damage that resulted from flood-related events. It is important to note that because of data limitations, we did not conduct comparative analyses across counties, such as comparing fatalities across counties/communities that were more or less vulnerable.

4.2 Reviewed Statewide Flooding Deaths and Property Damage

According to NOAA's Storm Data FAQ page, the NWS compiles all data files from their 123 Forecast Offices — and this data comes from a variety of different sources, ranging from local law enforcement and the general public to SKYWARN Spotter volunteers, the media, the insurance industry, as well as local, state, and federal emergency management experts. The NWS then submits the storm data files to the National Centers for Environmental Information (NCEI) approximately 75 days after the end of a data month. It is important to note that Storm Data has been shown to be problematic because of underreporting as well as inconsistencies in the level of detail provided for each event (e.g., some events do not document the age or gender of victims; see Sharif et al., 2015). Because Storm Data relies on NWS reports and news media coverage (as noted above), the focus appears to be on fatalities (i.e., injury counts are likely underreported even more so than fatalities) — and that is why we have decided to only report fatalities here.

Sharif and colleagues (Han and Sharif, 2020; Sharif et al., 2015) analyzed flood fatalities and vehicle-related flood fatalities in Texas based on NOAA's Storm Data. Figure 4.1 presents data Sharif et al. (2015) report regarding total flood fatalities in Texas by county between 1959 and 2008 and Figure 4.2 presents data Han and Sharif (2020) report regarding vehicle-related flood fatalities in the state by county between 1959 and 2019. It should be noted that Sharif et al. (2015) and Han and Sharif (2020) also normalized fatality counts against county populations to acknowledge how greater exposure might increase fatality rates. Figure 4.3 shows that the highest flood fatality rates occurred west/northwest and southeast of Flash Flood Alley. Similarly, Figure 4.4 shows that vehicle-related flood fatality rates were highest west of Flash Flood Alley. Even with normalization, Flash Flood Alley counties demonstrated modest fatality rates in both Figures 4.3 and 4.4.

Figure 4.1 Total Flood Fatalities in Texas by County (1959-2008)
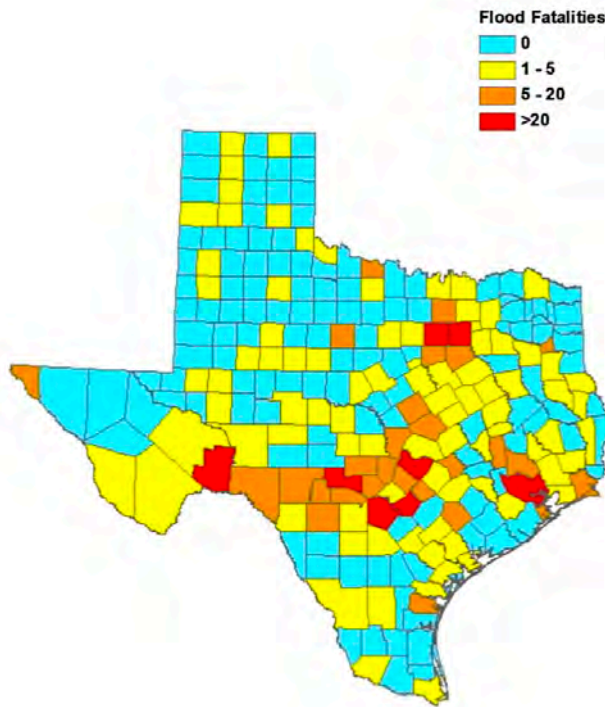
Figure Information: Bexar County, Dallas County, Travis County, Harris County, and Tarrant County were among the counties that experienced the highest numbers of fatalities. *Source: Sharif, H. O., Jackson, T. L., Hossain, M., & Zane, D. (2015). Analysis of flood fatalities in Texas. Natural Hazards Review, 16(1), 04014016. https://doi.org/10.1061/(ASCE)NH.1527-6996.0000145*

Figure 4.2 Vehicle-Related Flood Fatalities in Texas by County (1959-2019)
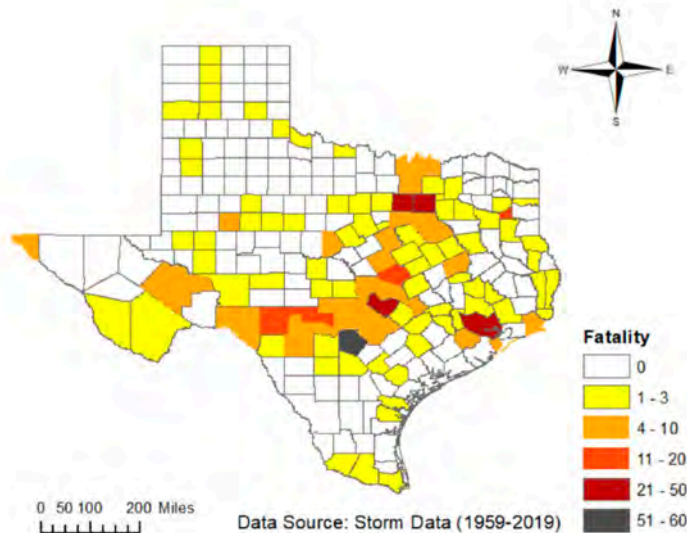
Figure Information: Vehicle-related fatalities mostly occurred in Flash Flood Alley. *Source: Han, Z., & Sharif, H. O. (2020). Vehicle-related flood fatalities in Texas, 1959-2019. Water, 12(10), 2884. https://doi.org/10.3390/w12102884*

Figure 4.3 Total Flood Fatalities in Texas by County (1959-2008)
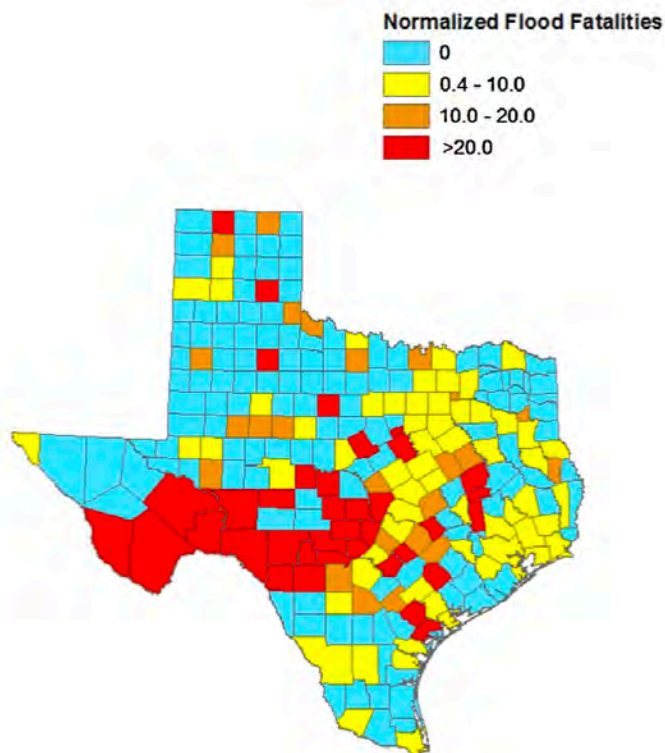
Figure Information: After normalization by county population, the highest flood fatality rates happened outside of Flash Flood Alley. *Source: Sharif, H. O., Jackson, T. L., Hossain, M., & Zane, D. (2015). Analysis of flood fatalities in Texas. Natural Hazards Review, 16(1), 04014016. https://doi.org/10.1061/(ASCE)NH.1527-6996.0000145*

Figure 4.4 Vehicle-Related Flood Fatalities in Texas by County (1959-2019)
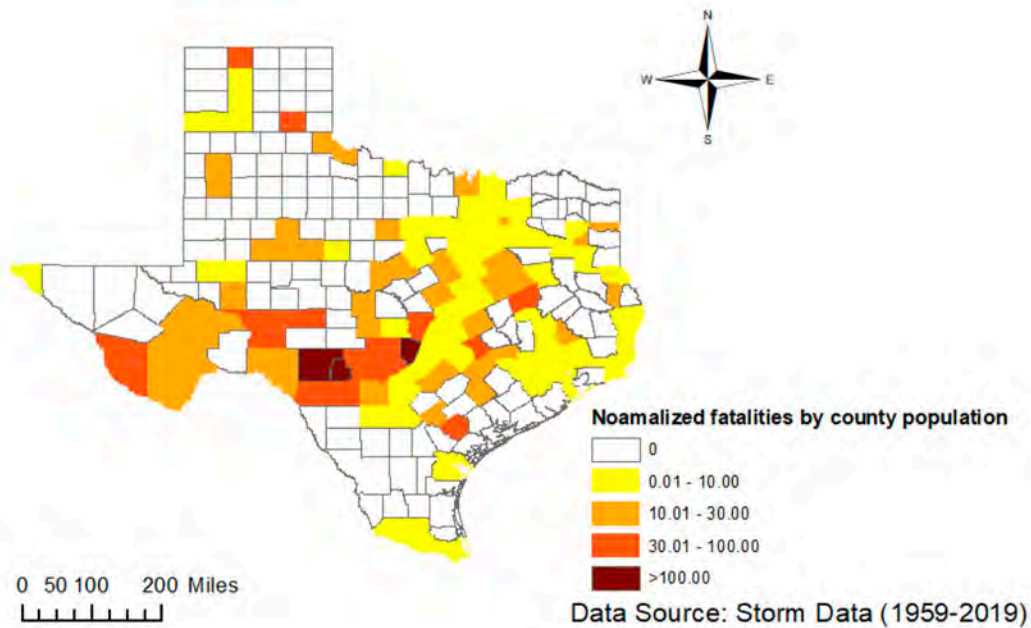
Figure Information: After normalization by county population, highest vehicle-related fatality rates occurred in more rural counties west of Flash Flood Alley. *Source: Han, Z., & Sharif, H. O. (2020). Vehicle-related flood fatalities in Texas, 1959-2019. Water, 12(10), 2884. https://doi.org/10.3390/w12102884*

A total of 6,478 flood fatalities occurred in the United States between 1959 and 2019. Compared to other states, Texas had the greatest number of flood fatalities (1,069) during that 61-year time period — with 53% (570) of flood fatalities being vehicle-related (see Figure 3.5 for more details). Of the vehicle-related flood fatalities in Texas that reported gender information over the 61-year timeframe (85%, or 483 fatalities), males were nearly twice as likely to die in vehicle-related flood accidents than were females (63% versus 37%, respectively; Han & Sharif, 2020). Of the vehicle-related flood fatalities in Texas that documented age information from 1959 to 2019 (67%, or 382 fatalities), the 20-29 age group represented the highest number of fatalities for both males and females (42 and 25 fatalities, respectively; see Figure 3.6 for more details). Sharif et al. (2015) also found similar gender and age trends for total flood fatalities, albeit over a slightly shorter timeframe (1959 to 2008). Interestingly, 1959 marked the first year that Storm Data started including all weather phenomena, and not only tornado, thunderstorm, and wind data. Sharif and colleagues conducted their analysis between 2011 and 2012 and chose to analyze flood fatality data for the period between 1959 and 2008. Of the flood fatalities in Texas that documented gender from 1959 to 2008 (566 out of 840), ***males were more than twice as likely to die in a flood than were females*** (68.4% versus 31.6%, respectively). It is important to note that Sharif and colleagues did not report a gender ratio for drivers during flood events, but they did point out that the proportion of males and females in the total population were very similar. While the ratio of male to female drivers has likely changed from 1959 to 2008 to the present, 50.5% of licensed drivers in Texas were female and 49.5% were male in 2019 (see U.S. Department of Transportation's Highway Statistics 2019). Of the flood fatalities in Texas that reported age from 1959 to 2008 (394 out of 840), nearly *50% (194) of victims were younger than 30 years old* (Sharif et al., 2015). It is noteworthy that as of 2021, approximately 42.7% of the Texas population was under 30 years of age (see Neilsberg, based on the U.S. Census Bureau American Community Survey (ACS) 2017-2021 5-Year Estimates). While we do not know how much this percentage has changed from 1959 to 2008 to the present, when Sharif et al. (2015)

adjusted the fatality numbers according to average age group proportions per 1960-2010 Census estimates, they found that fatality rates were lowest for the 30 to 39 age group and twice as high for the 10 to 19 and 20 to 29 age groups.

Figure 4.5 Annual Flood Fatalities and Vehicle-Related Flood Fatalities in Texas
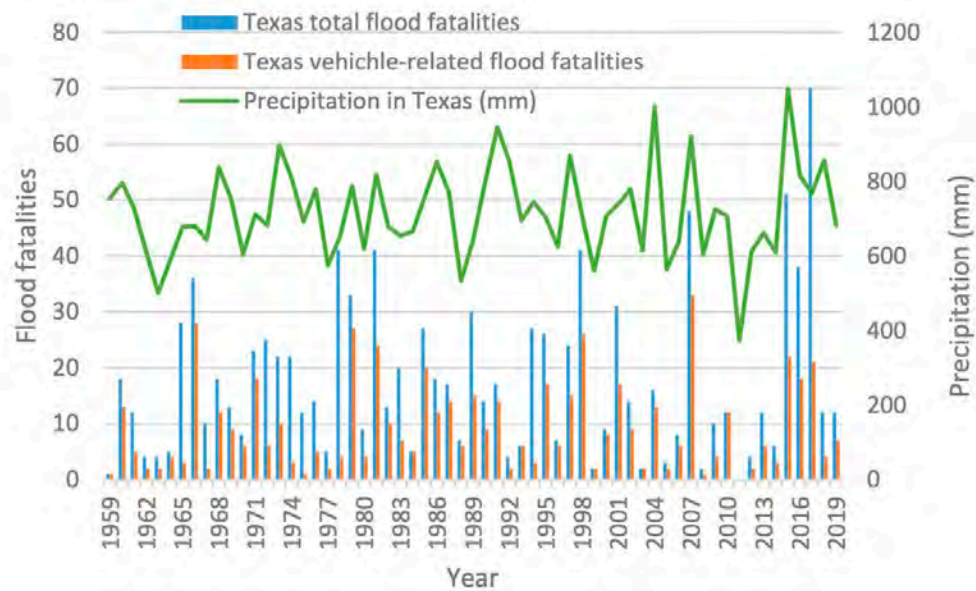
Figure Information: From 1959 to 2019, flood fatalities and vehicle-related flood fatalities occurred every year in Texas with the exception of 2011. The highest number of flood fatalities occurred in 2017 (70 fatalities). The highest number of vehicle-related flood fatalities occurred in 2007 (32 fatalities). Total flood fatalities and vehicle-related flood fatalities were both related to rainfall levels in Texas. *Source: Han, Z., & Sharif, H. O. (2020). Vehicle-related flood fatalities in Texas, 1959-2019. Water, 12(10), 2884. https://doi.org/10.3390/w12102884*

Figure 4.6 Vehicle-Related Flood Fatalities by Age and Gender in Texas
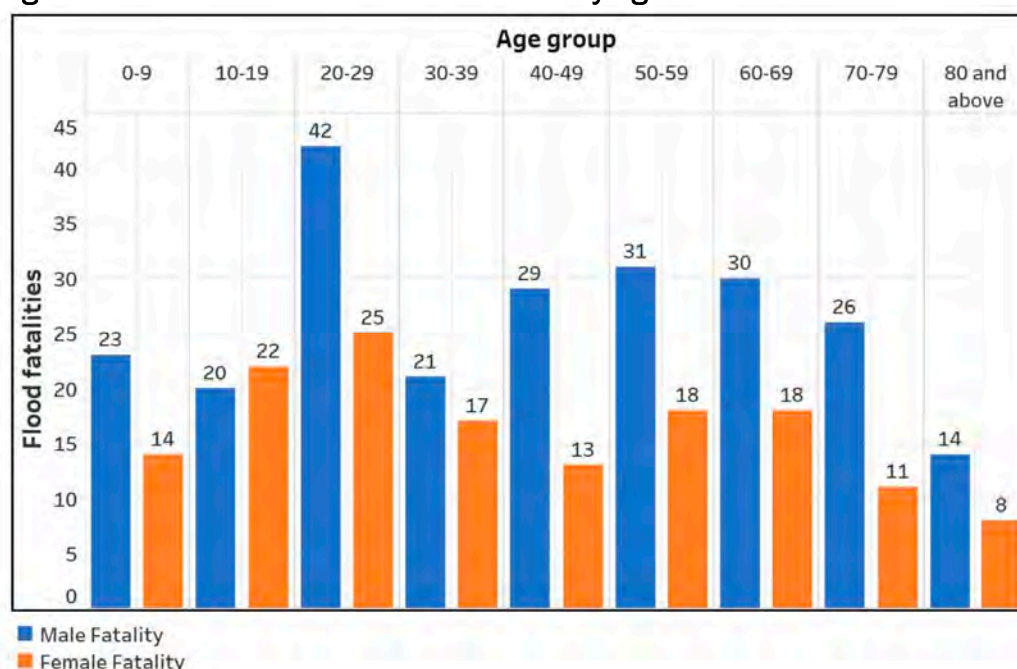
Figure Information: From 1959 to 2019, males outnumbered females in vehicle-related flood fatalities across all age groups, except for the 10-19 age group. Male vehicle-related fatalities were more than double female vehicle-related fatalities for the 40-49 and 70-79 age groups. *Source: Han, Z., & Sharif, H. O. (2020). Vehicle-related flood fatalities in Texas, 1959-2019. Water, 12(10), 2884. https://doi.org/10.3390/w12102884*

We also reviewed individual occurrences of property damage (i.e., physical detriment to residential, commercial, or government-owned property or structures across the state) as a result of flash flood, coastal flood, flood, heavy rain, storm surge/tide, tropical storm, hurricane (typhoon), tropical depression, and lakeshore flood events between October 2002 and October 2022. These event categories are identical to and taken from NOAA's Storm Events Database. Notably, the term "typhoon" is used in El Paso and the Upper Rio Grande Valley due to their weather events being influenced by the Pacific Ocean. The term "monsoon" can also be found in the local news in El Paso as well as in surrounding areas.

According to NOAA's Storm Data FAQ page, the NWS uses a "best guess" approach when compiling all available data for publication. Although the estimates in the Storm Events Database are updated 75-90 days after the end of a data month, they are likely different from the final valuations computed at the end of the year or later on. Thus, property damage estimates listed here are lower than would be expected. Interestingly, this underestimation is also confirmed by a NOAA report published in May of 2018 claiming that "the latest NOAA damage estimate from Harvey is $125 billion, with the 90% confidence interval ranging from $90 to $160 billion." This claim suggests that 1) there were one or more estimates prior to the "latest NOAA damage estimate" claimed in this 2018 report — and that there will likely be additional estimates after the report is published, and 2) a $70 billion-wide confidence interval implies a rather large standard error for the modelling procedure that is being used. Unfortunately, it appears that NOAA does not (nor does any other data source we are aware of) provide updated damage estimates for the other event types. See Table 4.1 for the total number of flood/flood-related events resulting in property damage as well as the amount of damage (in USD/United States Dollar).

Table 4.1 Flood/Flood-Related Events in the State of Texas (Oct. 2002-Oct. 2022)

Event	Total Number of Events Resulting in Property Damage	Total Dollar Amount of Property Damage
Flash Flood	2,197	57.394 B
Hurricane (Typhoon)	41	14.117 B
Storm Surge/Tide	31	9.903 B
Tropical Storm	61	3.721 B
Flood	305	1.432 B
Heavy Rain	67	6.202 M
Coastal Flood	32	1.350 M
Tropical Depression	8	1.091 M
Total	**2,742**	**86.575 B**

Table Information: Total number of flash flood, coastal flood, flood, heavy rain, storm surge/tide, tropical storm, hurricane (typhoon), and tropical depression events in Texas resulting in property damage between October 2002 and October 2022. Lakeshore flood events did not result in any amount of property damage. Events are listed from highest dollar amount to lowest dollar amount. Dollar amounts in Billions (B), Millions (M), and Thousands (K), and not adjusted for Consumer Price Index (CPI). *Source: https://www.ncdc.noaa.gov/stormevents/*

4.3   Social Vulnerability Overview

4.3.1   Racial/Ethnic Composition

In 2021, the White (non-Hispanic) population made up the largest racial/ethnic group in Texas, followed closely by Hispanic/Latino/a/e groups (of all races; see the U.S. Census Bureau's Topic of Race page for more information). The demographic breakdown in 2021 was the following: people identifying as White (non-Hispanic) made up 40.3%, Hispanic/Latino/a/e (of all races) was 40.2%, Black (non-Hispanic) was 12.3%, Asian (non-Hispanic) was 5.3%, multi-racial (non-Hispanic) was 1.6%, American Indian/Alaska Native (non-Hispanic) was 0.3%, and Native Hawaiian and Other Pacific Islander (non-Hispanic) were 0.1% (USAFacts). Figure 4.7 compares the racial/ethnic make-up in Texas between 2012 and 2021. As seen in Figure 4.8, the Hispanic/Latino/a/e (of all races) population has seen the most transformative growth in Texas. The latest estimates indicate that they now make up the largest share of the state's population (40.2%), edging out non-Hispanic White Texans (39.8%; see Texas Tribune's article for more details).

Figure 4.7 Comparison of Racial/Ethnic Make-Up in Texas Between 2012 and 2021
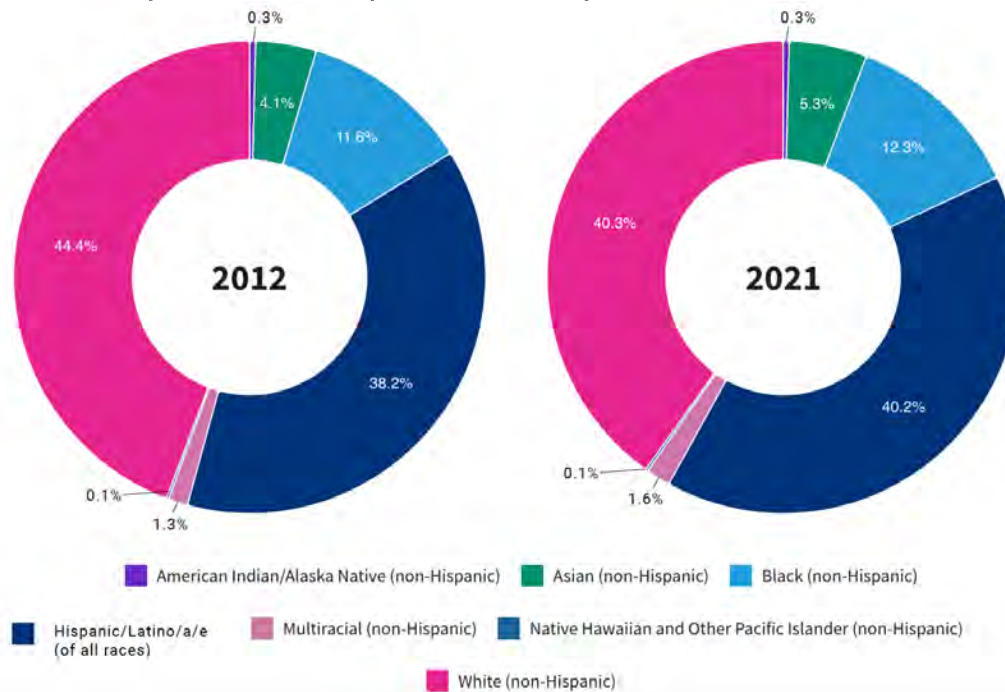
Figure Information: The pie chart is a side-by-side comparison of the racial/ethnic make-up in Texas between 2012 and 2021. *Source: Adapted from https://usafacts.org/data/topics/people-society/population-and-demographics/our-changing-population/state/texas/?endDate=2021-01-01&startDate=2012-01-01 (using Population Estimates Program data)*

Figure 4.8 Racial/Ethnic Make-Up of Texas Over Time (2012-2021)
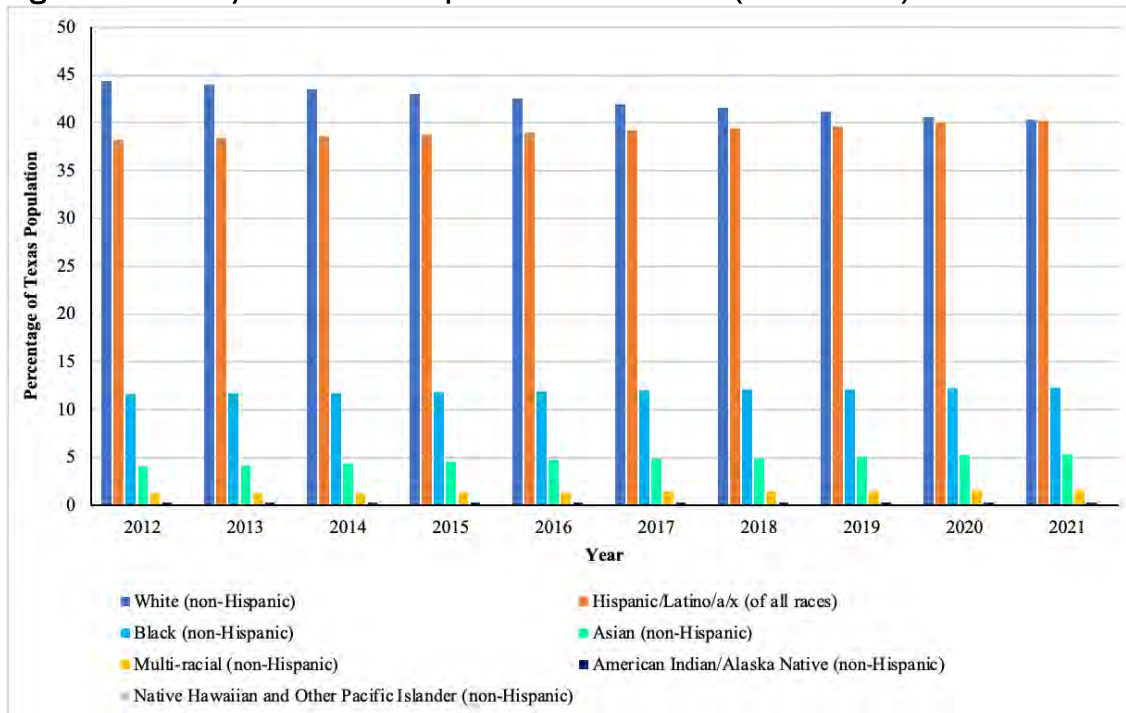
Figure Information: The graph demonstrates growth among the Hispanic/Latino/a/e groups (of all races). *Source: Data taken from https://usafacts.org/data/topics/people-society/population-and-demographics/our-changing-population/state/texas/?endDate=2021-01-01&startDate=2012-01-01 (using Population Estimates Program data)*

4.3.2   Population Centers in Texas

Not surprisingly, the Texas population is concentrated in large urban areas. The most populous counties in 2021 included Harris County (4,780,913), Dallas County (2,600,840), Tarrant County (2,154,595), Bexar County (2,059,530), Travis County (1,326,436), Collin County (1,158,696), Denton County (977,281), Fort Bend County (889,146), Hidalgo County (888,367), El Paso County (868,763), Montgomery County (678,490), and Williamson County (671,418; see USDA County-Level Data Sets & U.S. Census Bureau QuickFacts). Major cities that are in or near these counties include the following: Houston (Harris County), Dallas (Dallas County), Fort Worth (Tarrant County), San Antonio (Bexar County), Austin (Travis County), McKinney (Collin County), Denton (Denton County), Sugar Land (Fort Bend County), McAllen (Hidalgo County), El Paso (El Paso County), Conroe (Montgomery County), and Georgetown (Williamson County). While much of the population in Texas is concentrated in these cities, it is important to note that Texas has the largest rural population in the U.S. (nearly 4.2 million people live in rural areas; see the Kinder Institute for Urban Research for more details).

4.3.3   Population Age

The median age in the United States increased from 37.2 years in 2012 to 38.8 years in 2021, an increase of 4.3%. Texas is currently the second-youngest state (Utah is the first) with a median of 35.5 years. However, the current median represents an increase of 2 years over the last decade (2012 median age = 33.5) and the rate of change over this period (5.7%) has been significantly faster than the national average. Thus, the aging population in Texas is growing, both in total number and as a percentage of the state's overall population. Figure 4.9 presents population pyramids illustrating the aging trends by gender in Texas. In 2012, the 5-19 age group made up 22.3%, followed by the 20-34 age group (21.9%), 35-49 age group (20.2%), 50-64 age group (17.4%), 65 and older age group (**10.9%**), and 0-4 age group (7.4%). Recent trends show an upward shift among adults 65 years and older and a slight downward shift in the 0-4, 5-19, and 20-34 age groups. In 2021, the 5-19 age group made up 21.6%, followed by the 20-34 age group (21.3%), 35-49 age group (20.2%), 50-64 age group (17.3%), 65 and older age group (**13.1%**), and 0-4 age group (6.5%; USAFacts). See Figure 4.10 below for a side-by-side comparison of percentages for 2012 and 2021. While this age shift is occurring, Texas was among a handful of states (in addition to Arizona, California, Nevada, New Mexico, and Puerto Rico) where the Hispanic/Latino/a/e (of all races) group was the largest among its population under 18 years of age in 2020 (see the U.S. Census Bureau's Racial and Ethnic Diversity page for more details).

Figure 4.9 Texas Population Age Trends by Gender in 2012 and 2021
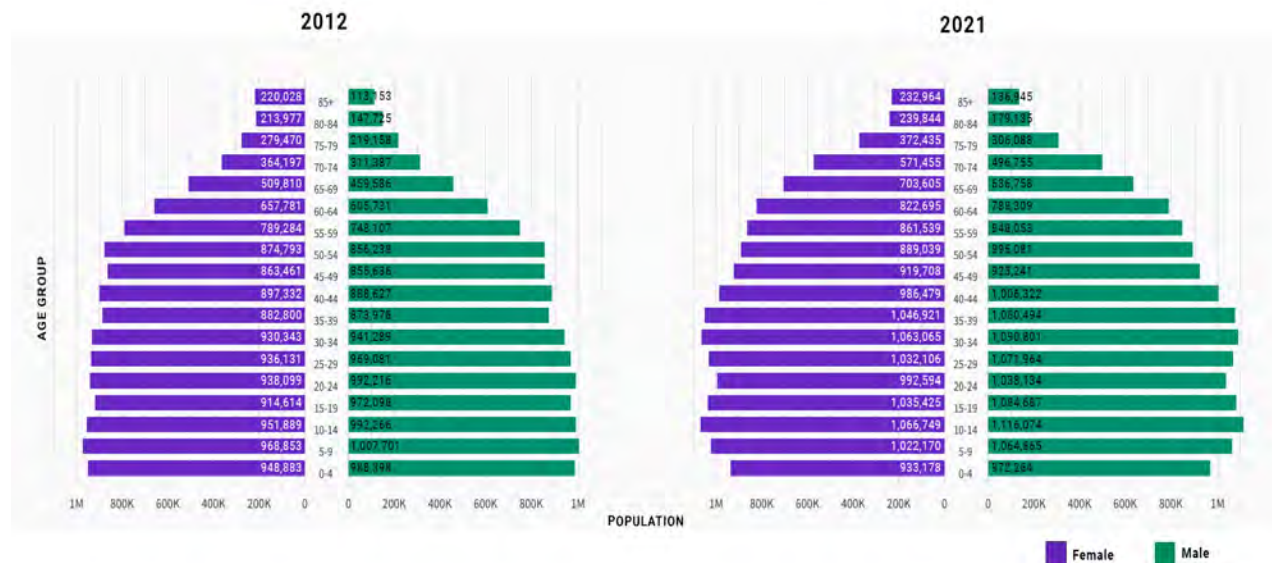
Figure Information: The population was younger in 2012, indicated by a wider pyramid base. The population has gotten older over the years, indicated by a wider pyramid top in 2021. *Source: Adapted from https://usafacts.org/data/topics/people-society/population-and-demographics/our-changing-population/state/texas/?endDate=2021-01-01&startDate=2012-01-01 (using Population Estimates Program data)*

Figure 4.10 Distribution of Ages in Texas in 2012 and 2021
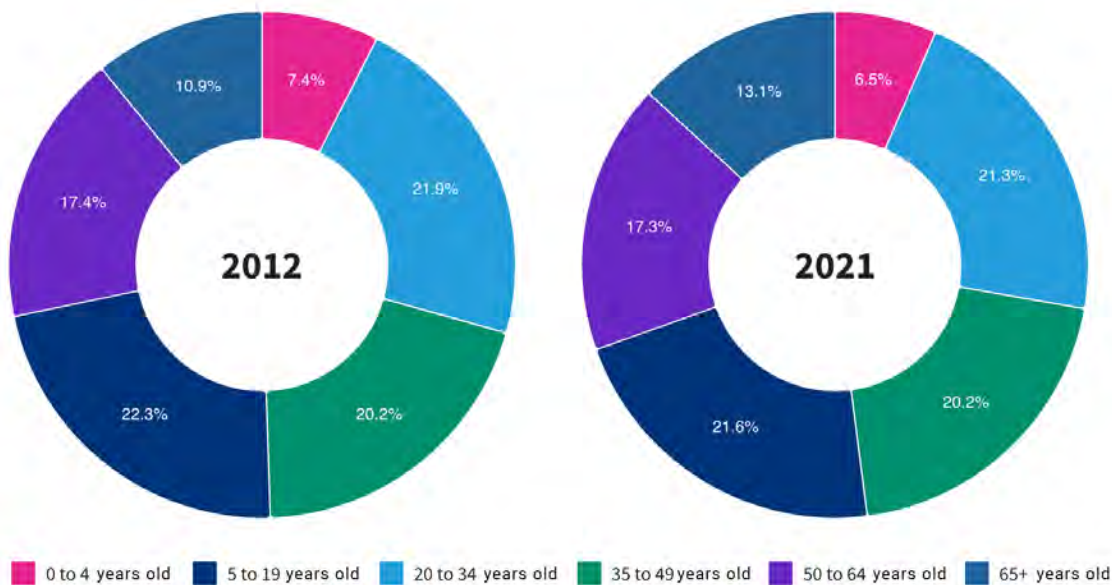
Figure Information: The share of the Texas population that is 65+ increased from 2012 to 2021. *Source: Adapted from https://usafacts.org/data/topics/people-society/population-and-demographics/our-changing-population/state/texas/?endDate=2021-01-01&startDate=2012-01-01 (using Population Estimates Program data)*

4.3.4   Population Growth

Between 2021 and 2022, Texas gained the largest number of people in the nation: 470,708 people, including net domestic migration (230,961), net international migration (118,614), and natural increase (118,159) (taken from a U.S. Census Bureau News Release, using Population Estimates Program data). From 2012 to 2021, Texas's population grew 13.2%, and out of all races, the Hispanic/Latino/a/e population saw the most growth — from 10 million people in 2012 to 11.9 million people in 2021 (1.9% increase; USAFacts, using Population Estimates Program data).

4.3.5   New Resident Demographics

In 2019, the majority of new residents from out-of-state relocated from California, Florida, Louisiana, Illinois, Oklahoma, New Mexico, Georgia, and Arizona. See Figure 4.11 for a map of the United States highlighting these states. Note, people are predominantly settling in Harris County as well as counties located in Flash Flood Alley.

Figure 4.11 Top U.S. States for People Moving to Texas in 2019

Figure Information: Note that several of the states where people move from are also flood-prone states (e.g., Florida, Oklahoma, Louisiana, Georgia), but others are not necessarily flood prone. *Source: https://www.texasrealestate.com/wp-content/uploads/2021RelocationReport.pdf*

Table 4.2 provides rankings of counties in Texas with the highest number of out-of-state movers, in-state movers, and movers from abroad in 2020. ***A majority of the top 10 counties where people move to in Texas are found in Flash Flood Alley,*** including Tarrant, Dallas, Bexar, Travis, Collin, Denton, Bell, and Williamson (see Figure 4.12 for a visual representation of Texas counties with the highest number of new residents moving in). Interestingly, out-of-state movers tend to be more ethnically diverse younger adults (between the ages of 25-44) with children. Additionally, Texas newcomers tend to earn higher incomes, have a higher educational background, and work in business and technology-related occupations (Texas Demographic Center, 2022, using U.S. Census Bureau's American Community Survey (ACS) 5-year Public Use Microdata Sample (PUMS) files).

Table 4.2 Counties in Texas With the Highest Number of People Moving in (2020)

County	Number of Movers From a Different State	County	Number of Movers From a Different County, Same State	County	Number of Movers From Abroad
1. Harris	66,477	1. Harris	95,375	1. Harris	47,069
2. Tarrant*	45,572	2. Dallas*	71,701	2. Dallas*	22,733
3. Dallas*	44,546	3. Tarrant*	63,444	3. Bexar*	14,207
4. Bexar*	44,286	4. Denton*	56,603	4. Tarrant*	12,886
5. Travis*	38,145	5. Travis*	49,889	5. Travis*	11,508
6. Collin*	30,043	6. Bexar*	47,504	6. Collin*	10,263
7. Denton*	24,067	7. Collin*	45,056	7. Fort Bend	9,255
8. El Paso	22,606	8. Fort Bend	34,188	8. El Paso	7,534
9. Bell*	19,118	9. Williamson*	32,427	9. Denton*	5,948
10. Williamson*	19,101	10. Montgomery	25,213	10. Hidalgo	4,830

Table Information: *County is located in Flash Flood Alley. *Source: https://flowsmapper.geo.census.gov/map.html# (using U.S. Census Bureau, 2016-2020 5-year American Community Survey)*

Figure 4.12 Texas Counties With the Most New Residents Moving in (2020)

Legend:
- Number of Movers From a Different County, Same State
- Number of Movers From a Different State
- Number of Movers From Abroad

County	Total	Different County, Same State	Different State	Abroad
Harris	208,921	95,375	66,477	47,069
Dallas	138,980	71,701	44,546	22,733
Tarrant	121,902	63,444	45,572	12,886
Bexar	105,997	47,504	44,286	14,207
Travis	99,542	49,889	38,145	11,508
Denton	86,618	56,603	24,067	5,948
Collin	85,362	45,056	30,043	10,263

Flash Flood Alley counties   Texas counties with maximum new residents moving in
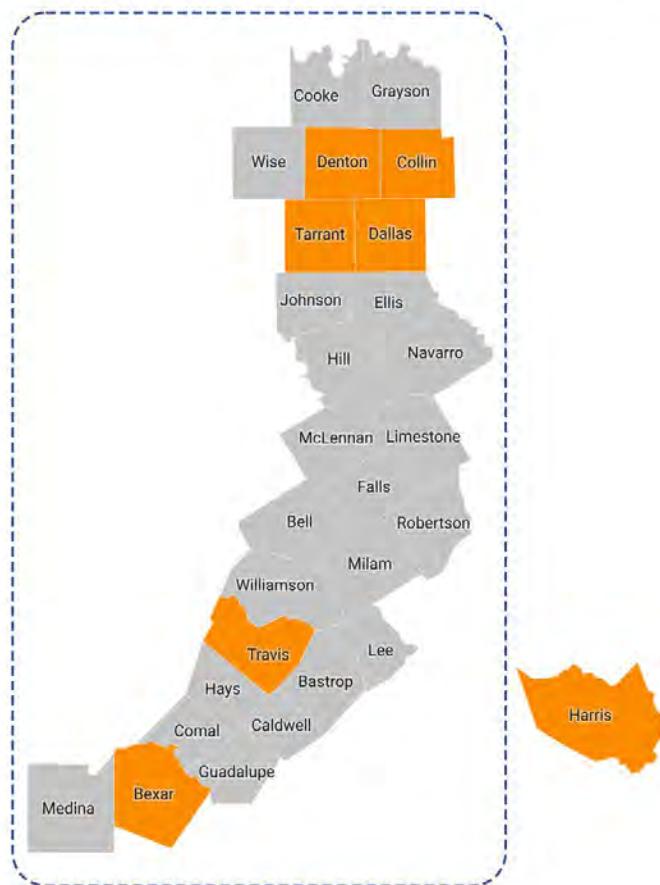
Figure Information: Note that the counties in the blue dashed border are in Flash Flood Alley. The counties that have the most new residents moving into them are indicated in orange. *Source: Adapted from https://www.sariverauthority.org/be-river-proud/flood-risk*

5   Literature Review and Lessons Learned

5.1   Literature Review to Identify Prioritized End-User Groups

We used different sources to collect the research and grey literature (i.e., non-conventional published material, such as government reports, created by organizations and think tanks; see the University of Michigan Library Guide for more details) reviewed in this report. Most of the literature described in the sections below is not openly accessible to the public (i.e., they are behind a paywall). Open access articles (i.e., non-paywalled articles that can be read and downloaded by anyone) can be found through Google Scholar, arXiv (a preprint repository), OSF Preprints (a collection of preprint repositories), Social Science Research Network (SSRN; a preprint repository), and DSpace@MIT (includes published papers), as well as directly from an author. It is important to note that some working papers and pre-prints have not been peer reviewed (i.e., a process where the work is checked for quality, validity, or significance by other researchers before publication in a journal; see https://libraries.mit.edu/scholarly/publishing/find-oa-articles/ for more information). This is also the case when reviewing important grey literature. Our team was able to access articles behind the paywall using the UT Austin library.

To summarize the literature around flood awareness and communication, it is important to consider the following questions: Why do people need awareness? What factors influence people's understanding of flood risk and their decision making? How can people mitigate flood risk? In the next three sections, we will provide answers to these questions using multiple studies — based in Texas and other states and countries — that have aimed to answer these questions and draw conclusions around the best ways to raise awareness around flooding for select end-user groups.

5.1.1   Why People Need Awareness: Safety, Vehicles, and Floodwaters

Overview of Findings. People need to become more cognizant of their flood risk, especially male drivers — both younger and older in age — who are confronted by flooded roads during night hours. Increasing drivers' awareness around flood risk should be informed by previous statistics and trends, social, environmental, and situational factors, as well as drivers' underlying motivations and beliefs. The studies considered in this section each used different public database sources and data collection methods. The state or country in which the flood events occurred also varied across the studies, as well as the time period and variables considered for analysis. Interestingly, several studies also warned that there are numerous obstacles to accurately recording past flood events — such as isolated locations that are oftentimes ignored, errors in communicating to database officials, and imbalanced news coverage (e.g., Maples & Tiefenbacher, 2009; Sharif et al., 2015). Consequently, there are likely slight discrepancies and misrepresentations in the frequency and nature of flood fatalities as well as vehicle-related flood deaths.

The frequency of flood fatalities — *especially vehicle-related flood fatalities* — is important to consider when evaluating flood hazards. Understanding the circumstances surrounding flood fatalities can be applied toward risk prevention, early warning systems, public preparedness, as well as help rescue personnel and emergency managers (Špitalar et al., 2020). Analyzing 21,549 flash flood events between 2006 and 2012 in the *United States* and recorded in the NOAA Flooded Locations and Simulated Hydrographs (FLASH) database, Špitalar et al. (2014) found

that 68% (222 out of 326) of flash flood fatalities were vehicle-related, and 62% (138 out of 224) of flash flood injuries were also vehicle-related.

Sharif et al. (2015) observed that 77% (471 out of 616) of *Texas flood fatalities* with chronicled circumstances from 1959 to 2008 occurred in a vehicle. They attributed this finding to the high number of low-water crossings across Texas as well as extensive droughts that do not offer the financial incentive to build costly structures at street-stream crossings to prevent over-the-road water flow. When reviewing flood fatalities as well as vehicle-related flood fatalities in Texas from 1959 to 2019, Han and Sharif (2020) found that 53% (570 out of 1069) of fatalities with known circumstances were vehicle-related. As Sharif and his colleagues note in the articles cited here, the circumstances for flood fatalities are recorded in the NOAA database for slightly less than 3 in 5 (59%) of cases. Given that we don't know the circumstances for the other 41% of cases, we are reluctant to draw any conclusions about increasing or decreasing trends in vehicle-related flood fatalities.

Similar trends have been observed in *other countries*. When analyzing 13 flood events that occurred in the United States and Europe between 1989 and 2003, Jonkman and Kelman (2005) revealed that most flood disaster fatalities were drownings, with vehicle-related drownings (i.e., people attempting to cross a flooded bridge, stream, or street) accounting for slightly less than half of them (81 out of 167). Across flood fatalities that occurred in Slovenia between 1926 and 2014, Špitalar et al. (2020) showed that car fatalities in flash floods (defined as "a flood caused by heavy or excessive rainfall in a short period of time, generally less than 6 hours") increased over a ten year period (2004-2014), increasing disproportionately compared to flood-related fatalities due to collapsed buildings, low risk perception, or low familiarity with local area where flooding occurred. The researchers attribute this increase in part to a rise in the frequency of drivers on the road after sunset, when fatalities are more likely as a result of reduced visibility.

Gender and Age of Flood Victims. Several flood fatality studies have also found demographic factors — especially gender and age — to be significant. Note that in several studies, the amounts do not add up to 100% because of incomplete reporting. Out of a total of 74 flood fatalities that occurred in Slovenia between 1926 and 2014, Špitalar et al. (2020) found that gender was documented for 43 fatalities: 60% (26 out of 43) were male fatalities, and 40% (17 out of 43) were female fatalities. Akin to Jonkman and Kelman (2005), Špitalar and colleagues claimed that the trend could be attributed to higher risk taking among males than females (a trend that has been observed in many contexts; Harris et al., 2006) as well as a higher proportion of males working in the emergency sector. Interestingly, Diakakis (2020) established two categories of flood victim behaviors: the "Deliberately Active Cases" where victims deliberately or voluntarily decide to interact with floodwaters (e.g., enter floodwaters to save animals), and the "Passive Cases" where victims are involuntarily or unwillingly forced to encounter floodwaters (e.g., unable to evacuate because of a physical impairment). Across flood fatalities in Greece from 1960 to 2019, the study revealed that male and younger victims as well as rural and outdoor fatalities were more prone to active behaviors than female and older victims as well as urban and indoor fatalities (Diakakis, 2020). Petrucci et al. (2019) analyzed flood fatality trends across a span of 39 years (1980 to 2018) in 8 countries, namely the Czech Republic, Israel, Italy, Turkey, Greece, Portugal, France, and Spain. Unlike the other studies, Petrucci et al. (2019) reviewed flood fatalities on a much larger scale and across several different countries, and their analysis led to data uncertainties where some of the variables were either not reported or unavailable in some of the countries. They revealed that fatalities were more often male victims (46.9%, or

1157 out of 2466 fatalities, compared to 779 (31.6%) female fatalities), local residents (53.0%, or 1307 out of 2466 fatalities), and in a vehicle (e.g., bus, car, caravan, tractor, truck, van; 19.8%, or 489 out of 2466 fatalities, compared to 220 (8.9%) fatalities where the individual was standing). These researchers do not provide base rates regarding the presence of men, women, locals, or non-locals in the areas where flooding occurs, so no comparative conclusions can be drawn about a particular demographic group being more likely to die in a flood than another.

Males also account for a large proportion of vehicle-related flood fatalities in the United States and in Texas. For example, Jonkman and Kelman (2005) found that males in the United States and Europe were more vulnerable to drowning and physical trauma fatalities caused by vehicle crashes. Of the cases that recorded gender from 1959 to 2008, Sharif et al. (2015) found that males were more likely than females to be victims of vehicle-related Texas flood fatalities (64% versus 36%). Similarly, of the cases that reported gender from 1959 to 2019, Han and Sharif (2020) demonstrated that males were nearly twice as likely to be victims of vehicle-related Texas flood accidents than females (63% versus 37%). Maples and Tiefenbacher (2009) found that in Texas from 1950 to 2004, a majority of the drivers in 5 out of the 8 age cohorts (20-29, 50-59, 60-69, 70-79, and 80-89) were men in flooded-road fatalities, normalized against the population of drivers. Women were the majority in the 30-39 and 40-49 age cohorts.

Overall, age trends varied across studies. For instance, Han and Sharif (2020) found that vehicle-related flood deaths happened predominantly in the 20-29 age group and far less in the 80 and above age group for both males and females, while Maples and Tiefenbacher (2009) showed that mostly young adults as well as middle- and older-aged male drivers were victims of flooded road accidents. Sharif et al. (2015) also found that an increase in age is linked to greater vulnerability to all flood fatalities, which they posited could be linked to physical impairments — such as vision difficulties — or an inability to respond quickly during emergencies.

Time of Day and Spatial Distribution of Flood Fatalities. Temporal parameters — such as the time of day — have also been considered when looking at flood fatalities, and the *dominant finding is that rush hour and night-time is most risky*. Špitalar et al. (2014) revealed that while the *number of injury events* in the United States peaked at 17:00 (i.e., recorded as 5PM local time) between the years 2006 and 2012, the most impactful time for both *injuries and fatalities* was 21:00 (i.e., recorded as 9PM local time). In other words, injurious events were more common during rush hour traffic and commuting hours; however, when injurious and fatality events happened at night, they injured and killed many more people at each event. Špitalar and colleagues linked these trends to a driver's inability to see the flooded roads in darker environments. In fact, when only considering the frequency of vehicle-related injuries and fatalities, they demonstrated that 64% of vehicle-related fatalities occurred between 22:00 and 06:00 (i.e., recorded as 10PM and 6AM local time; thus, a 2:1 ratio of fatalities to hours over that interval), and 40% of vehicle-related injuries happened during those same hours, which happen to be after sunset. Sharif et al. (2015) also found that 52% (296 out of 564) of Texas flood fatalities with a recorded time of day happened at night between 1959 and 2008, while Han and Sharif (2020) showed that at least 45% (more than 180 out of 416) of vehicle-related flood fatalities in Texas with a recorded time of day occurred at night (i.e., recorded as 9PM to 5AM local time) between 1959 and 2019. Maples and Tiefenbacher (2009) found that nearly one-third (38 out of 140) of vehicle drowning incidents in Texas occurred on familiar roads (i.e., roads that were in proximity to the victim's home or place of employment) between 1950 and 2004, and

approximately two-thirds (27 out of 44) of vehicle drowning incidents with available data occurred at night-time.

Studies have also considered the spatial distribution of flood fatalities. Shah et al. (2017) observed that between 2005 and 2014 over half (1777 out of 3256) of swift water rescues (i.e., to save an individual from fast-moving water) in Texas happened in Flash Flood Alley counties — and 95% of these counties were urban — albeit these occurrences did not consider fatalities nor were any details provided as to whether these individuals entered swift water via foot or vehicle. It is also important to note that the authors did not provide important context for these statistics, particularly the percentage of traffic in Flash Flood Alley counties. Sharif et al. (2015) argued with little detailed discussion that because of greater exposure to flood hazards (i.e., increases in population growth and development driving greater runoff, see page 6 of Sharif and colleagues' paper for this assertion), the highest flood fatalities in Texas from 1959 to 2008 were located along Flash Flood Alley (identified in this study as Bexar County, Dallas County, Travis County, and Tarrant County, which are among the most populated counties in Texas), with vehicle-related flood fatalities following a similar distribution. Notably, Han and Sharif (2020) showed the same trend: Flash Flood Alley counties reported the highest numbers of vehicle-related flood fatalities, with *Flash Flood Alley counties accounting for nearly 83% of vehicle-related flood fatalities in Texas*. Špitalar et al. (2014) found that injury and fatality events occurred more often in rural areas than in urban areas in the United States; however, when these events did happen in urban areas, they injured and killed many more people at each event. Špitalar and colleagues explained that urban regions are more vulnerable to flash flood-driven injuries and deaths due to channelization (i.e., channelized streams with higher flows that can lead to downstream flooding) and a depletion of infiltration in the built environment (i.e., soils absorbing less water), which in turn increases the severity, velocity, and amount of water runoff. On the other hand, rural zones might experience more injury/fatality events because of treacherous low-water crossings as well as arroyos in arid and barren landscapes. Rural areas also do not have emergency responders in close vicinity to the flood location to quickly block flooded roads.

Maples and Tiefenbacher (2009) created an event-specific conceptual model to account for the different factors that contribute to a flooded road hazard — and ultimately automobile drownings on flooded roads. A combination of short- and long-term climate, geography, and topography (i.e., hydrologic/climatologic factors) affect an area's investment in road infrastructure (i.e., economic factors), their road conditions and signage (i.e., built environment), as well as the speed and depth of water flow across their roadways (i.e., nature of a flood event). Economic factors also feed into the built environment, which in turn interacts with the nature of the flood event and creates a risk for flooded roads — feeding into a driver's confidence and comfort to move in that landscape (i.e., cognitive processes of a driver). Social pressures also interact with a driver's cognitive processes as well as the technology a driver is relying on (i.e., their vehicle's condition, up-keep, speed, and weight; Maples & Tiefenbacher, 2009). See Figure 5.1 for the event-specific conceptual model.

Figure 5.1 Maples & Tiefenbacher's (2009) Conceptual Model
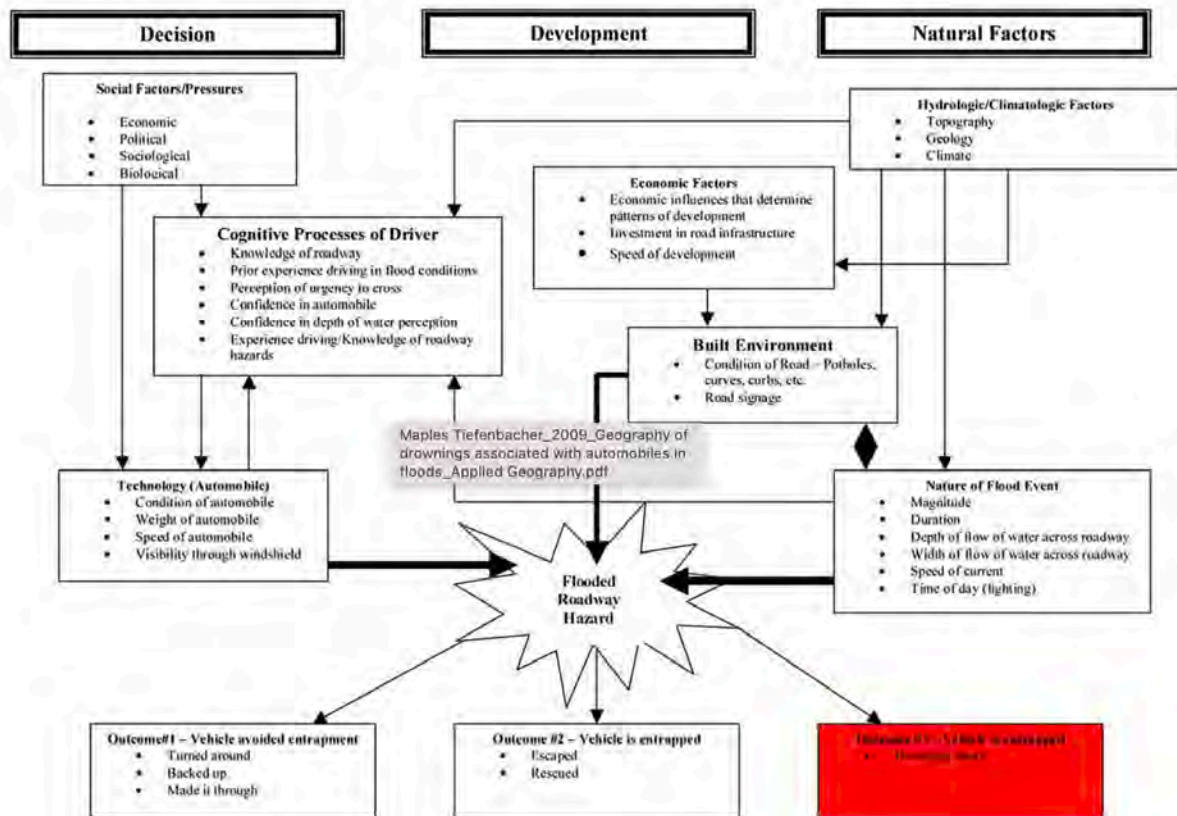
Figure Information: The model considers all components that contribute to a vehicle being trapped in floodwaters.
Source: Maples, L. Z., & Tiefenbacher, J. P. (2009). Landscape, development, technology and drivers: The geography of drownings associated with automobiles in Texas floods, 1950-2004. https://doi.org/10.1016/j.apgeog.2008.09.004

What Motivates People to Drive Through Flood Waters? Studies have tried to understand the motivating factors behind driving into flooded waters that ultimately put people at risk (e.g., Ahmed et al., 2018; Hamilton et al., 2018b; 2019). Hamilton et al. (2016) showed that an individual's behavioral beliefs (e.g., driving through floodwaters would allow them to reach their destination), normative beliefs (e.g., other family members would approve of them driving through floodwaters), and control beliefs (e.g., a small distance of water would not prevent them from driving through floodwaters) guided their willingness to drive through a flooded road. People who reported being more willing to drive across a road — whether they were presented with a low-risk (i.e., a road that is covered in 20 centimeters of floodwater) or high-risk situation (i.e., a road that is covered in 60 centimeters of floodwater) — also underestimated the distance of water and were confident they would be able to reach their destination. In other words, *drivers' confidence and optimism outweighed the risk*. Also, people who were presented with low-risk scenarios focused on material and personal costs (i.e., their vehicle would sustain damage, they would be swept away), while people who were posed with high-risk scenarios contemplated more about endangering themselves (i.e., they would face hidden hazards, they would be stuck or stranded). Hamilton and colleagues did mention that the use of self-report surveys can lead to social desirability bias, and they recommended using observational cameras or other objective measures in future studies to tap into more realistic representations of drivers' risk-taking behaviors. Also, Coles and Walker (2021) found that 88.0% of residents in Tucson, Arizona indicated that they would use some kind of flood avoidance behavior (e.g., change their

mode of transportation, leave at a different time) before departing if they notice it is raining outside and flooding is possible, while 91.7% of residents indicated that they would use an adaptive behavior (e.g., pause their trip) if they encounter a flood while driving in their vehicle. As suggested above, it is important to acknowledge that some respondents might have been reluctant to admit their more risky behaviors, such as not turning around when they should. This is because they do not want to appear irrational or irresponsible.

When speaking with drivers who had already driven through flooded streets in the past, Hamilton et al. (2019) found that these individuals based their decisions on past successes (e.g., they had been living in a flood-prone area for 35 years and felt confident in their ability to assess risk), pressure to travel to their destination (e.g., they felt concerned about the welfare of their family and pets at home), fear of being left stranded on the road, lack of alternative routes and/or safe roads, pressure or encouragement from fellow drivers, speed and depth of the floodwaters as well as length of the crossing, and confidence in their vehicle's capabilities (e.g., four-wheel drive, diesel vehicle). In a systematic review of 24 studies on vehicle-related flood behavior across 4 countries (United States, Australia, Sweden, and Greece), Ahmed et al. (2018) found that drivers' risk perception — and ultimately their decision to either drive through floodwater or turn around — tends to be related to a *wide array of factors*, including demographic (e.g., gender), social (i.e., peer pressure), situational (e.g., street characteristics), individual (i.e., characteristics and experiences unique to a person), and environmental or natural factors, as well as indicators of risk (e.g., physical cues on the street). Therefore, the underlying reasons behind people's decisions on the road are many, varied, and complex. We review recommendations on how to reduce risky decision-making through flood safety education and communication campaigns next.

Recommendations From Literature to Reduce Vehicle-Related Flood Risks. To manage future risks posed by human-flood interactions, several studies have suggested different strategies. Sharif et al. (2015) asserted that a combination of flood safety education and communication campaigns, enhanced hydro-meteorological forecasting, and swift action from local authorities might influence human behavior and psychology behind vehicle-related flood fatalities in Texas. Špitalar et al. (2020) recommended creating improved flood road hazard maps as well as constructing roads with building standards that can withstand floods with a greater return period (i.e., the longer the return period, the more intensive the extreme flood event). Han and Sharif (2020) asserted that the risk of vehicle-related flood fatalities in Flash Flood Alley could be lessened by *investing more in road flood safety* — including improved road signages, barricades, depth gauges, and flashing light signals — *earlier warnings, and safer alternative routes during flood events* (see also Coles & Walker, 2021; Diakakis, 2020; Hamilton et al., 2016; Hamilton et al., 2019). Hamilton et al. (2019) also suggested that roads be closed off, police be used as deterrents, roads be monitored in real-time with cameras, and "cues to action" like small bumper stickers be placed on cars or be disseminated via emergency notification messages to mobile phones.

Research also recommends that education programs be *tailored to younger male drivers* because they underestimate the risk of floodwaters and overestimate their vehicle's power and their own personal driving skills (see Han & Sharif, 2020). Older individuals and their caregivers who live in flood-prone areas are additional audiences who need education (Diakakis, 2020). Notably, Hamilton et al. (2016) suggested that safety messages for risky driving behaviors, like those more frequently taken by younger male drivers, should emphasize positive outcomes and instill

confidence in the driver's own control (e.g., if you decide not to drive across the flooded street, you will not be swept away) rather than frame the situation in a negative light. Hamilton et al. (2019) also described the need to emphasize the unpredictability of floodwater conditions as well as the risk of miscalculating and underestimating water depth and speed, and to help mitigate internal pressures and stress by encouraging drivers to create a plan before a disaster. Because of social pressures to drive through floodwater, Hamilton and colleagues also recommended a two-pronged approach: 1) telling drivers that most people do not drive through floodwaters (i.e., descriptive norm information), and 2) by refusing to drive through floodwaters, drivers can encourage and ultimately prevent other drivers from making a potentially deadly decision (i.e., persuasive messaging; Hamilton et al., 2019). Because people claim they use more adaptive behaviors for less urgent trips (i.e., running errands) than for commutes to work or school, Coles and Walker (2021) encourage employers to help keep workers off the road — and ultimately reduce flood fatalities and injuries — by giving their employees flexible and more lenient schedules or remote work options during severe weather conditions. Navigating future risks posed by human-flood interactions is a very precarious line that taps into the delicate intricacies of human psychology.

5.1.2   Factors That Influence Flood Risk and Decision Making

Risk perception is defined as "the subjective judgment that people make about the characteristics and severity of risk" in reference to disasters or health (Kim & Madison, 2020). It affects the personal decision-making process based on an individual's frame of reference and is developed over a lifetime. Specifically, accurate risk perception helps create an environment that is more resilient to natural disasters — such as floods — as well as diminish potential negative effects of flood events. Knowing what factors contribute to individuals' risk perceptions can help risk managers influence preparedness behaviors and create strategies that allow for effective risk communication. The studies below help illuminate public understanding of risk and how it depends on the cultural characteristics and ideology of a society. Individual differences create difficulties for risk awareness campaigns because of the variability in risk perceptions, estimations, and understanding of risk information.

Risk perception is a crucial component in flood risk management (Lechowska, 2018). Although people commonly experience natural hazards and disasters, risk perception of the disaster varies by individuals' psychological frames and/or previous experiences and reflects specific individual values (Kim & Madison, 2020). Scholars have attempted to explain what factors influence people's understanding of flood risk and how they perceive flood risk in a specific way.

Young adults and adolescents are a highly vulnerable group by virtue of their age, absence of flood insurance, lack of flood and other disaster experience, and cultural barriers (in the case of international students) (Edey et al., 2022; Ponstingel et al., 2019). Risk perceptions represent one of the factors of social vulnerability to floods and contribute to flood-related behavior, including protective techniques and precautionary actions used by young adults. When analyzing college students' flood risk perceptions in Texas, studies have found that students who have experienced flooding are more likely to take precautions and have higher flood perceptions (Edey et al., 2022; Ponstingel et al., 2019). According to Ponstingel and colleagues' (2019) study on Texas State University students in San Marcos, Texas, most of the students who had higher flood perceptions were in their senior year of college, aged 21-22 years old, rented apartments/houses/rooms, and

did not have flood insurance (factors of social vulnerability). Most of them lived within 0.1 to 0.5 miles of the rivers.

The findings also showed that students use some quick decision-making shortcuts — or heuristics — when estimating flood risk. They use their prior experiences with floods (heuristic principle: availability of instances), and they estimate their level of preparedness based on their level of knowledge about floods (heuristic principle: adjustment to anchor). Although students' flood perceptions were high, heuristic principle #2 (the similarity of past experiences with hypothetical future events, examining students' preparedness levels for past floods and if they were informed about past floods) did not guide students' perceptions regarding flood risk in San Marcos. Thus, students primarily relied on Texas State University to warn them about upcoming floods and evacuation orders. However, based on the students' comments, most of them felt anxious and insecure when it came to flood risk. Comments showed negative experiences with flood management, including many complaints addressed to Texas State University and the City of San Marcos (Ponstingel et al., 2019). Therefore, there is a strong need for additional flood education and flood awareness campaigns at universities to improve risk communication and flood management. However, most schools do not provide hazard education, resulting in students not knowing how to prepare for or respond to disasters. Addressing the dearth of natural disaster education, scholars Edey and colleagues (2022) created and pilot-tested an online interactive natural disaster curriculum for young college students in Texas. This program consisted of 5 learning modules (Hazards, Natural Hazards in Texas, Disasters, Planning and Mitigation, and Hurricane Harvey: A Case Study) as well as pre- and post-program risk perception survey questions. Each module contained a pre-test, followed by activities, scientific papers, maps, related games, and a post-write-up. The curriculum significantly improved natural disaster awareness and emergency planning efforts (creating a plan and knowing where to meet their family). After being exposed to the curriculum, students' risk perceptions increased for hurricanes and floods. In addition to increasing risk perceptions, the curriculum also increased their knowledge about Hurricane Harvey (Edey et al., 2022). While Edey and colleagues did provide example screenshots of the modules (see page 461 of their paper), the full curriculum is not publicly available.

To examine the role of past flood experiences and how communication campaigns shape perceptions, one study distributed a survey to 2,976 residents in Paris, France. The study found that younger, less educated respondents who had less first-hand flood experience had a knowledge gap and had less confidence in answering the survey questions related to floods.

Flood experience positively influenced the indicators for worry, control, prediction, duration, and exposure, but not trust and perceived consequences of flooding. This latter effect could be because respondents who had experienced a flood event in the past did not suffer large consequences. The findings also indicated that direct flood experience influences flood risk perceptions more than the effect of indirect consequences in the form of a power outage. That is, people who have recently experienced a flood may find the scenario of a flood recurrence easier to imagine — thus, they intuitively think about the risks of flooding. The authors suggested that flood risk communication policies could be improved by increasing the frequency of risk communication campaigns. Regular communication should target individuals who are unaware

of their exposure to floods, including vulnerable individuals, newcomers, renters, younger people, and those lacking previous flood experience (Rufat et al., 2022).

Flood Risk on a Community Level. It is also important to examine flood risk understanding in the context of community. To identify what factors promote or obstruct precautionary flood risk management at the municipal level, a survey was conducted in Rhine, Germany among 70 representatives of municipalities and 8 river associations. The findings indicated that risk appraisal (i.e., perceived probability and severity of future floods, worry) and coping appraisal (i.e., preparedness, availability of information or financial resources, efficacy of flood mitigation measures) motivated the intention to engage in additional flood prevention actions. Worrying about a potential threat to the municipality was also a major motivator for the community to engage in flood mitigation behaviors, such as hazard mapping, pre-warning systems, and IT risk management (Becker et al., 2014).

Furthermore, Babcicky and Seebauer (2020) empirically investigated the effect of collective efficacy on risk perception, fear, and self-efficacy (i.e., a person's perceived ability to carry out a specific action that would reduce a risk or negative consequences) for natural hazards in Austria. The authors defined collective efficacy as a group's sense of its ability to achieve a specific outcome (Babcicky & Seebauer, 2020). According to Protection Motivation Theory, risk perception, fear, and self-efficacy are key explanatory factors for individuals engaging in protective behaviors. Findings illustrated that the combination of efficacy belief in social support and citizen groups was the most promising for stimulating protective action, as they together promoted both risk and coping appraisal. Also, risk perception and fear were lowered by social cohesion (i.e., trust and solidarity), and social support increased self-efficacy. Therefore, the authors suggested that when measuring the readiness of communities to engage in collective action, risk researchers and risk managers should precisely define the context and the specific tasks of collective action they want to address (Babcicky & Seebauer, 2020).

How to Communicate About Flood Risk. Risk communication has usually been viewed as a single, one-time, and generic concept. Balog-Way and colleagues (2020) suggested that effective risk communication should instead be *an ongoing process requiring a multifaceted approach*, and they asserted that in addition to exploring concepts such as trust, framing, risk perception, and public engagement, researchers should engage in contemporary developments (e.g., providing transparency and the use of social media). This is because risk communication can sometimes fail to meet residents' needs for information in the period before a flood event — leaving people to feel uncertain about how to prepare for and respond to a flood. For instance, residents in the town of Corbridge, Northumberland, United Kingdom reported wanting information on when and how flooding might occur (flood dynamics) so that they could understand their risk and feel in control of their decisions around how to respond (Rollason et al., 2018). In addition to conveying transparency and trust, messaging should also consider how framing risk can motivate individuals to be careful about safety issues. For example, flood risk communication framed in terms of prevention — along with notions of chance and harm woven into a story — encourages individuals to protect their families and themselves. These risk frames were especially effective among prevention-focused people. Those are individuals having a strong desire to be careful about safety issues and protect themselves and their families from danger) because they are more invested in safety, stability, obeying rules, and security (de Boer et al., 2014).

Moreover, a recent study investigated South Louisiana residents who often experienced pluvial floods to understand the theoretical relationship between risk perception attitude (RPA) and information-seeking efficacy (ISE) — and how this can be applied to flood awareness campaign efforts (Kim & Madison, 2020). RPA is defined as the relationship between risk perception and changes in attitudes and behaviors. ISE is defined as an individual's confidence in seeking necessary information to overcome difficult situations or resolve problems. ISE determines how well an individual can secure information before, during, and after a disaster. The study's analysis of data from 716 residents in South Louisiana revealed a statistically strong relationship between RPA and ISE; a higher ISE was linked to a lower RPA. The authors found that RPA was lower among those who were more confident in information-seeking because they believed that they could get necessary information effectively once a disaster occurred. The specific groups that showed lower risk perception attitudes were those who lived in non-flood zones, homeowners, business owners, men, as well as individuals with higher perceived economic statuses and educational levels.

Risk and Probability Understanding From Multiple Types of Disasters. Some scholars have explored how including probability information and different disaster scenarios influence risk perception, and the findings vary between disaster types and how the messages are presented. For example, one study by Heard & Rakow (2021) investigated how scenarios that evoke strong emotional response vs. scenarios that evoke low emotional response impact risk perception when probability information is presented. The authors presented a risk booklet to the participants about two studies — lung cancer for the strong emotional response scenario and car crash for the low emotional response scenario. They found that participants perceived lung cancer more negatively than car crashes, judging it as more lethal (Heard & Rakow, 2021).

In addition, Rahn and colleagues (2021) examined the influence of type of hazard, warning message, and trait anxiety (individuals who perceive situations as threats) on different components of risk perception (Rahn et al., 2021). A sample of 614 Germans viewed scenarios including one of five hazards (severe weather, act of violence, breakdown of emergency number, discovery of a World War II bomb, or major fire). The participants received a warning message pertaining to that disaster and regardless of how likely they perceived the hazard occurring, receiving the warning message led to a significant decrease in the negative emotions participants expected would occur if they experienced the hazard.

Michailova et al. (2016) examined whether individuals search for and employ probabilistic information (information that provides the likelihood or chance of a certain event occurring) in situations that are representative of natural disasters where they have no control and physical and human loss can be great. Natural disaster scenarios involving risky situations were presented to 116 participants. With only a basic description of the situation, participants had to seek out additional information from the experimenters. Results found that people want to know probabilistic data when they are faced with a threat during a real disaster event, and this interest increases as the importance of the situation to the decisionmaker also increases.

5.1.3   Mitigating Flood Risk and Possible Decisions

Overview of Findings. Here, we focus on decisions that members of the public might be able to make (depending on their local circumstances) concerning flood mitigation. Flood mitigation behaviors can vary largely in scale and cost — from implementing dry/wet flood-proofing

measures and purchasing flood insurance to elevating one's home. Encouraging flood mitigation behaviors on both an individual and community level requires utilizing strategies that appeal to the homeowner, renter, and their neighbors. Self-efficacy (i.e., believing in one's own ability to do something), social norms (i.e., what others do or believe should be done), and negative emotions are among some of the powerful mechanisms driving current and future flood adaptive behaviors.

Any flood awareness campaign needs to determine the exact flood mitigation activities included in its awareness messages — and how to encourage our target audiences to engage in these kinds of behaviors — because raising risk perception is not enough, people also need to know what actions to take. The following academic studies focus on the underlying motivations behind different kinds of mitigation and adaptive behaviors related to flooding, as well as strategies to promote these practices. Note that the papers discussed in this section use the terms 'mitigation' and 'adaptation' interchangeably. Either term can refer to physical (e.g., flood-proofing measures) or behavioral changes (e.g., purchasing flood insurance).

Flood Insurance as a Mitigation Strategy. Studies have analyzed the underlying factors behind people engaging in flood mitigation behaviors such as buying flood insurance. When reviewing residential flood insurance purchasing behaviors in the U.S. state of Georgia from 1978 to 2010, Atreya et al. (2015) found that market penetration rates (i.e., flood insurance policies-in-force purchased per 1000 population) were higher in coastal counties compared to inland counties. Market penetration rates were also the highest where the proportion of floodplain area was the largest (i.e., coastal regions), which Atreya and colleagues attributed to compulsory purchasing requirements for residential properties in the 100-year floodplain as well as a higher risk perception among coastal residents. Notably, residents who previously incurred flood damage were more likely to purchase flood insurance; nonetheless, ***this effect was only significant for flood damages occurring up to 3 years back***, disappearing after that time period. African American residents were slightly more likely (4.3%) to buy flood insurance than White residents and people over 45 were more likely (17.4%) to buy flood insurance than younger people (Atreya et al., 2015). Unfortunately, the study did not compare purchase rates **among** households outside of a floodplain with either high or low flood damage.

Mitigation has also been linked to financial, cultural, language, and age vulnerabilities. For instance, insurance uptake rates were related to the perceived costs of flood insurance (e.g., flood insurance is unaffordable, filing claims is a burdensome task with a prolonged pay-out) as well as distrust in the National Flood Insurance Program (NFIP) and real estate actors (Zinda et al., 2021). Using data from 4,623 Americans in 958 counties, Cong and Feng (2022) observed that adults between 18 and 44 were more likely than those between 65 to 74 to set aside money for emergencies among Hispanics, those with minors in the household, and those living in communities with higher levels of poverty, higher percentages of minorities, and higher percentages of no vehicles. However, Whites in this age range were less likely to do so. This pattern could occur because compared to their baby boomer peers, older Hispanics are more likely to be immigrants with language barriers. Also, older adults with minor children are likely living in multigenerational households that are under both financial and psychological stress (Cong & Feng, 2022; see also Doley et al., 2015; Gassoumis et al., 2009).

Physical Changes to Mitigate Against Floods. Botzen et al. (2019) revealed that among homeowners in New York City, only 16% of interviewees had elevated their homes, 69% implemented at least one dry flood-proofing measure (e.g., investing in flood shields, putting in a pump or drainage system), and 77% applied at least one wet flood-proofing technique (e.g., installing a water-resistant floor, moving furniture away from flood-prone areas of the house). Botzen and colleagues argued that the *frequency of flood risk reduction actions were linked to their cost*. Homeowners who were more invested in building code requirements and believed they were able to elevate their homes (i.e., they scored higher on perceived self-efficacy) were more likely to have elevated their homes. Living in the 1% annual chance floodplain (100-year floodplain) and believing in both their own ability to carry out a dry/wet flood-proof measure as well as the effectiveness of the dry/wet flood-proof measure (i.e., scoring higher on both perceived self-efficacy and response efficacy, respectively) were among the factors that had encouraged homeowners to implement dry and wet flood-proofing measures (Botzen et al., 2019).

Furthermore, Papagiannaki et al. (2019) investigated the underlying mechanisms of both current flood preparedness (e.g., whether or not they had their drains or rain gutters cleaned at the time of data collection) as well as preparedness intention (i.e., willingness to invest in future flood preventative measures) by surveying 1,855 Greek residents. In line with findings discussed in earlier sections of this report, Papagiannaki and colleagues found that if an individual had gone through a more severe flood experience in the past, was more aware of their flood vulnerability (e.g., their home's distance from a body of water), and expressed lower trust in authorities (e.g., their degree of satisfaction with the local authorities' preventative measures) — they self-reported greater feelings of worry — which in turn increased current flood preparedness as well as preparedness intention. If an individual had endured a more severe flood experience in the past, was more aware of their flood vulnerability, and expressed lower trust in authorities — they self-reported greater risk perception (e.g., likelihood of an injury or loss of family in a flood event) — which in turn increased preparedness intention (Papagiannaki et al., 2019; see also the paper by van Valkengoed & Steg, 2019 for more details about the greater influence of risk perception on intended behavior compared to past behavior). That is, *when people had a heightened sense of awareness of floods and were losing faith in the capabilities of local authorities, worry and risk perception made people more likely to be prepared.* Individuals who were more prepared at the time of data collection were also more willing to invest in future flood protection measures — perhaps because mitigation efforts are not a one-time investment, but instead a process that requires maintenance and renewal (Papagiannaki et al., 2019).

Using survey data from 4,688 residents living in flood-prone coastal cities in the United States, China, Indonesia, and the Netherlands, Noll et al. (2022) found that if an individual reported being more worried about floods (i.e., threat appraisal), they intended to install a greater number of construction measures (e.g., install a pump to drain floodwater, raise the electricity meter above the most likely flood level). If a resident reported believing a construction measure is effective (i.e., response efficacy coping appraisal), affordable (i.e., perceived cost coping appraisal), and they considered themselves capable of installing the measure (i.e., self-efficacy coping appraisal), they were also more likely to intend to implement it in the future.

Because *self-efficacy* plays an important role in residential flood mitigation practices, previous research has examined how self-efficacy can be triggered in flood-prone communities. For example, Seebauer and Babcicky (2020) surveyed 381 households in Austria and demonstrated

that past experiences — whether personally experienced (e.g., number of floods experienced in their home) or vicariously experienced (e.g., number of important people they know who had experienced floods in their home) — were poorly linked to self-efficacy. However, social norms — also known as descriptive and injunctive norms (i.e., they see other people take flood-proofing measures or approve of the measures, respectively) — had a more persuasive effect on an individual's self-efficacy to perform behaviors that were more visible to the public (e.g., water-tight door and window frames, keeping valuables on an upper floor). ***Social norms led individuals to believe that they could follow suit.*** Personal competencies (e.g., technical competence, ability to understand laws and regulations) were also shown to be influential on an individual's self-efficacy to engage in relatively more complex tasks (e.g., portable pump storage, electrical/heating installation). Interestingly, in a meta-analysis of 106 studies from 23 different countries, van Valkengoed and Steg (2019) showed that greater ***descriptive norms, perceived self-efficacy, outcome/response efficacy, and negative affect were strongly linked*** to greater climate-induced adaptive behavior. Past experiences with natural hazards and injunctive norms had a relatively smaller effect on adaptive behaviors. It is important to note that van Valkengoed and Steg (2019) considered climate disasters that extended beyond just floods. It could be that flood mitigation behaviors are encouraged differently than mitigation practices for other kinds of hazards.

In addition to identifying the underlying factors that drive flood adaptive behaviors, it is also important to understand the reasons behind people being reluctant to implement flood resilience measures on their properties. For example, Glencross et al. (2021) interviewed 11 homeowners and 3 business owners in Scotland who had already experienced a flood on their properties. They found that interviewees were resistant to accept flooding as an ongoing risk because they were not located near a body of water or river. Interviewees also perceived flood events as "freak" occurrences that only happen every several decades. Glencross and colleagues attributed this denial of risk to an individual's reluctance to revisit the devastation and suffering of the previous flood event, wanting instead to focus on the future and a return to normalcy. Implementing protective measures at their own properties — such as installing flood gates or self-closing air bricks — were generally frowned upon. ***Flood resilience measures were also either deemed to be expensive or not worth the investment without evidence of its effectiveness*** (Glencross et al., 2021).

Moreover, residents felt that local authorities should be held accountable for allowing homes to be built on floodplains and providing inadequate drainage infrastructure at a regional and community level (e.g., neglecting to build culverts on their property's street or remove leaves after a flood). Homeowners were confident that with these preventative measures (i.e., improved drainage maintenance), water would no longer enter their properties during future flood events (Glencross et al., 2021). In similar fashion, Zinda et al. (2021) found that residents in Troy, New York also expected their local government to enforce better flood protection measures, especially cleaning out the drains before heavy rain events. Interestingly, while floodplain managers' perceptions about their communities' abilities to mitigate against and respond to floods have been relatively positive — 52% (104 out of 200 floodplain managers in the U.S.) thought their community's flood mitigation and response was good, and 55% (110 out of 200 managers) believed their community to be somewhat prepared — the majority of floodplain managers also believed their community was very (33%, 66 managers) or somewhat (39%, 77 managers) concerned about floods. Therefore, it is pertinent for communities to bolster their flood management practices for their residents (Tyler et al., 2022).

Recommendations From Literature to Increase Flood Adaptive Behaviors. To encourage flood risk awareness and increase flood mitigating behaviors, several studies have suggested a variety of strategies including the promotion of cheaper and more affordable solutions, online resources that are easy to find and understand, and strong community ties. For awareness campaigns aimed at increasing residential flood insurance uptake, Atreya et al. (2015) recommended targeting audiences who are younger and more prone to taking risks. Botzen et al. (2019) asserted that media campaigns should also communicate the effectiveness of comparably easier and cheaper flood damage mitigation techniques — such as dry and wet flood-proofing measures. Glencross et al. (2021) suggested that flood risk, preparedness, and resilience resources should be made more searchable and accessible online to explain how a property is at risk, address concerns about the efficacy of property-level protective measures, show practical and clear examples of such measures, and provide decision aids to help homeowners decide on which measures to install. Online resources should include different sources of support, including available grants, trusted advisors, and community groups. Glencross and colleagues recommended that publicizing grants or loan schemes, or having insurance stakeholders financially incentivize resilience measures, could help encourage homeowners implement the measures, especially when the high costs are a major obstacle to committing to a long-term and uncertain investment.

Social Norms in Flood Awareness Campaigns. Seebauer and Babcicky (2020) suggested that flood awareness campaigns can use social norms messaging to motivate residents' flood preparedness behaviors. For example, when surveying 2,286 residents in flood- and hurricane-prone states in the United States, Lim et al. (2022) tested 3 types of social norms messaging — descriptive norms messaging (i.e., what other people do), injunctive norms messaging (i.e., what other people believe should be done), and social disapproval messaging (i.e., not engaging in a behavior leads to a negative social result). The study found that injunctive norms messaging using weather forecasters (e.g., "All of your local weather forecasters agree that everyone living in hurricane-prone areas should purchase flood insurance") and social disapproval messaging (e.g., "Because if you don't, your damaged home can harm others' homes and lower your community's property values") increased social norms perceptions and intention to purchase flood insurance. Additionally, injunctive norms messaging using weather forecasters (e.g., "All of your local weather forecasters agree that everyone living in hurricane-prone areas should install water barriers"), injunctive norms messaging using neighbors (e.g., "Most of your neighbors think you should install water barriers"), and social disapproval messaging (e.g., "Because if you don't, your damaged home can harm others' homes and lower your community's property values") increased social norms perceptions, which in turn increased mitigation intentions to install water barriers. Lim and colleagues argued that injunctive norms using neighbors as the reference was only effective if the mitigation behavior lowered both individuals' and neighbors' flood risks — as was the case with water barriers. Contrary to expectations, descriptive norms messaging (e.g., "Over 10 million Florida residents have purchased flood insurance/installed water barriers") did not encourage social norms perceptions or mitigation goals. Because weather forecasters are shown to be trusted messengers, the study recommended that *emergency management agencies and government organizations collaborate with weather forecasters* to conduct flood risk reduction webinars, workshops, and community gatherings (Lim et al., 2022). In another study, Seebauer and Babcicky (2020) did not differentiate between injunctive and descriptive norms, but they proposed that local media messaging could leverage the influence of role models by recognizing champion households in

the community with flood protection prizes. This strategy could in turn encourage other households' confidence in their own flood mitigation capabilities, but to date has not been tested.

5.2   Literature Review Focused on Populations Marginalized by Floodings

As a complement to the sociodemographic analysis, this section reviews the relevant research literature informing decision-making about vulnerabilities and end-user group foci. In this context, we use the term "vulnerability" to refer to a disposition of a population to be adversely affected by flood-related events. "Social vulnerability" is a related but distinct construct referring to the sensitivity of a population to these events and its ability to respond to and recover from hazard impact. This construct is multidimensional, varying across time, space, and sociodemographic characteristics such as income, education, home ownership, ethnic minority status, gender, age, and vehicle access (Cutter et al., 2014; Cutter & Finch, 2008; Flanagan et al., 2011; Scherzer et al., 2019). Reducing social vulnerability can decrease both human suffering and economic loss (Flanagan et al., 2011).

Various strategies for measuring social vulnerability have been used ranging from hierarchical models based on civic participation data and/or expert knowledge to more holistic profiling strategies intended to identify interactions across various indicators rather than mere aggregation. The research literature on social vulnerability explores the various factors that lead certain populations to be more adversely affected than others by natural disasters and, in some cases, to suffer more exposures to disasters than others (Cutter et al., 2010). In the case of flooding, socially vulnerable populations often experience more exposures than others because they have less purchasing power and thus are more likely to buy property in areas prone to flooding (Cannon, 2015; Eisenman et al., 2007). There is evidence that more socially vulnerable populations experience significantly more flood fatalities than less vulnerable ones. Specifically, in a study of 832 county-wide flood events (defined as "partial or complete inundation of 2 or more acres of normally dry land area") that occurred in south-central Texas between 1997 and 2001, Zahran and his colleagues (2008) found that socially vulnerable populations, as well as communities in areas with longer flood duration and more property damage, experienced significantly more flood causalities. It is also noteworthy that the Texas Water Development Board (TWDB) has an ongoing project with another research team at the University of Texas at Austin to develop a flood-specific SVI (social vulnerability index) for Texas.

People with disabilities are poorly represented in emergency planning and are less prepared when there is a disaster (Adams et al., 2019). Fox et al. (2007) surveyed FEMA disaster sites and found that most counties experiencing disasters lacked specific guidelines for first responders to address the needs of persons with physical disabilities. The lack of guidelines was typically attributed to lack of funds, training, and prioritization by state emergency management and FEMA officials. These circumstances prompted the researchers to recommend creating marketing materials such as user-friendly fact sheets for landlords, emergency services planners, and first responders to help them better assist people with mobility impairments and other disabilities in addition to training and workshops. Similarly, Adams et al. (2019) used Los Angeles County community survey data from the Public Health Response to Emergent Threats Survey and the Healthy Places Index to examine the relationship between disability and preparedness. They noted that people with disabilities who are limited from participating in daily

activities might also be restricted from involvement in preparedness behaviors, particularly for activities requiring more time and effort, such as attending community planning events. They also found that people who have rated their health as worse have lower confidence in their ability to engage in preparedness behaviors, and that living in a more advantaged community has a positive impact on preparedness. Housing and social environments also have a substantial impact on preparedness behaviors (Adams et al., 2019).

Furthermore, other scholars (Bolton et al., 2021; Senkbeil et al., 2021; Sherman-Morris et al., 2020) have examined how populations with disabilities receive and respond to weather alerts/warnings and have proposed ways communicators can maximize accessibility of flood outreach. This theme highlighted the challenges socially vulnerable communities face in seeking and processing risk communication information, including complex language, information overload, and contradictory information (MacIntyre et al., 2019). For example, Sherman-Morris et al. (2020) conducted interviews with legally blind people to better understand how they receive and respond to tornado warnings. They found that providing different modes of accommodation and detailed descriptions were of the greatest importance to them for using these warnings and acting on them. Interviewees suggested including audio for television warning crawls, and providing geographic details (i.e., reading street names) to improve and personalize the warnings. Other researchers have suggested that becoming familiar with the communication conventions used within socially vulnerable populations can improve warning impact. One example is the capitalization of 'Deaf' as it refers to a specific person with the physical condition of deafness who embraces the condition's cultural aspects. (Bolton, 2020). Such awareness makes communication easier while acknowledging and respecting socially vulnerable peoples' history, culture, and rights (Bolton, 2020).

Several scholars have studied the influence of socioeconomic factors on flood preparedness and the lack of accessibility to basic public utility infrastructure services. Age, gender, ethnicity, and income have all been found to be important moderators of flood preparedness and exposure. For example, Špitalar et al. (2019) and Donner et al. (2018) examined the factors rendering older adults as more vulnerable during a disaster. Factors such as difficulty in accessing warning information, disability, or social network isolation might be more impactful on older people's vulnerability than poor preparedness per se.

Focusing on gender, McDowell et al. (2020) assessed gender-related differences in flood risk perception among groundwater supply users in Ireland. They found gender differences associated with health risks during and after floods. Females in their study were less aware and lacked information about appropriate actions to take after a flood than males. Therefore, the authors suggested focusing on gender-specific methods of communication, such as using more traditional media outlets, including magazines, newspapers, radio, and television, while also emphasizing that preventive actions (e.g., using sandbags) be conducted by females and males.

In many areas, a history of flooding has directly and indirectly concentrated *certain ethnic groups* (African American, Latino/a/e, etc.) in flood-prone areas (Bullard & Wright, 2009; Liévanos, 2020). In others, particularly in coastal areas, premiums on waterfront property bring White residents to predominate in flood zones (Grineski et al., 2015; Qiang, 2019). Regardless, where communities of color face flood hazards, racialized social processes contribute to conditions of vulnerability, in which people facing hazards are constrained in preventing and recovering from impacts (Bullard & Wright, 2009; Semien & Nance, 2022). Discrimination in

housing markets and mortgage lending have blocked racially marginalized households from accumulating capital homeowners often rely on to finance protective measures and cope after disasters (Liévanos, 2020; Paganini, 2019). Post-disaster aid processes have been shown to aggravate racial disparities, in part through their focus on restoring property and complicated filing procedures that require substantial time and resources (Howell & Elliott, 2019).

Communities of color also face disproportionate exposure to health risks (Brailsford et al., 2018; Grineski et al., 2015; Pastor et al., 2001). Hence, racially marginalized residents of flood-prone areas, constrained in access to resources and information while also burdened with multiple exposures, may be less likely than White residents to take protective measures. Research on adoption of protective measures for natural hazards shows mixed effects of demographic measures, including race (Grover et al., 2022; Lindell & Perry, 2004). A study of residents in hurricane-affected Texas counties found higher self-reported hurricane preparedness among White respondents (Reininger et al., 2013). Maldonado and colleagues (2016) found greater perceived flood risk and reduced protective measure adoption among Hispanic immigrants relative to people who identify as non-Hispanic white or U.S.-born Hispanic. In contrast, Meyer et al. (2018) found a positive effect of non-White identification on Louisiana residents' intent to evacuate in the event of a hurricane (i.e., non-White residents were more likely to evacuate). A recent nationwide survey indicated that households with an African American head are more likely than those with a household head identifying as White to take action-based protective measures but less likely to take costly resource-based measures (Zamboni & Martin, 2020). In an even more recent study of the geography of flood exposure and social vulnerability in the United States, Tate et al. (2021) observed that racial minorities and/or people living in mobile homes were more likely to reside in flood-prone areas.

Income is another important factor. Research suggests that in many situations, people of low socio-economic status may be unable to respond to official warnings about disasters. Fothergill and Peek (2004) observed that groups including people experiencing homelessness, unemployed persons, and other people of lower income status lack money and resources needed to evacuate — so, although they might receive and understand disaster warnings, they are less able to respond to them than people of higher socioeconomic status (SES) (Gladwin & Peacock, 1997; Morrow, 1997; Enarson, 1999b; Fothergill & Peek, 2004). In a study of disaster preparedness across age and income ranges, Al-Rousan et al. (2014) observed that older people with lower incomes were significantly less prepared than younger people with low incomes or older people with higher incomes. Another moderator of income's impact is civic trust – i.e., the degree to which people believe members of their communities and associated institutions are fair, honest, and dependable. In a study of low-SES Mexican-American households in Texas counties where hurricanes and flooding are frequent, people who reported more civic trust were also more likely to prepare for these events than others with lower trust (Fothergill & Peek, 2004). These and related findings indicate the combined effects of sociodemographic factors on disaster preparedness.

Infrastructure in Underserved Areas. Although ethnicity, age and income are factors and contributors to flood preparedness and flood exposure, infrastructure also plays a role. **Colonias in Texas are an example of how infrastructure in underserved areas relates to flooding.** A "colonia" is a peri-urban (i.e., located in an area adjacent to an urban area/city), rural, and low-income community lacking drinking water supply, sewage treatment, paved roads, and adequate drainage. There are more than 1,800 colonias in Texas, and most of them are located near the

U.S.-Mexico border (Parcher & Humberson, 2009; the Attorney General of Texas, n.d.; Wutich et al., 2022). Colonia residents might not be able to find a sponsor and/or motivate a utility company to connect their community to a nearby water pipe. County, state, and utility representatives argue that water infrastructure projects in the colonias are too costly relative to the number of residents who benefit, beholden to construction codes, and in jurisdictional "donut holes" — ultimately ranking these communities out of water-project priority lists (Tippin, 2022).

Informality is an essential part of colonia housing — homes and lots are built or acquired with ambiguous titles, informal lending, and unenforced building codes (Richardson & Pisani, 2012). Seasonal flooding is a pervasive and worsening danger for colonia residents; their vulnerable infrastructure — such as a deficient drainage system and unpaved roads — heightens the impact of widespread flooding (e.g., unable to commute to their jobs and losing income, missing school; Belury, 2022). Heavy rain can also expose septic/cesspool systems and shallow, self-built groundwater wells to greater levels of microbial contamination (Rowles III, 2020). Improving and maintaining the colonias' drainage systems can help reduce the negative impact of flooding on the operation of residents' septic tanks, whereby septic systems overflow when there is heavy rain (Arraya et al., 2023). To make matters even more complicated, recovery in an unincorporated colonia is difficult because the self-built environment is either deemed as private and ineligible for FEMA public reimbursements, or colonia residents are afraid to apply for FEMA individual assistance because of U.S. residency requirements (Collins, 2009, 2010).

It is important to understand how to mitigate risk and attenuate hardship under these complex living conditions. To communicate public health and risk information to colonia residents, public agencies (e.g., Texas Department of Aging and Disability Services) perceived television, radio, and public events as the most effective communication channels, and nonprofit organizations (e.g., Valley Association for Independent Living (VAIL)) viewed radio and bilingual staff outreach — such as case managers and promotoras, or outreach employees who are colonia residents — as most effective. In contrast, social media (e.g., Facebook, X (formerly called Twitter)) and billboards were never ranked as most effective (Arlikatti et al., 2014), but this research was conducted before 2014 and social media tools are now regularly used.

Rainey et al. (2021) recently observed that urban areas experience severe and frequent flooding that is oftentimes dispersed throughout neighborhoods in both small and large communities. Smaller and more low- to moderate-income communities typically do not have the resources to handle large rain events. They also do not meet the level of economic losses required for federally supported disaster assistance that would be used for public infrastructure, rather than for individual households (Rainey et al., 2021). In a survey of stormwater and floodplain management practitioners across the U.S., they found that respondents reported inadequate or under-designed drainage infrastructure devoid of proper maintenance and greater local runoff as the leading drivers of urban flooding. To alleviate inadequate drainage of stormwater runoff in urban and economically vulnerable communities, a combination of structural (i.e., engineered infrastructure) and non-structural strategies (i.e., preventative action and changes in behavior, such as controlling debris levels to avoid blockages) must be implemented (Parkinson, 2003).

Language Vulnerabilities. Another important barrier is language. Language barriers are a common theme in disaster social vulnerability analyses, suggesting the importance of making preparedness and warning messaging available in the various languages of the target audiences. An individual's ethnicity and level of language skills (English language proficiency) influence

their levels of disaster preparedness and response to disaster situations (Teo et al., 2019). To reach groups with limited language proficiency, messages must be translated into their language and be culturally and linguistically appropriate (Maldonado et al., 2016; Teo et al., 2019). It is also important to consider a group's history, culture, and tradition when designing a message that provides disaster information and resources (Maldonado et al., 2016; Špitalar et al., 2019; Teo et al., 2019). For example, Hispanic immigrants tend to come from collectivist cultural backgrounds and rely heavily on family and friends as trusted sources of disaster information; therefore, their familial connections may serve as a more effective channel than mass media. Thus, looking into informal community networks may be vital in engaging the group (Teo et al., 2019). Another recommendation is for children to be a communication entry point for the other family members by providing them with bilingual information about flood risks and prevention/recovery resources at school (Tate et al., 2019).

In conclusion, considering the factors that render some populations more socially vulnerable to flood-related events than others holds many implications for various agencies responsible for hazard mitigation, preparedness, response, and recovery. Importantly, considering these factors can improve the quality of service received by people vulnerable to floods. Agencies can use maps to identify critical areas to set up shelters for flood-affected communities that will service the largest number of people vulnerable to floods without placing them at greater risk by setting the shelter in a flood zone (CDC, 2022). They can also use this information to promote and host preparedness events, and/or distribute resources in advance of hazardous events. Examples include geographically/locally tailored and language-diverse materials or workshops regarding how to reduce standing water after a storm, or trainings showing how to distribute sandbags to protect property from floodwaters. In the wake of a flood-related event, socially vulnerable hotspots could be highlighted for FEMA Public Assistance grants and establishing Points of Distribution during disaster recovery. Social vulnerability analysis can inform priority areas to check for damage to critical infrastructure, people who are hurt or in danger, and areas where the loss of electricity and water, often disrupted or damaged during an event, will have a severe impact on already vulnerable populations less equipped to cope with service loss.

Moreover, the research reviewed in this section clearly indicates that individuals with diverse backgrounds exhibit different reactions and needs toward disaster situations, and thus a targeted approach is needed when communicating with various populations to reduce their vulnerability (Maldonado et al., 2016, Teo et al., 2019; Yari et al., 2019). Therefore, understanding who is most exposed and at risk to floods can be used to tailor mitigation strategies to target those in need and help maximize accessibility to flood outreach and flood products.

5.3 Literature Review on Types of Media, Themes, and Messaging

In addition to this literature review, Part 2 of this report will dive deeper into these themes and will include focus group results that explain Texas-specific findings.

Media Channels. *Social media, online news, and paper newspapers* have been shown to be effective means to communicate flood prevention and mitigation strategies to the public because they help distribute information on a wider scale, making it more accessible and manageable for the end-user. For example, Facebook and X (formerly called Twitter) are commonly used to share flood awareness information, including resources, tips, and emergency contacts (Smith et al., 2008). Social media and newspapers showcase the potential of media messaging because

they increase the visibility of prevention and mitigation resources and instructions for media consumers to apply (Vincenzo et al., 2020). Instructional messaging encourages media consumers in flood-risk areas to follow evidence-based strategies from government and institutional environmental sources to minimize the negative implications of flood disasters such as flash and environmental flooding (Sharp & Carter, 2008; Xiangfu et al., 2022).

Promoting preparedness messages through social media captures attention. For instance, the Centers for Disease Control and Prevention's (CDC's) "Preparedness 101: Zombie Apocalypse" campaign centered around social media and proved cost-effective and attracted significant viewership. Within 10 minutes of promoting the zombie blog post on X (formerly called Twitter), the campaign witnessed a staggering increase in page views, reaching an average of 30,000 views per hour compared to the previous average of 80 page views per hour on the CDC's own blog website (Fraustino & Ma, 2015).

Moreover, in a study by Armstrong et al. (2021), their research established a connection between prior disaster experience, *media usage*, and perception. Students exposed to Hurricanes Harvey and Irma considered mediated sources (such as television, radio, newspaper, email, internet sources, social media, and official policy, including broadcast news and meteorologists) more critical compared to students with no exposure to these hurricanes. However, both groups viewed non-mediated sources (such as friends, in-person interactions with strangers, written notices, and phone calls) similarly in terms of importance.

Messaging Content and Strategies. Previous research has explored messaging, campaigns, outreach, and flood modelling (Dobson et al., 2018; Rufat & Botzen, 2022; Salman & Li, 2018; Sanders et al., 2020; Song et al., 2022; Steib et al., 2019). Kuller et al. (2021) recommended using appropriate language, specificity, transparency, and consistency when crafting messages. Crucial elements of warning messages include the *source, hazard details, location, time, and recommended actions* (see also Mileti & Sorensen, 1990). Kuller and colleagues suggested incorporating mixed formats, such as numeric and verbal probability, and using visualizations to enhance risk communication. Pre-testing visualizations with relevant audiences is essential prior to public dissemination (Kuller et al., 2021).

Visual aids like flyers, newsletters, and memes are widely used to disseminate flood prevention and mitigation strategies, increasing accessibility and engagement (Ahmed & Sinnappan, 2013; Bird et al., 2012; Stephenson et al., 2008). These strategies have proven highly effective in raising awareness about flood prevention measures domestically and internationally (Rinne & Nygren, 2016; Young et al., 2021). Photographs and videos are valuable visual aids for enhancing public flood risk perception (Markanday et al., 2022; Salman & Li, 2018; Bodoque et al., 2019). Negative photographs portraying the consequences of natural hazards can significantly impact public risk perception. Markanday's (2022) study demonstrated that including a photo illustrating the impacts of climate change motivated action, driven by social/moral reasoning and emotional responses. Visual reminders of environmental or social devastation connected individuals to the issue, leading to greater investment in climate protection. Similarly, showing images and videos of past floods increased awareness and preparedness for flash floods. People demonstrated greater optimism when evaluating negative events they believed they could control through their behavior (Bodoque et al., 2019).

Scholars have provided recommendations on effective communication methods for flood-specific risk messages *using texts, numbers, maps, and brochures* (Dobson et al., 2018; Kuller, 2021; Lindell, 2020; Lindell et al., 2021; Salman & Li, 2018; Sanders et al., 2019; Song et al., 2022; Stieb et al., 2019; Wing et al., 2022). Graphics like maps and brochures are considered valuable tools for communication and education to raise awareness (Lindell, 2020; Stieb et al., 2019). However, *if flood maps lack audience-centered design, they can cause uncertainty* (Wing et al., 2022). Song's (2022) study demonstrated that informative and user-friendly web hazard maps enabled students to accurately identify risk areas. Conversely, Sanders' et al. (2020) study found skepticism among residents who struggled to magnify flood maps to street-level details. Therefore, one recommendation is to provide a brief hazard description and direct users to a website with complete information (Sanders et al., 2020; Lindell et al., 2021). Stieb's (2019) systematic review recommended understanding users' backgrounds, defining terms, and engaging with them to enhance map interpretation. Personalized messages, considering factors like location and individual characteristics related to vulnerability, should be incorporated into the maps (Stieb et al., 2019). It is crucial to use non-technical language for better comprehension and attention (Charalambous et al., 2018). In conclusion, maps should be clear and easy to interpret, catering to individuals with varying map skills and technological proficiency.

Participatory events offer a way to understand flood audiences better. These events involve end-users in creating the tools they require (Rollason et al., 2018; Sanders et al., 2020; Stieb et al., 2019). Input from end-users should be incorporated when designing visual forms like maps (Dobson et al., 2018). Sanders' et al. (2020) study highlighted the benefits of working with end-users to develop flood hazard models and maps, including building a shared understanding of flood risks, fostering interaction between scientists and end-users, and providing accessible and understandable information. *Workshops and participatory efforts emerged as effective risk communication tools to raise awareness and promote protective behaviors among residents in flood-prone areas* (Charalambous et al., 2018; Heidenreich, 2020; MacIntyre et al., 2019; Osbeghaus & Hinricks, 2020; Ramasubramanian et al., 2019; Rollason et al., 2018). Heidenreich's (2020) study demonstrated that a six-day workshop on private flood protection in Germany enhanced participants' self-efficacy and flood knowledge. Similarly, a workshop on past flash floods in Navaluega, Spain increased awareness and local understanding (Bodoque et al., 2019). MacIntyre et al.'s (2019) study found that public participation measures involving diverse community stakeholders were highly effective in creating disaster awareness. Workshops encouraged individual action, improved community trust, and fostered cooperation in planning and messaging (MacIntyre et al., 2019). To ensure successful and well-attended workshops, Heidenreich et al. (2020) recommended organizing large-scale events with scientific themes for the general public. These workshops should be easily accessible to at-risk individuals, held in flood-prone neighborhoods to address specific issues, and considered as alternatives to online or paper materials. They should be scheduled during non-working hours to accommodate a larger audience, and ideally, organized following flood events to counteract the tendency to forget about floods and their impact (Charalambous et al., 2018).

Different strategies have been employed to communicate with the public and influence behavior, but messaging content can sometimes yield unexpected outcomes. For instance, Johnston et al. (2020) found that Australian government messaging emphasizing agency capacity, equipment, and training created unrealistic expectations and a belief that the government will solely ensure residents' safety. To balance this, *communication should also focus on self-reliance, resilience-building, accurate risk identification, shared responsibility, and strong community ties*

(Johnston et al., 2020). Personal narratives and stories have been recognized as powerful tools in making extreme weather and climate change messaging more relatable and bidirectional. Community residents can easily relate to stories and share their experiences, fostering stronger connections (Bodoque et al., 2019; de Boer et al., 2014; MacIntyre et al., 2019). Digital storytelling — through stories, anecdotes, photographs, and physical markers — can strengthen community relationships, promote flood resilience, and enhance preparedness (Holmes & McEwen, 2020). After the United Kingdom's 2007 summer floods, digital stories showcasing redemption and individual resilience proved effective in communicating among residents (Holmes & McEwen, 2020). Additionally, utilizing different promotion channels like social media and local press to target specific groups has been recommended, as *tailored, people-centered risk communication practices* have shown greater effectiveness compared to top-down approaches (Heidenreich et al., 2020; Osbeghaus & Hinricks, 2020).

Messaging studies have utilized various experimental approaches to find that *focusing on simple language and cost-effective, practical solutions* appear most helpful. For instance, flood risk messages emphasizing coping appraisal (e.g., actions requiring less money and time) instead of threat appraisal (e.g., fear) encourage residents to engage in protective behaviors, such as moving valuables from the ground/basement floor (Babcicky & Seebauer, 2019). In the "Red Dirt Ready (RDR)" preparedness campaign in Oklahoma, Adame and Miller (2015) examined factors such as stake, salience/relevance, certainty, immediacy, self-efficacy, and response efficacy in 60-second television public service announcements (PSAs). One message condition emphasized self-efficacy by stating that assembling a preparedness kit is easy and affordable (they called this "a high-vested message"), while another message condition indicated that it might be challenging and costly (i.e., "a low-vested condition"). Individuals exposed to high-vested television messaging demonstrated higher intent to build a disaster kit and create an emergency plan. However, there were no differences in attitudes toward the message or message source credibility across the manipulations of message vestedness (Adame & Miller, 2015). Fraustino and Ma (2015) compared different media (social media (blogs) vs traditional media (newsletters)) and messaging strategies (humorous zombie-related messaging vs non-humorous all-disaster-preparedness messaging) among college students to assess the effectiveness of the CDC's "Preparedness 101: Zombie Apocalypse" campaign. The results showed that students exposed to the humorous zombie-related messaging were *less likely* to express intent to prepare an emergency kit, create a household evacuation plan, take overall emergency preparedness actions, or seek additional emergency preparedness information compared to those exposed to non-humorous messaging (Fraustino & Ma, 2015). While they were less likely to make behavioral changes, it is important to note that the humorous zombie-related blog post on X did garner more attention on the CDC's blog website (30,000 views per hour from a mere 80 views per hour, see above for more details). Therefore, humorous messaging can at the very least be a way to get exposure and awareness among target audiences.

In a study focusing on tornado preparedness messages, Ma et al. (2021) ran an experiment where either the tornado or the human had action ability (a concept called agency). When the message said the tornado did the action, people felt a higher susceptibility and threat. When the message said humans can take action to protect themselves from the tornado, people felt their freedom was threatened and they felt pressured to behave in a way that went against their own will However, the different messages did not significantly impact attitudes towards the message,

intention to engage in preparedness behaviors, perceived efficacy, or feelings of anger (Ma et al., 2021). Conversely, messages that emphasized the geophysical hazards of storms and utilized fear appeals to highlight threats to human life have been associated with increased intentions to evacuate, risk perceptions, and response efficacy (Morss et al., 2018).

Experimental studies have also investigated the impact of messaging strategy and content within a broader context, including personality development, life experiences, and situational factors (Morss et al., 2016a, 2016b, 2018). Individual characteristics and variables related to situational meaning formation, interpretation, and worldviews influenced the likelihood of taking protective action. For instance, Morss and colleagues (2016b) found that interpretation and decision-making regarding flash flood forecasts and warning communication were situationally dependent. Participants who had lower trust in flash flood warnings, had not made prior preparations for flash flooding, and believed they were safer from flash flooding, tended to estimate low likelihoods of flash flooding despite receiving a warning (Morss et al., 2016b). In a flood risk communication study in the Netherlands, framing the communication in terms of prevention and incorporating a story about the need to protect oneself and family showed a significant effect, particularly among participants with pre-existing prevention motivation.

Creating messages about prevention that are specifically designed for a certain group could lead to a greater emphasis on avoiding issues (de Boer et al., 2014). In a study conducted in Miami, Florida, messages containing strong and personalized language such as "complete destruction," or "persons not heeding evacuation orders in single-family one- or two-story homes may face certain death" were perceived as exaggerated, and the source was deemed less reliable, particularly by respondents with strong individualist worldviews. However, messages emphasizing the effectiveness of evacuation resulted in lower perceptions of exaggeration, suggesting the potential value of efficacy messaging (Morss et al., 2016a). Another study focusing on efficacy found that participants who received a news article with more efficacy information and supportive peer feedback through social networking messages showed higher levels of involvement and greater intentions to engage in protective behavior. When presented with a less efficacious news article, the impact of peer feedback on these variables was significantly stronger (Verroen et al., 2013).

In conclusion, it is crucial to understand the target audience when developing outreach materials and flood awareness messaging. A single, generic message is not effective, and a multifaceted approach is recommended.

6 Market Research and Lessons Learned

6.1 Findings From Market Research

Market research highlights flood safety communication through warnings as well as steps that can be taken prior to a flood event — such as gathering important documents, preparing a safety-kit, and understanding one's risk. Our research found that very few flood awareness campaigns have been formally evaluated in the United States (cf. Osberghaus & Hinrichs, 2021, for an example in Germany; Taylor et al., 2020, for an example in Australia). We came across one research effort (a master's thesis) that examined the (in)effectiveness of Turn Around Don't Drown® (Bryant, 2021). Bryant (2021) found that the hashtag #turnarounddontdrown was used on X (formerly called Twitter) 184,365 times by 77,187 users between July 2006 (the year X was created) and July 2021. The hashtag focused on Texas 36,532 times between 2009 and 2020, with only 1,192 uses between 2009 and 2014, increasing drastically to 7,660 times in 2015. Texans' adoption of the #turnarounddontdrown hashtag coincided with an uptick in vehicle-related deaths across the state between 2015-2017 (Bryant, 2021). It might be that people in Texas heard about vehicle-related fatalities more often in the news, and that drove them to use the hashtag more frequently.

6.2 Existing Outreach Campaigns on Flood Insurance

Academic literature has focused on understanding what might influence people to engage in flood mitigation behaviors, such as buying flood insurance (e.g., Brody et al., 2017; Lim et al., 2022; Lo, 2015). FEMA has conducted audience analysis research in partnership with the advertising firm Yes&, and they have developed outreach materials and new website content that target audiences who can afford to purchase flood insurance (defined as families making over $100,000, as indicated from our team's interview with members of NFIP's outreach team on September 26, 2022). This is also evidenced by U.S. Department of Homeland Security's Affordability Framework for the NFIP, whereby median household income is significantly higher for policyholders compared to non-policyholders (or households that currently do not have flood insurance). Other resources being developed by FEMA include a quiz helping people identify if they need flood insurance, brochures incorporating cultural differences, as well as commercials and YouTube videos involving flood survivors.

The FEMA Yes& partnership has focused on using positive emotion — evoking a sense of pride in the lives people have built in their communities — to drive their multi-channel campaign that targets residents in Florida, Texas, and Louisiana and provides materials in English and Spanish. To learn more, see their website that describes an 80% increase in digital display and paid search click rates over the past two years, as well as a 6% jump in flood insurance policy sales in some markets.

Their core messages targeted to Texas are:
- Even the hurricanes are bigger in Texas…but now I can weather the storm,
- Protect your corner of the world with flood insurance,
- Every three years a major hurricane hits Texas…protect your corner of the world with flood insurance.

See Figure 6.1 for example snapshots from this flood insurance awareness campaign. If you want to see how the Texas messages compare to those targeting Louisiana and Florida, click on their website and you see a strong example of geographic identity targeting.

They have allocated money to create IT solutions that will allow customers to purchase flood insurance online. This project focused on Texas takes into account the market research FEMA's NFIP team has done to apply a similar concept to the end-user groups we plan to target.

Figure 6.1 Snapshots of FEMA's Flood Insurance Awareness Campaign Specific to Texas
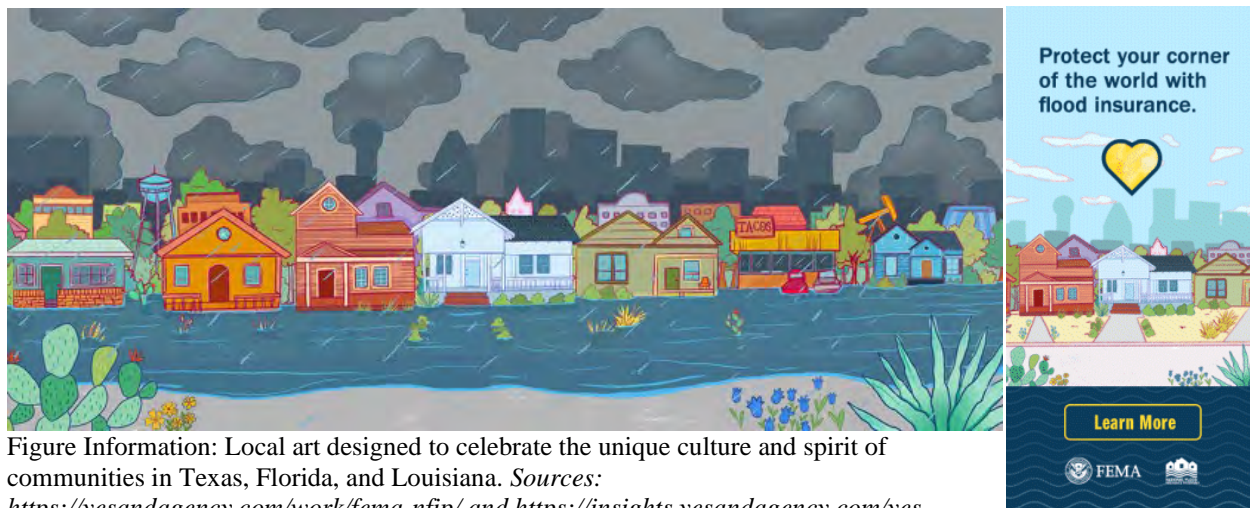
Figure Information: Local art designed to celebrate the unique culture and spirit of communities in Texas, Florida, and Louisiana. *Sources: https://yesandagency.com/work/fema-nfip/ and https://insights.yesandagency.com/yes-launches-flood-awareness-campaign-with-fema*

6.3   Market Research on Campaigns in U.S. States and Neighboring Countries

Table 6.1 is a sortable table that provides details from our market research on flood awareness campaigns and education programs in the U.S. as well as neighboring countries. Based on relevance and significance to the current project, the campaigns and programs were categorized using their location, type of flood risk (e.g., coastal, flash flood), disaster phase outreach (e.g., before a flood, during a flood), visualization method (e.g., pictures, maps), type of message (safety versus property, or a combination of both), use of multiple languages, as well as targeted audiences (e.g., drivers, homeowners, children, community organizations). Almost all existing flood communication efforts are directed toward general audiences or the local-residents-at-large, without any specificity for the diversity of languages spoken, cultural characteristics, age differences, degree of unfamiliarity with a region, or residents' special needs (e.g., they are mobility restricted). The literature reviewed did not include any proprietary research that the organizations may have conducted and not shared publicly.

There are a variety of flood awareness messages on city, county, state, and national agency websites, as well as websites for non-governmental organizations, non-profits, and community organizations. See Table 6.1 for the most relevant resources presented in a sortable manner.

Much of the identified content in the U.S. flood awareness and communication campaigns focuses on messages around ***flood safety and property***. This provides insight into how campaigns might best focus on different end-users and how communication might be tailored to these groups. Specifically, the key themes include:

- using messages with fear appeals around fatalities related to flooding,
- providing details about what causes flooding,
- highlighting the unexpected power of water,
- explaining how flash flooding occurs,
- discussing how litter/leaves can contribute to flooding,
- helping potential homebuyers understand flood risk and get flood insurance, and
- educating coastal residents about storm surges.

The communication approaches to flood awareness and prevention strategies across the U.S. highlights the documented concerns and predictable outcomes associated with flooding in Texas. Moreover, fear and risk messages — using text, visual, and video recorded images — have the potential to target incoming Texas residents and prepare them for a new reality of flooding and expose them to ways of minimizing the consequences of environmental disasters.

6.3.1   Specific Examples

Examples of flood awareness and communication outreach from neighboring states, as well as states that can serve as exemplars, are described below.

New Mexico. Flood awareness campaigns in what is often called the Tri-State Area, including the Upper Rio Grande Valley of Texas, New Mexico, and Chihuahua, Mexico, can be very different from campaigns seen on the Texas Gulf Coast region and the rest of the state. One example is New Mexico's launch of the "Turn Around Don't Drown Story Map" where they used ArcGIS. To reduce flooding fatalities, the campaign appeals to residents living in various at-risk counties by detailing instances of unfortunate drowning event victims. A secondary purpose of New Mexico's flood mitigation efforts is to address Monsoon Season, a term often used in this specific area of the U.S. to describe the time of year this area is most prone to rain and severe storms, which lasts from June 15th to September 30th. The rain is often caused by weather events from the Pacific Ocean, and people can also be affected by what they refer to as typhoons (akin to hurricanes, another example of how different terms are used to describe weather linked to flooding in parts of the state). Note that most places along the Gulf Coast of Texas call the time when they are more at risk from rainstorms and hurricanes, Hurricane Season, but in the Upper Rio Grande Valley, including El Paso, Texas, they often use the terms *monsoon and typhoon*. This language difference is found in El Paso news reports, as well as when **our** team conducted interviews in that geographic area of the state. Using their website platform, the New Mexico campaign displays raw images of flood damages — including buried vehicles and damaged bridges and roads — with a short narrative explaining the science and consequences of monsoon flooding.

Arkansas. The Weather Forecast Office in Little Rock, Arkansas strategically positioned their 2022 Flood Safety Awareness Week around flash-flood safety by providing visual aids and definitions (see Figure 6.2).

Figure 6.2 Arkansas Encourages Flash Flood Safety Through Visual Aids and Definitions
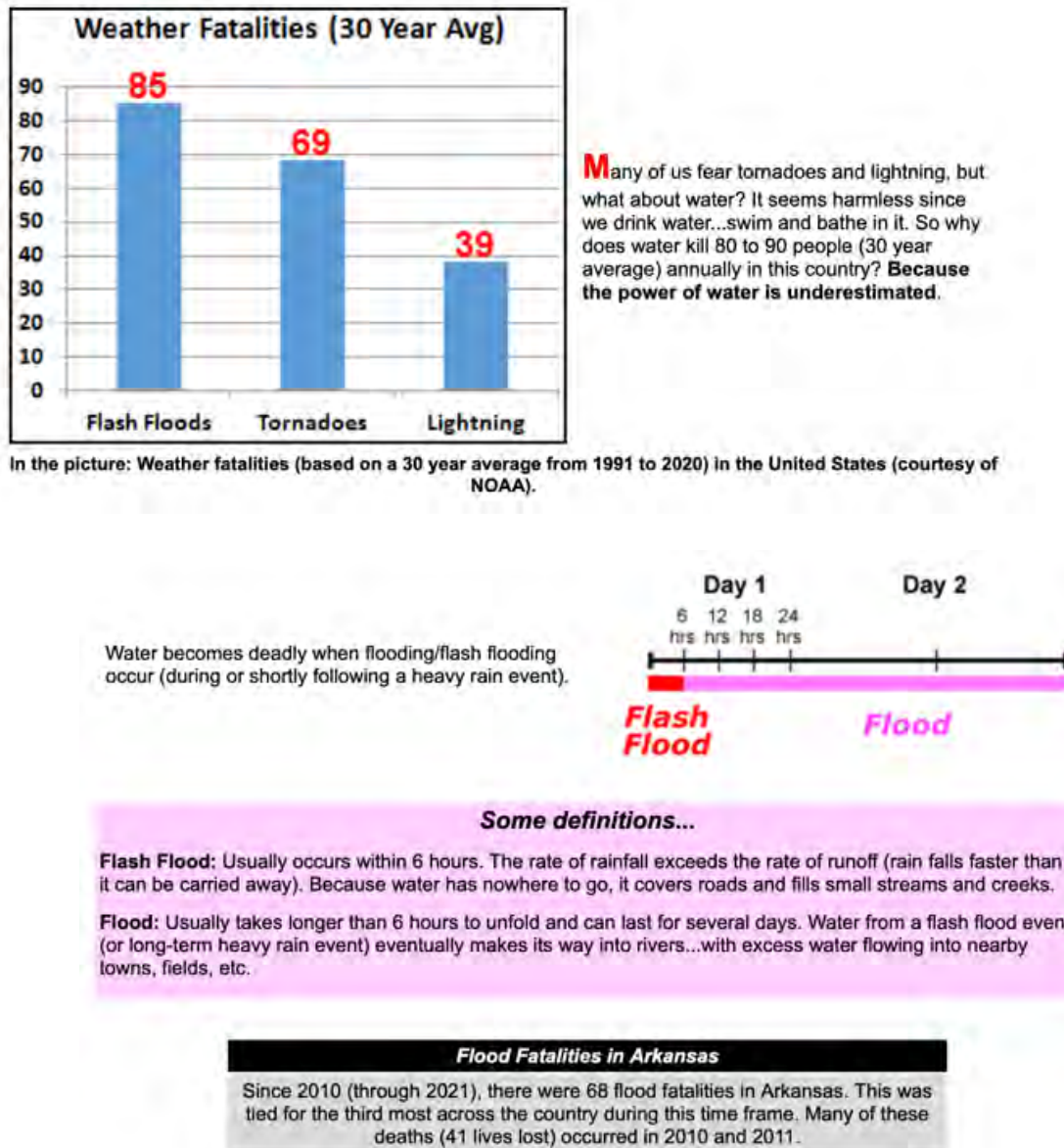
Figure Information: Flash flooding and floods caused by heavy rainfall are a serious threat and have caused numerous fatalities in Arkansas in the past decade. *Source: https://www.weather.gov/lzk/floodsafety.htm*

Oklahoma. A State of Oklahoma campaign uses a flood control program to educate residents about flood control dams and how they protect against flood damage by allowing watersheds — drainage basins or catchment areas — to trap and store post-storm runoff water. The program's campaign theme, "Protecting People and Property Around the State," centers around state-wide efforts to raise awareness and encourage strategies for prevention. In addition, the State of Oklahoma provides program assistance for residents to sign up and receive digital or print communication updates and suggestions on how to prepare for flood seasons.

The city of Tulsa has also created a "Know Your Risk of Flooding" digital pamphlet that succinctly outlines how to prepare for, respond to, and recover from floods (see Figure 6.3).

Figure 6.3 City of Tulsa's "Know Your Risk of Flooding" Digital Pamphlet
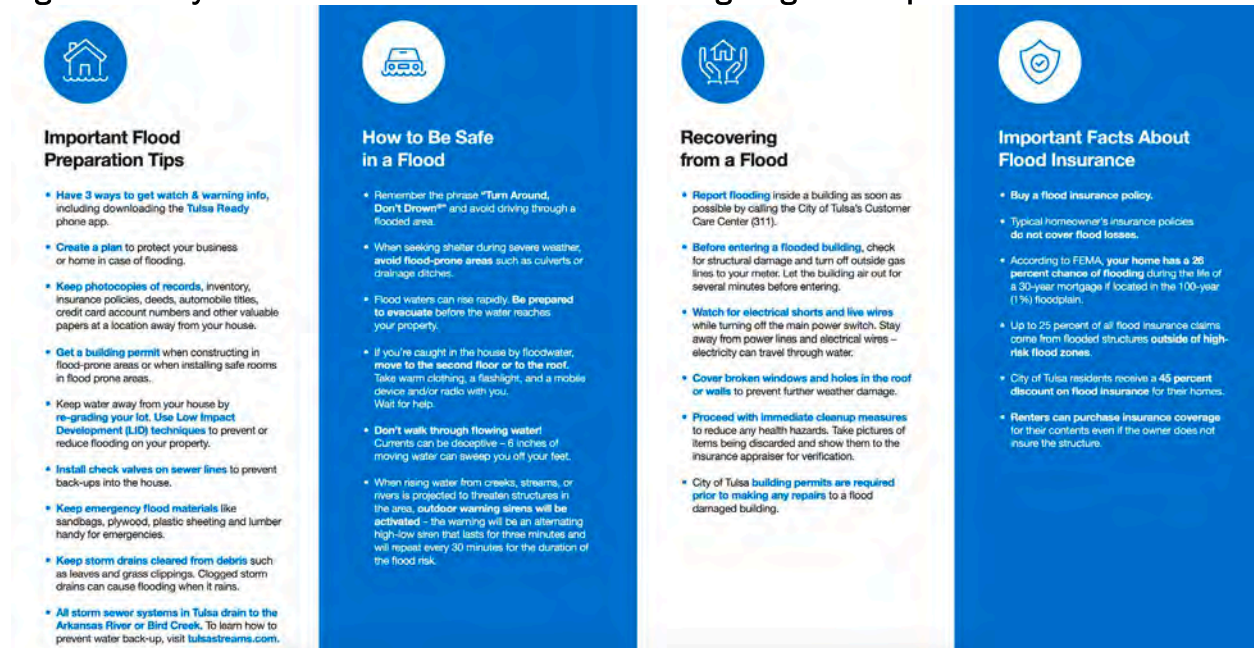
Figure Information: A page from the City of Tulsa's "Know Your Risk of Flooding" digital pamphlet. *Source: https://www.cityoftulsa.org/government/departments/engineering-services/flood-control/*

Florida. There are many resources available for Florida residents across its many regions, and almost every county in the state participates in Flood Awareness Week and Hurricane Awareness Activities. The Southwest Florida Water Management District attempts to define flood-related terms by using simple visuals and examples. For instance, they explain what a watershed is through so-called virtual watershed excursions where they take the person viewing the website on an educational journey (see Figure 6.4 for the webpage and an example of one of the virtual watershed excursions).

Figure 6.4 Southwest Florida Water Management District
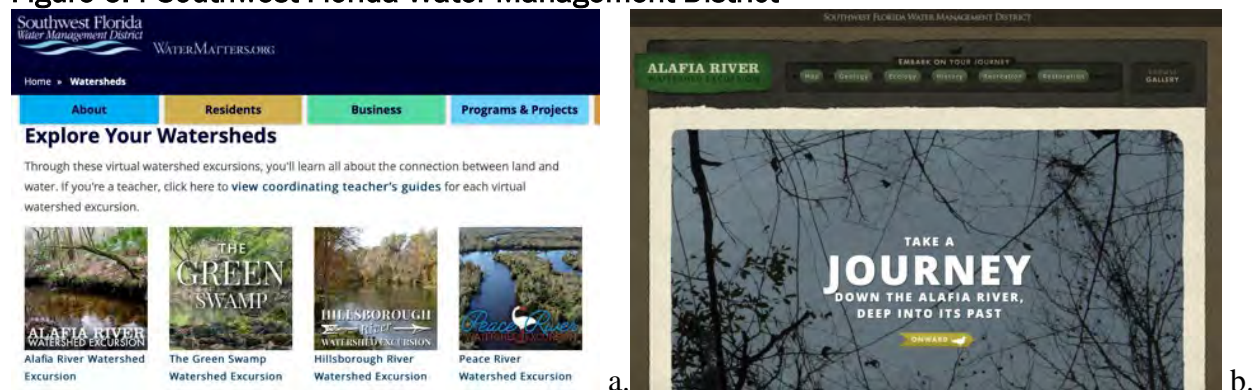
Figure information: Screenshot of (a.) the virtual Watershed Excursion webpage and (b.) the Alafia River Watershed Excursion start page. *Source: https://www.swfwmd.state.fl.us*

The Southwest Florida Water Management District also has put together an "H$_2$O Zone" for children to learn about their relationship with water; the topics range from the water cycle and freshwater supply to stormwater runoff (see Figure 6.5) and water cycle extremes.

Figure 6.5 Florida Stormwater Runoff Awareness Campaign

In Florida, **stormwater runoff** occurs during or after a rainfall event. Stormwater from the rain flows over **impervious**, or hard, surfaces like driveways, sidewalks, streets, parking lots and roofs, where it is unable to **percolate** (filter or seep) into the ground. This unfiltered water then reaches our neighborhood streams, ponds, lakes, bays, wetlands and oceans. It can even make its way into our groundwater.

Figure Information: Screenshot of the H$_2$O Zone's Stormwater Runoff webpage. *Source: https://www.swfwmd.state.fl.us*

Numerous Florida counties and cities produce digital brochures and pamphlets for their residents to communicate their flood risk and the resources that are available to them (see Figure 6.6 for example images of Dania Beach, Miami, and Pinellas County).

Figure 6.6 Digital Brochures for Florida Residents

a.

Figure Information: Example of a digital brochure and/or pamphlet for Florida residents in (a.) the city of Dania Beach. *Source: https://daniabeachfl.gov/2941/Flood-Safety*

b.

Figure Information: Example of a digital brochure and/or pamphlet for Florida residents in (b.) the city of Miami.
Source: https://www.miamigov.com/My-Government/ClimateChange/King-Tides

Research and Toolkits for Flood Communication and Awareness in Texas | TWDB & The University of Texas at Austin

Flood Zones and Evacuation Zones are Different

Whether you are thinking about buying or building a home, knowing the flood risk and evacuation zone can protect you from unplanned expenses. Find out your flood risk and evacuation zone at www.pinellascounty.org/flooding/maps.htm

Understanding Flood Maps

FEMA flood zone maps, known as **Flood Insurance Rate Maps (FIRMs)**, show areas of high and moderate to low flood risk. These maps are used to set minimum building requirements and to determine flood insurance requirements and rates.

Types of Flood Zones

High Risk (Special Flood Hazard Area)*
Zones A (A, AE, AH, AO)
Zones V (V, VE)

Moderate/Low Risk (Non-Special Flood Hazard Area)**
Zones B, C, X

* If the building is located in the SFHA, flood insurance will be required for federally backed mortgages.

** Moderate to low risk flood zones account for more than 25 percent of National Flood Insurance Program claims.

County floodplain maps from detailed watershed studies show areas that have a 1% or greater chance of flooding in any given year. Like with the FIRM high risk area, these floodplain areas are also considered high risk areas and subject to specific regulation. **Storm surge maps** display where flooding will occur when an abnormal rise of water generated by a storm is pushed toward the shore by strong winds. These maps are used for hurricane preparedness and planning. Evacuation may be necessary due to the risk of storm surge from tropical storms or hurricanes.
Evacuation zone maps are based on ground elevation and the area's vulnerability to storm surge. Know your zone and follow evacuation orders.

Flood Insurance Discount

By providing the flood services mentioned in this brochure and participating in the National Flood Insurance Program Community Rating System (CRS), many residents and businesses throughout Pinellas County are eligible for a discount on their flood insurance premiums.

Unincorporated residents and businesses may receive up to a 25 percent premium discount, which is a cumulative savings of more than $5.5 million a year for policyholders. Discounts vary by municipality, so check with your flood insurance agent to make sure your flood insurance policy is rated correctly and you are receiving the correct CRS discount.

With your continued support, there is an opportunity to save even more in the future. For more information about your flood risk, visit www.pinellascounty.org/flooding or contact the Flood Information Services at (727) 464-7700. Go to www.floodsmart.gov or call toll-free (888) 379-9531 for more flooding resources.

ADDRESS OR PARCEL ID: _____ **DATE:** _____

☐ This property is in a Special Flood Hazard Area (SFHA), which is a high-risk area. Flood insurance is required for structures in the SFHA on this property if they have a mortgage from a federally regulated or insured lender.

OR

☐ This property is in a moderate or low-risk area. Flood insurance is recommended and you may be eligible for a highly discounted preferred risk rate.

ALSO MAY APPLY:

☐ Flood insurance through the NFIP may not be available at this property because it is in an area designated under the Coastal Barrier Resources Act. Coverage may be obtained in the private market. Contact your insurance agent for more information.

☐ This property is in a storm surge area.

☐ This property is in evacuation zone _____

Comments: _____

This form does not imply that the referenced property will or will not be free from flooding or damage and does not create liability on the part of the realtor, Pinellas County or any official or employee thereof.

Pinellas County complies with the Americans with Disabilities Act. To obtain accessible formats of this brochure, please call (727) 464-4062 (V/TDD). Funding provided by Pinellas County Natural Resources. Produced in cooperation with the Pinellas County Communications Dept. 5/21.

Know Your Risk
Before Buying or Building in Pinellas County
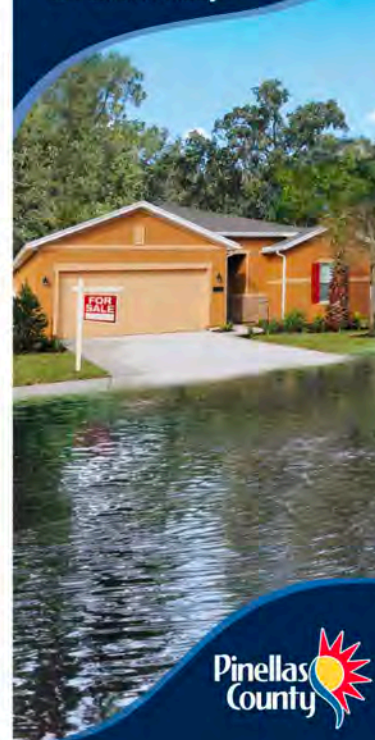
Pinellas County

Everyone is in a Flood Zone

Pinellas County often has storms that cause flooding. If you are considering buying a property, check out flood hazards before you buy. Flooding can occur when there is heavy rainfall or a tropical weather event. Flooding and other surface drainage problems can occur well away from a river, lake or ocean.

Find Out Your Flood Risk

Be an informed buyer and arm yourself with the knowledge to better protect your home from hazards.

- What flood zone is the property located in?
- What types of flooding is the property susceptible to?
- How deep could the flood get?
- Will I need flood insurance?
- How much will flood insurance cost?
- What evacuation zone is the property in?

To find answers to these questions and more, visit www.pinellascounty.org/flooding or contact Pinellas County Flood Information Services at (727) 464-7700.

Did You Know?

- Flooding occurs in and out of designated high risk flood zones.
- The force of moving water can destroy a building.
- A few inches of water in your house could cause thousands of dollars in damage. Find out how much a flood could cost.
- Floodwaters carry mud, chemicals, road oil, bacteria and viruses that cause health hazards.
- If your property is in a Special Flood Hazard Area (SFHA), there is at least a one in four chance of flooding during a 30-year mortgage.
- Nearly 20 percent of flood insurance claims in Florida come from areas that are not in a SFHA. Take advantage of a highly-discounted Preferred Risk Policy.

Understanding Flood Insurance

Protect your new home or business and your belongings with a flood insurance policy. Most homeowners' insurance policies do not cover losses due to flooding. Condominium association flood policies typically cover common areas and certain building elements within the unit.

Coverage: Find out what your homeowners and flood insurance policies cover and do not cover.

Deductibles: Find out your building and contents deductible amounts.

Rates: National Flood Insurance Program (NFIP) rates do not differ from company to company or agent to agent. They depend on many factors, such as the flood risk, the lowest floor elevation of the building, and the date and type of construction of the building. Build smart to lower your rate!

Find out if an elevation certificate is available for the property and what the flood insurance rate will be prior to purchasing a property. Pinellas County and its municipalities provide copies of completed FEMA elevation certificates.

Flood insurance is mandatory for federally backed mortgages on buildings located in a SFHA. There is a 30-day waiting period before coverage goes into effect, so don't delay. Visit www.pinellascounty.org/flooding/insurance.htm for technical assistance on flood insurance or for more information.

Stay Connected and Informed

Sign up for **Alert Pinellas** to receive free emergency notifications from the county, www.pinellascounty.org/alertpinellas.

Download the **Ready Pinellas** app to look up your evacuation level, preparedness checklists and plans. Download on your mobile device through Apple App Store or Google Play. Pinellas County and its municipalities regulate construction and development in floodplains to reduce damage from future flooding.

Build Smart

- Get required permits before you start new construction, or any home repair or improvement.
- Build your new home or elevate your existing home and/or equipment, such as water heaters and A/C units above the base flood elevation to reduce your flood risk and your flood insurance premium.
- Living space, electrical outlets, appliances and bathrooms below an elevated house are illegal.
- Plan for proper drainage and use low impact development (LID), such as rain gardens, pervious pavers and vegetative buffers.

Buying a Fixer-Upper?

Be aware of the substantial improvement rules:

- Remodeling projects that cost half of the value of the original structure will require you to elevate the building above the flood level.
- Houses substantially damaged by fire, flood or any other cause must be elevated above the regulatory flood level when they are repaired.
- Inspect and repair sewer laterals to prevent sewer backups and overflows.

c.

Figure Information: Example of a digital brochure and/or pamphlet for Florida residents in (c.) Pinellas County.
Source: https://pinellas.gov/know-the-flood-risk-before-buying-or-building-brochure/

Louisiana. To help residents be more cognizant of threats along the coast, Louisiana initiated the Interagency Coastal Storm Surge-Based Flood Risk and Resilience Awareness Campaign. The State created a "Story Map" as well as fact sheets to educate the public on storm-surge flooding and coastal erosion, and how these processes adversely affect transportation infrastructure, the education system, and healthcare industries along the working coast (see Figure 6.7).

Figure 6.7 A Story Map of Coastal Storm Surge in Louisiana
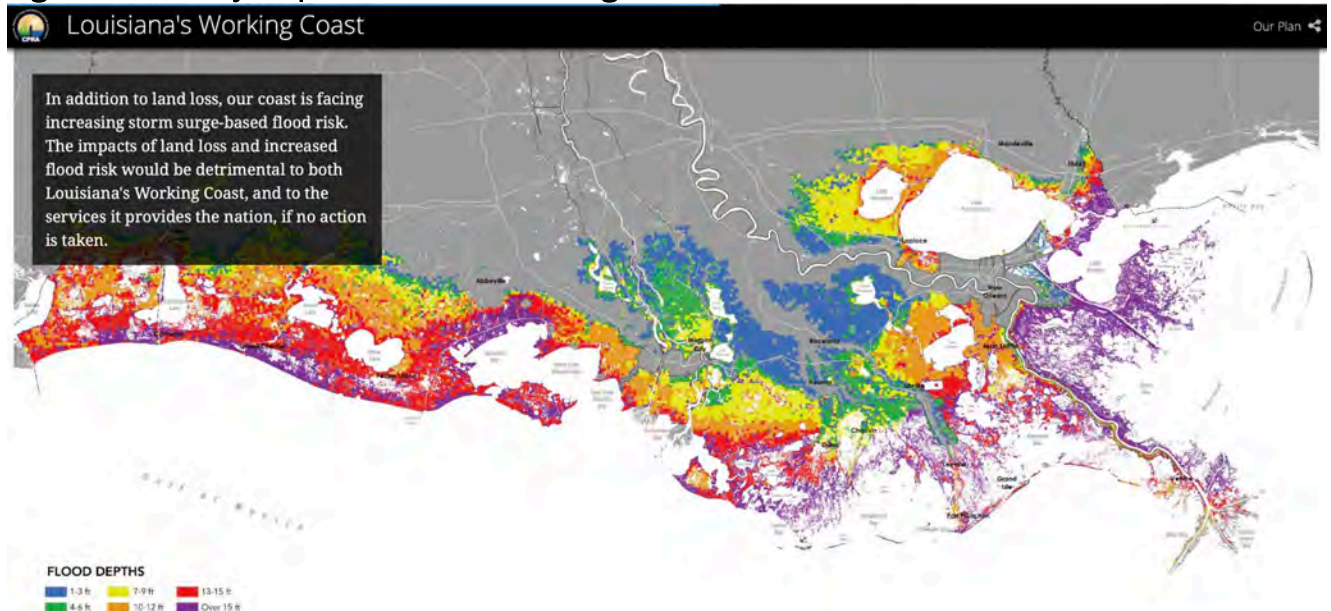
Figure Information: A screenshot of Louisiana's Working Coast Story Map showing storm surge flood risk. *Source: https://www.arcgis.com/apps/Cascade/index.html?appid=ee64700765d34634a75c8c81731fbf70*

The Louisiana Stormwater Coalition uses a grassroots approach to promote public awareness around the benefits of stormwater management; the group advocates for anti-litter education and efficient garbage programs, as well as drainage systems to capture litter and green infrastructure to absorb stormwater. They communicate with anti-litter messages through a Facebook page (see Figure 6.8).

Figure 6.8 Louisiana's Program for Anti-Litter and Stormwater Management
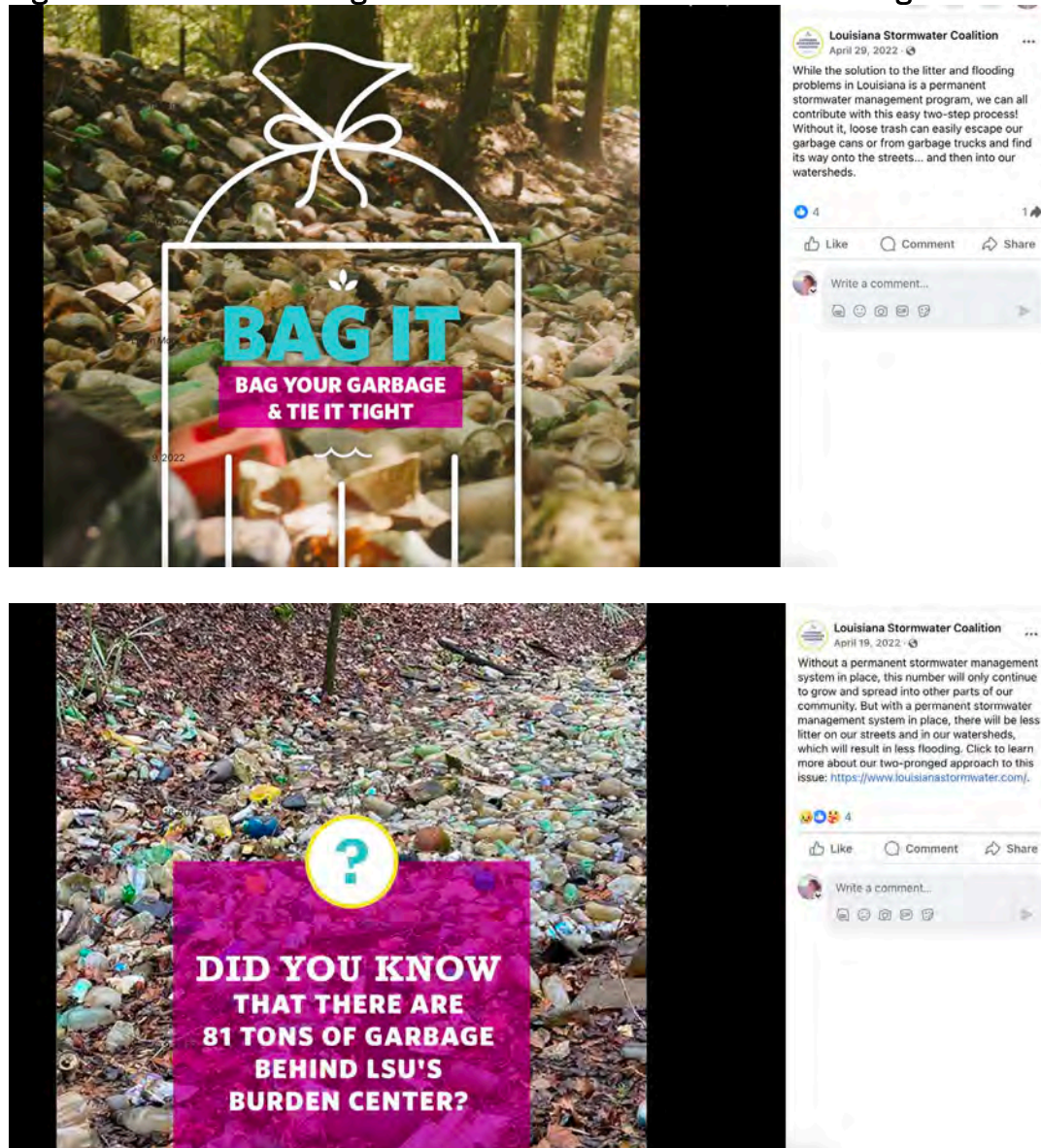
Figure Information: Screenshots of two Facebook posts about the importance of stormwater management. *Source: https://www.facebook.com/LouisianaStormwater*

The city of New Orleans has also initiated "Ready for Rain" through the Office of Homeland Security & Emergency Preparedness's NOLA Ready disaster preparedness campaign. The webpage decidedly frames flooding as a universal threat to all residents by explaining why and how floods happen in simple and clear terms. Ready for Rain also provides a range of quick and easy-to-follow tips on how to mitigate flood risk at home as well as who to reach out to in the community for help and guidance (see Figure 6.9).

Figure 6.9 New Orleans' "Ready to Rain" Webpage

a.

b.

c.

d.
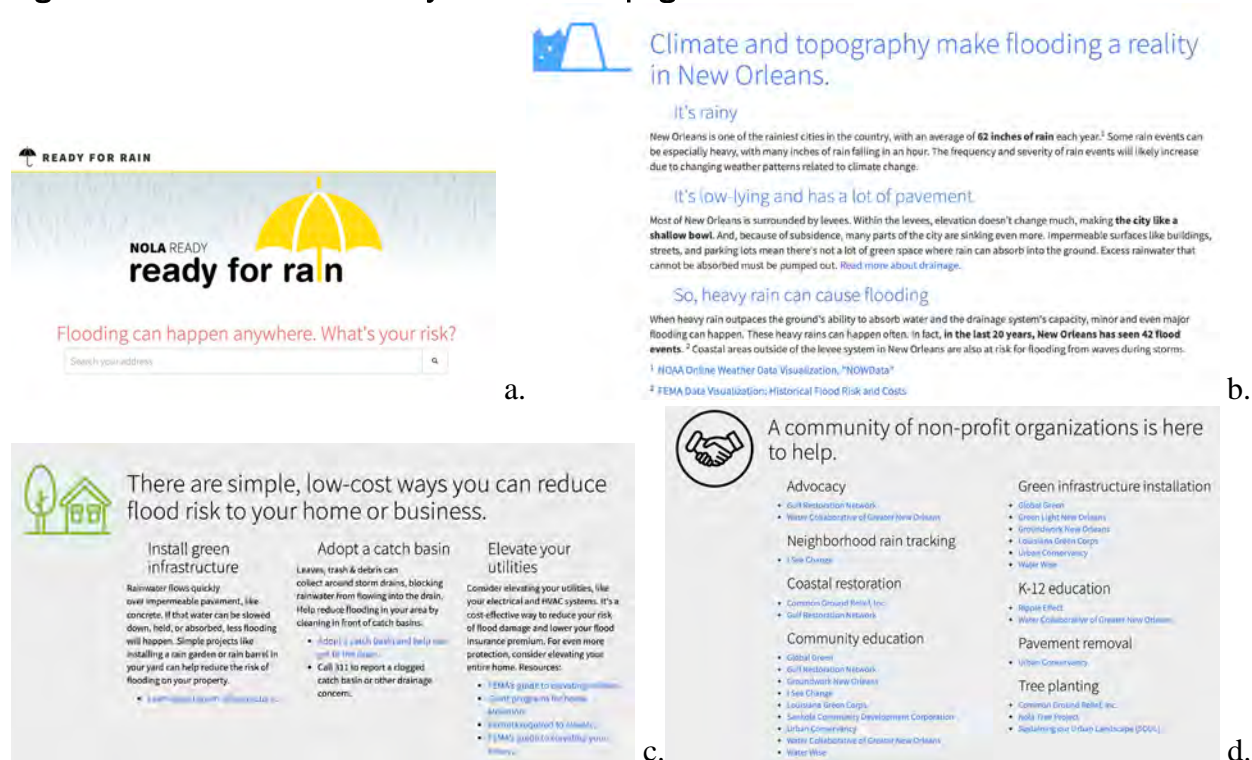
Figure Information: NOLA Ready's "Ready for Rain" webpage, including (a.) the logo, (b.) an explanation of flood risk, (c.) easy-to-do steps to lower flood risk, and (d.) a list of community organizations that can help. *Source: https://ready.nola.gov/home/*

6.3.2   International Perspective on Flood Prevention Strategies

The media preferences among Texas's neighboring countries — such as Mexico, Guatemala, and Canada — for disseminating flood mitigation messages consists of social media, websites, and printed brochures. In addition, each country uses a series of digital campaigns focused on flood prevention and awareness content. However, each country differs concerning the types of prevention strategies offered and resources available as they encourage their public to be prepared before, during, and after a flooding event. The following describes these findings and provides examples that demonstrate the science and proactive suggestions to reduce the environmental damage associated with flooding. The visual references provide language and symbols that help viewers know what to do as well as provide them comprehensive instructions. Lastly, the visual references also provide insight into the current flood prevention strategies that represent the interest of neighboring countries.

Mexico. Messages originating in each country use logic and situational messaging through local language and contextual specificity to provide flood prevention and mitigation information. For example, Mexico uses a narrative-style information approach that explains the science of flooding for residents. Mexico's media approach involves the Spanish phrase, "Riesgo hydrometeorologicos inundaciones," meaning "hydrometeorology risks and floods". The campaign features a cartoon-style information narrative explaining the science and prevention suggestions for resident Spanish speakers. See Figure 6.10 for example images of Mexico's campaign narrative.

Figure 6.10 Response Times for Inundaciones Súbitas vs Inundaciones Lentas

Figure Information: Screenshots of Mexico's campaign narrative style where they explain the difference between flash flooding and slow flooding. *Sources: https://www.cenapred.unam.mx/PublicacionesWebGobMX/buscar_buscaSubcategoria.action and https://www.cenapred.unam.mx/es/Publicaciones/archivos/184-FOLLETOINUNDACIONES.PDF*

La Cruz Roja Mexicana (the Mexican Red Cross) is also spearheading a Flood Resilience Project to help residents understand the risk of floods through social cohesion and ultimately action at both the family and community level (see Figure 6.11).

Figure 6.11 YouTube Video on the Implementation of a Flood Resilience Project

Figure Information: Screenshots of La Cruz Roja Mexicana's video for their Flood Resilience Project. *Source: https://www.youtube.com/watch?v=mC5sWC_8VXg&feature=emb_imp_woyt*

Guatemala. Guatemalan campaigns such as "Prevent to Live" and "Garbage in Its Place" recognize how pollution contributes to floods and encourages residents, business owners, and people with disabilities not to pollute storm drains (see Figures 6.12 and 6.13 for examples of each campaign).

Figure 6.12 "Prevent to Live" X (Formerly Called Twitter) Posts From Guatemala

a.

b.

c.
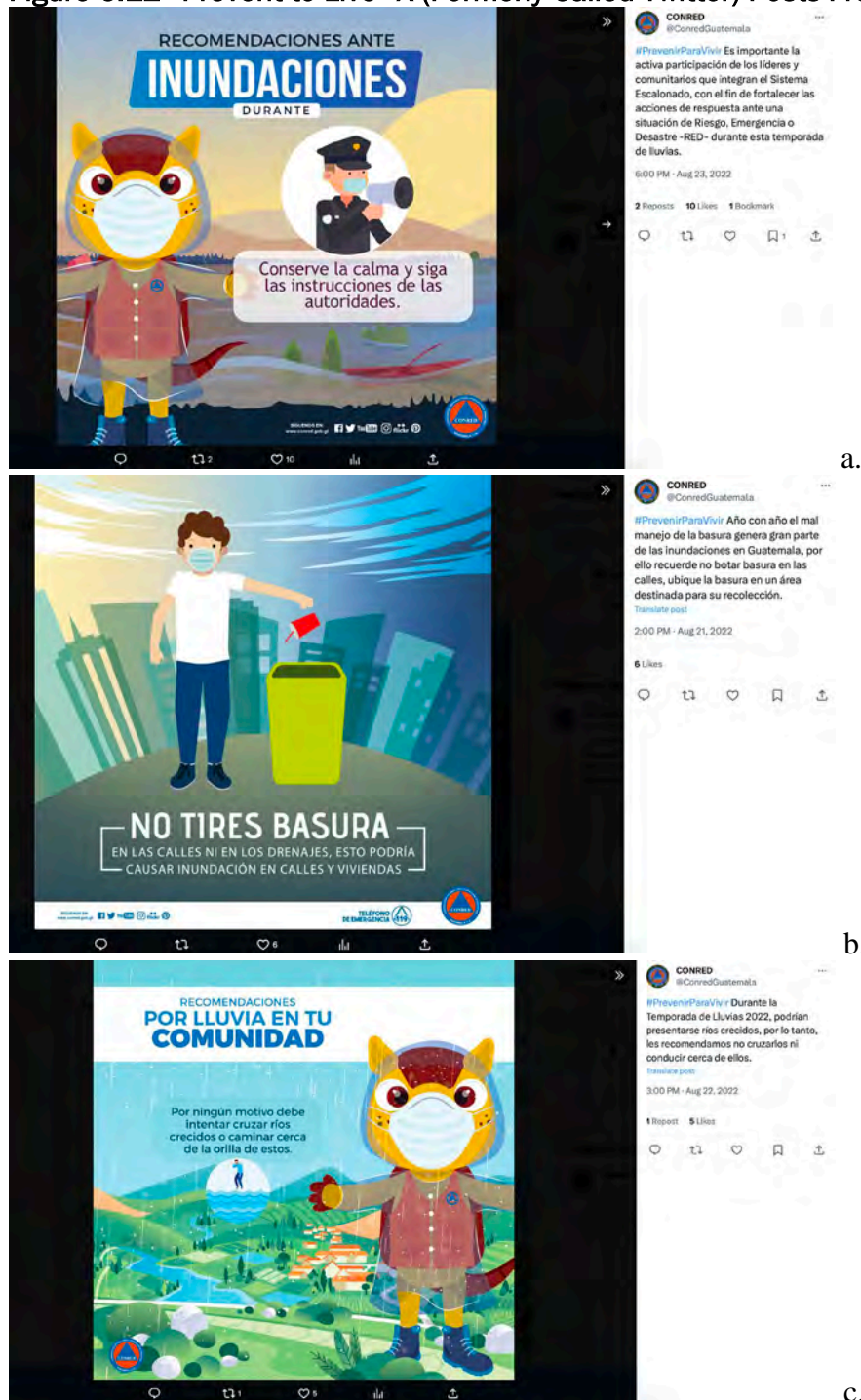
Figure Information: X (formerly called Twitter) posts asking the community (a.) to work together during a disaster, (b.) properly dispose of trash, and (c.) avoid swollen rivers during the rainy season. *Source: https://twitter.com/ConredGuatemala*

Figure 6.13 "Garbage in Its Place to Avoid Flooding" Advertisement

Figure Information: A poster for the "Let's Avoid Floods, Garbage in Its Place" campaign. *Source: https://conred.gob.gt/la-basura-en-su-lugar-ayudanos-a-prevenir-inundaciones/*

Central and South America. In addition to Mexico, several Central and South American countries — including El Salvador, Honduras, Nicaragua, Costa Rica, Bolivia, and Peru — participate in a variety of flood resilience programs. These countries have teamed up with the Zurich Flood Resilience Alliance — a group of researchers, NGOs, humanitarian and private entities (e.g., The London School of Economics and Political Science, Mercy Corps, Practical Action) — working together to increase flood resilience among community members that have been affected by floods. Figure 6.14 is an example of a YouTube video by the Practical Action group highlighting the voices of residents from 11 communities in the Bolivian cities of San Buenaventura, La Paz and Rurrenabaque, Beni. The video's central message is to communicate how the land is connected to its people and their livelihoods.

Figure 6.14 YouTube Video of Residents Affected by Floods in Bolivian Cities

Figure Information: Example image of a video by the Practical Action group showing the importance of working towards community flood resilience. *Source: https://www.youtube.com/watch?v=p5uRQJ0gur8*

Peru. In a YouTube video from the National Meteorology and Hydrology Service of Peru (also called Senamhi), the intent is to teach viewers about the causes and dangers of river flooding through the eyes of a young girl and toucan (see Figure 6.15).

Figure 6.15 YouTube Video by Peru's Senamhi Educating Viewers About River Flooding
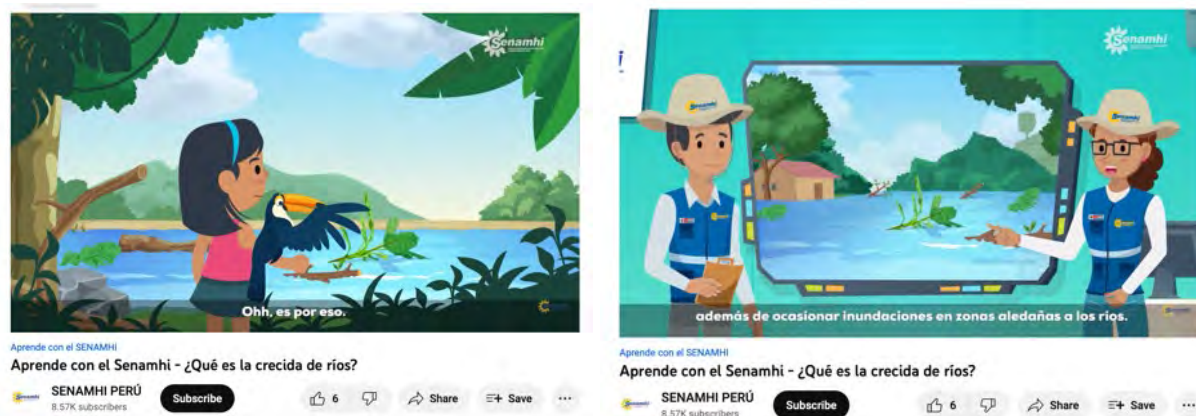
Figure Information: Example images of Senamhi's video explaining river flooding. *Source: https://www.youtube.com/watch?v=V1XBKgx_ILE*

Canada. Canada's Flood Ready campaign has created a series of YouTube videos on steps to take to protect one's property before a flood occurs. FloodSmart Canada is a website led by a research group at the University of Waterloo (Partners for Action, P4A), and they have created several resources (e.g., practitioner reports, lesson plans and an activity book for school aged children, infographics for social media platforms/websites/flyers) for community members — renters, homeowners, children, business owners, and cities — on how to be aware of flood risk and prepare for floods. See Figure 6.16 for examples of these resources.

Figure 6.16 Examples of Resources From FloodSmart Canada

a.

b1.

b2.

b3.

c.
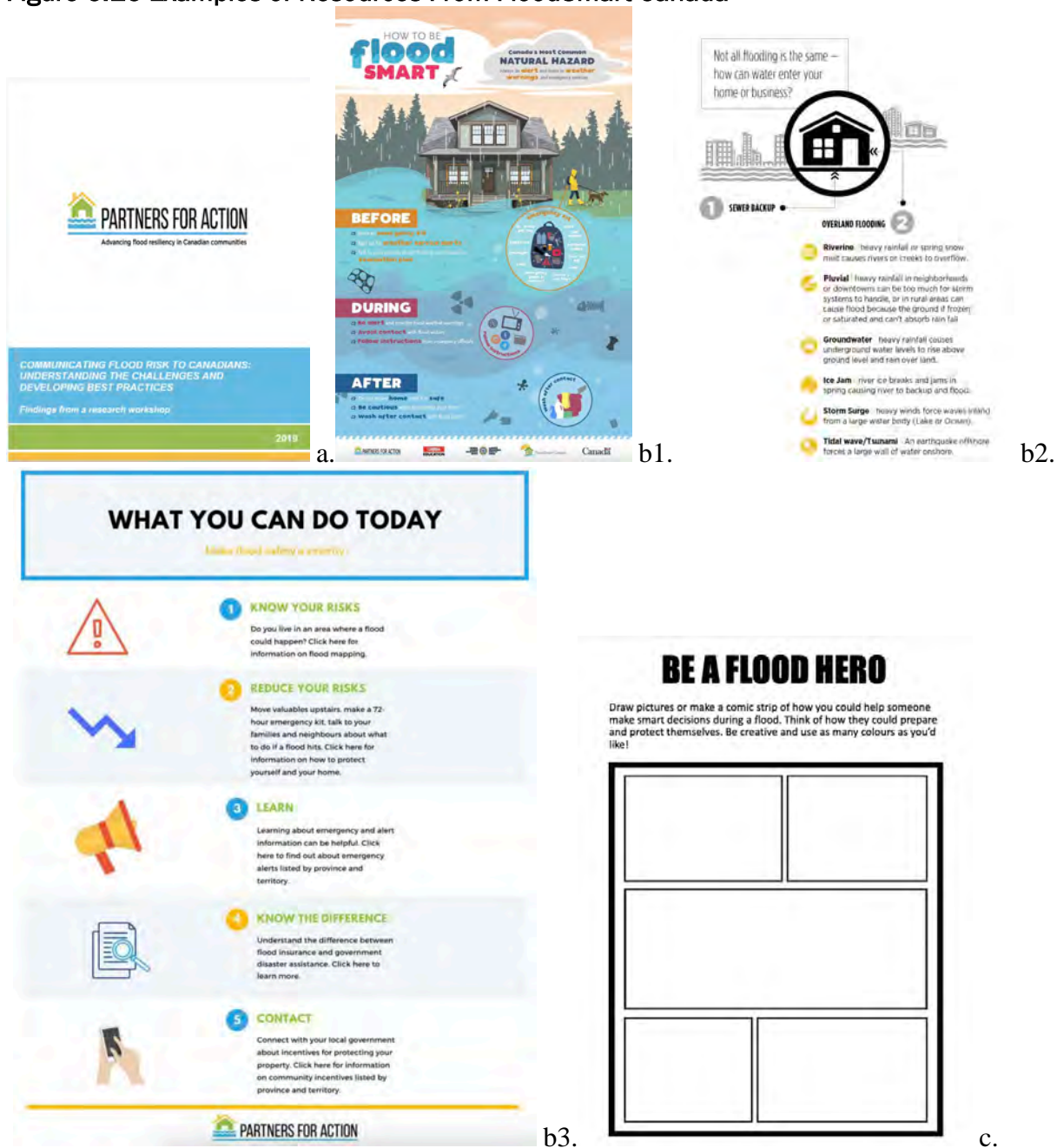
Figure Information: Resources from FloodSmart Canada, including (a.) findings from a Flood Risk Communication Workshop, (b1. – b3.) a variety of infographics on flood preparedness and risk, and (c.) a sample page from the Children's Activity Booklet. *Source: http://floodsmartcanada.ca/floodsmart-resources/*

Canada and Guatemala both use flood information infographics to provide examples of flood risks, particularly how location can escalate risk exposure and strategies to prevent flooding. Canada's Conservation Ontario campaign — "Flood Management-Risk to Resiliency" — suggests flooding is a documented public emergency. Conservation Ontario promotes educational infographics on their X (formerly called Twitter) page (see Figure 6.17).

Figure 6.17 Infographics Retweeted by Conservation Ontario

a.

b.

Figure Information: Conservation Ontario retweeted infographics educating the public about (a.) Geographic Information Systems (GIS) and (b.) climate change impacts in the Great Lakes Basin. *Source: https://twitter.com/conont*

6.4   Analysis of Neighboring Countries' Flood Outreach

These neighboring countries use a multi-channel media approach that consists of website domains, digital infographics, and brochures targeting the general public. They have also focused on end-users such as homeowners, renters, and communities in the coastal regions. The communication channels show a marked shift toward developing and promoting flood mitigation content for digital-native audiences, specifically using social media platforms. Finally, a noticeable difference in audience segmentation is the ***absence of targeted messages for specific vulnerable groups*** (e.g., people with disabilities, young adults). While it is impossible for our research team to know the research conducted for these campaigns, and to find all possible campaigns, they do not appear to be targeted to specific demographic groups in Mexico or Guatemala. We came across one exception — an infographic made specifically for the First

Nation Communities in Canada (see Figure 6.18), who have been historically socio-economically marginalized (e.g., Kim, 2019).

Figure 6.18 Canada Infographic Aimed Towards Indigenous Populations
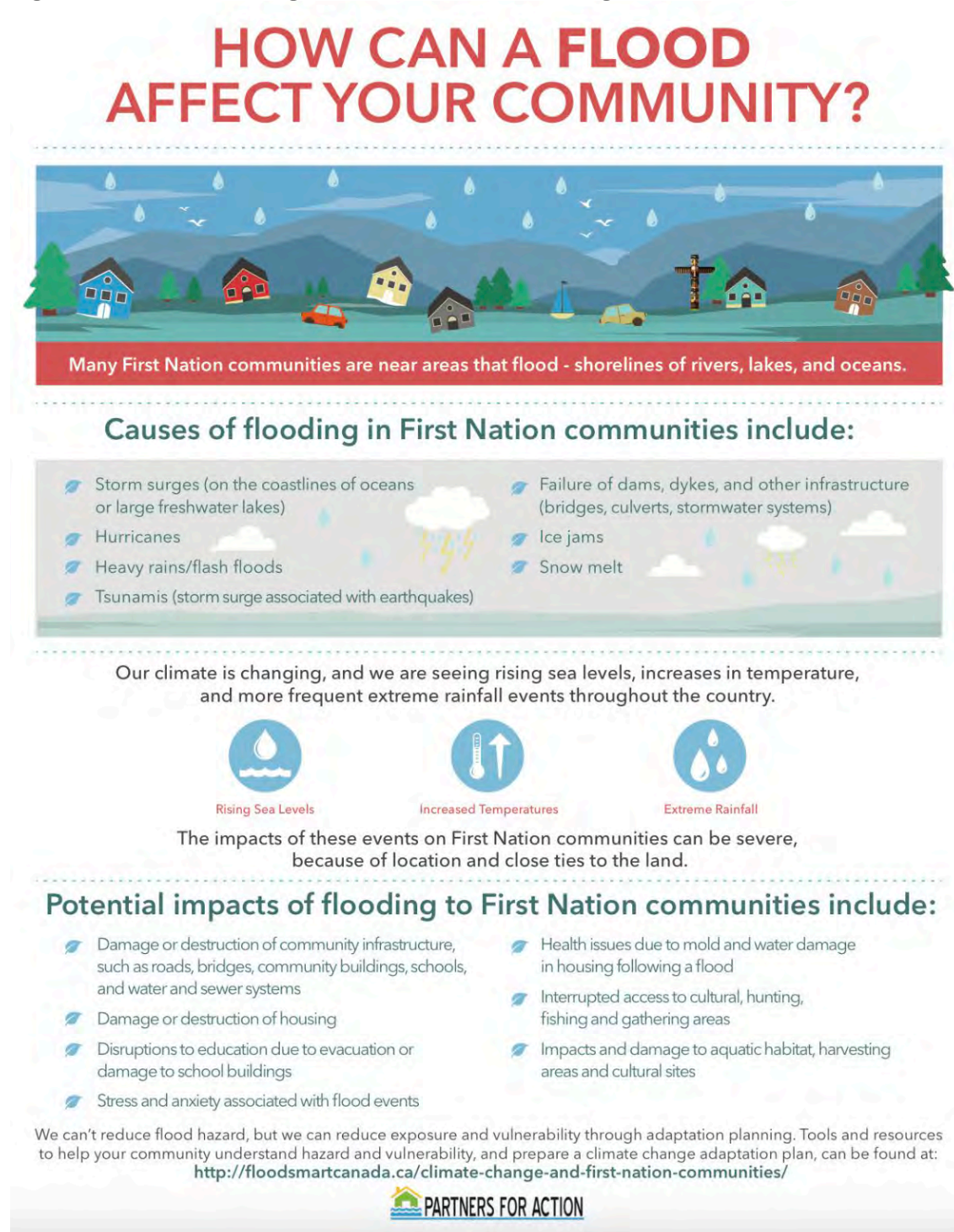
Figure Information: Screenshot of an infographic for First Nation communities in Canada. *Source: http://floodsmartcanada.ca/*

7   Identification of Three to Four End-User Groups

7.1   Overview of Reasoning for Audience Choices

We reviewed potential end-users who need to make decisions around flood risk and chose four to be prioritized. In the following sections, we provide the research that allowed us to determine four groups we recommend should be prioritized.

1) People who predominately speak Spanish, because 28.7% of Texans speak Spanish at home and they are often missed in flood warnings and messages. In Texas, 13.1% of people speak English less than very well (see U.S. Census Bureau's 2021 Language Spoken at Home for more details).
2) New Texans moving into Flash Flood Alley (the part of the state where most are relocating), because they bring their expectations about flooding with them, which are often not applicable to Texas.
3) Young males 18-35, who account for the largest percentage of flood deaths by driving through flood waters.
4) Older adults with disabilities, who are a growing demographic in Texas and need to prioritize planning for floods and potential evacuations.

While the focus of this project is to identify specific end-user audiences for flood awareness and communication, it is important to have a high-level view of the different types of stakeholders in Texas who are involved in and around flood decisions in Texas. A full understanding of stakeholders beyond the public, and those who could best be utilized to reach the chosen end-users, is addressed in detail in Part 5 of this report.

7.2   Process of Identifying End-Users

After reviewing the demographic and social vulnerability data and the academic and market research findings, we created a list of potential end-users. These people included some general groups of Texans (e.g., rural, children, pet owners), people with various home arrangements (e.g., renters, mobile homes), and our four prioritized groups. While we discuss each of the prioritized groups in section 7.3, Table 7.1 summarizes the Texas-specific data for each considered end-user group.

Table 7.1 Initial List of Potential End-Users

Initial End-Users Considered (Based Off Research):	Texas-Specific Data on End-User Group
General Groups of Texans	
1. Rural populations	16.3% of Texans live in rural areas (U.S. Census, 2020 most recent data)[1]
2. Urban populations	83.7% of Texans live in urban areas in 2020 (U.S. Census)[1]
3. Children in Texas	24.8% of Texans are children under 18 years old (U.S. Census, 2022)[2]
4. Tourists and travelers in Texas	Travel is increasing and nearing pre-pandemic averages with Texas outpacing the national average (Travel Texas)[3]
5. Pet owners in Texas	58.20% of Texans are pet owners (2018, AVMA)[4]
6. Business owners in Texas	There was a total of 638,183 employer establishments in Texas in 2021 (U.S. Census)[2]
7. College students in Texas	A total of 1,385,460 undergraduate students enrolled in college in Texas (2022-2023 academic year, UnivStats)[5]
Various Home Arrangements	
8. Renters in Texas	37.6% of properties in Texas are rental properties (Towncharts, 2022 American Community Survey Census)[6]
9. Homeowners/buyers in Texas	62.4% of housing units in Texas are occupied by owners (Towncharts, 2022 American Community Survey Census)[6]
10. People living in mobile homes	760,201 manufactured homes in Texas (2010-2014 ACS 5-Year Estimates; Texas leads the market in the U.S.)[7]
Prioritized Groups (summarized here, but discussed more in section 7.4)	
Immigrants and People Who Do Not Speak English Well	
11. People who speak Spanish at home in Texas	**28.7% of Texans speak Spanish at home (2021 ACS 5-Year Estimates)[8]**
12. People with limited English proficiency in Texas	13.1% of Texans speak English less than very well (2021 ACS 5-Year Estimates)[8]
13. Immigrants living in Texas	17.1% of Texans are foreign-born (2018-2022 ACS 5-Year Estimates)[2]
14. International students in Texas	A total of 67,000 international students enrolled in a Texas college with the highest portion (22%) of them being from India (ApplyBoard, 2020/21)[9]
Vehicle Drivers	
15. Male drivers	Academic and market literature demonstrate they are at the highest risk of driving through

	floodwater. 8,822,318 male drivers in Texas in 2019 (U.S. Department of Transportation)[10]
16. Male drivers (ages 18-34)	**2,653,941 male drivers between the ages of 18 and 34 in Texas in 2019 (based on how the U.S. Department of Transportation breaks down their age groups)[10]**
People Moving Into Texas*	
17. People moving into Texas	1,846,041 people moved into and within Texas in 2020 (U.S. Census Flows Mapper, 2016-2020 5-Year American Community Survey)[11]
18. People moving into Flash Flood Alley	**638,401 people moved into Flash Flood Alley counties in 2020 (including the highest ranking counties only: Dallas County, Tarrant County, Bexar County, Travis County, Denton County, & Collin County) (U.S. Census Flows Mapper, 2016-2020 5-Year American Community Survey)[11]**
19. People moving into Harris County	208,921 people moved into Harris County in 2020 (U.S. Census Flows Mapper, 2016-2020 5-Year American Community Survey)[11]
People With Disabilities	
20. People with disabilities and/or medical conditions in Texas	8.2% of Texans under 65 years of age have a disability (2018-2022 ACS 5-Year Estimates)[2]
21. Older adults with disabilities	**35.2% of the Texas civilian noninstitutionalized population 65 years and older have at least one disability (2021 American Community Survey, 1-Year Estimates)[12]**

Table Information: *All totals include movers from a different state (out-of-state), movers from a different county (within state), and movers from abroad (international). *Sources:*

[1] *https://www.census.gov/programs-surveys/geography/guidance/geo-areas/urban-rural.html*
[2] *https://www.census.gov/quickfacts/TX*
[3] *https://www.traveltexas.com/*
[4] *https://www.avma.org/resources-tools/reports-statistics/us-pet-ownership-statistics (see also https://www.pawlicy.com/blog/us-pet-ownership-statistics/#)*
[5] *https://www.univstats.com/states/texas/student-population/*
[6] *https://www.towncharts.com/Texas/Texas-state-Housing-data.html*
[7] *https://prosperitynow.org/sites/default/files/resources/Affordable%20Homeownership/Snapshots/TEXAS_DATASS NAPSHOT_mg.pdf*
[8] *https://www.census.gov/acs/www/about/why-we-ask-each-question/language/*
[9] *https://www.applyboard.com/applyinsights-article/texas-trends-as-the-third-most-popular-us-state-for-international-students#:~:text=International%20Student%20Population%20in%20Texas%20by%20Source%20Market&text=Tex as%20accounted%20for%20just%20under,another%2019%25%20came%20from%20China*
[10] *https://www.fhwa.dot.gov/policyinformation/statistics/2019/dl22.cfm#foot1*
[11] *https://flowsmapper.geo.census.gov/map.html#*
[12] *https://data.census.gov/table/ACSDP1Y2021.DP02?g=040XX00US48*

Careful consideration of existing academic and market literature and initial interviews with key informants guided our selection of the four groupings of audiences we chose for our initial

investigation: **People who predominately speak Spanish, Male drivers aged approximately 18 to 35 (which is slightly broader than what is reported in Table 7.1), People moving into Flash Flood Alley, and Older adults with disabilities.** The groups all share higher risk for negative consequences of flooding combined with less likelihood they are aware of their risk. Therefore, targeted messages to these groups could have greater impacts than a general flood awareness campaign. To better understand why they might be good target end-users, next we briefly review one model describing how humans make decisions.

To understand the human decision-making process concerning flood mitigation, it is helpful to use a model that describes the stages people move through to change their behavior. There are several similar models; we are using Stages of Change (Prochaska & Velicer, 1997). Stages of Change is a well-documented model of behavior change, and it shows that people must move from the precontemplation stage to the action stage (see Figure 7.1 for the Stages of Change model and diagram).

Figure 7.1 Stages of Change Transtheoretical Model

Figure Information: People must change their behaviors by moving from the precontemplation stage to the action stage. *Source: Prochaska, J. O., & Velicer, W. F. (1997). The transtheoretical model of health behavior change. American Journal of Health Promotion, 12(1). https://doi.org/10.4278/0890-1171-12.1.38*

While the Stages of Change Model offers solid insight into what people are thinking as they move through different stages towards a decision to change, Convery et al. (2021) applied this model specifically to household choices around flood resilience behaviors (see Figure 7.2).

Figure 7.2 Flood-Specific Model of Stages of Change
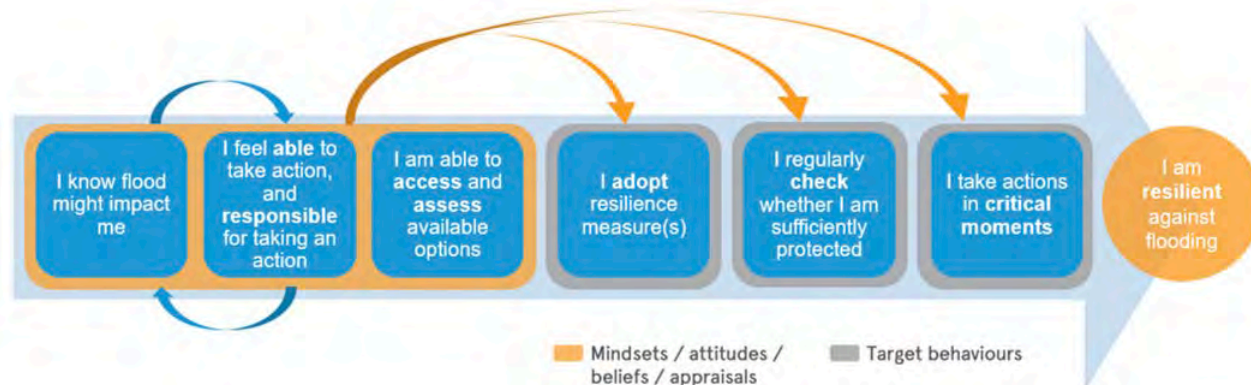
Figure Information: The Stages of Change model in a flood-specific context. *Source: Convery, E., Farrell, A., Farrington, J., Gross, M., Park, T., Schein, A., Ahern, J., Oakley, M., Bransby, L., & Cotton, J. (2021, August 26). Applying behavioural insights to support flood resilience. The Behavioural Insights Team. https://www.bi.team/wp-content/uploads/2021/08/210621-EA-Flood-resilience-report_final-draft.pdf*

7.3   Four End-User Groups Chosen for Focus

The following graphic provides some detail on the public end-user groups and the decisions they can make (see Figure 7.3).

Figure 7.3 Flood Preparedness & Action: Public End-User Decision Map
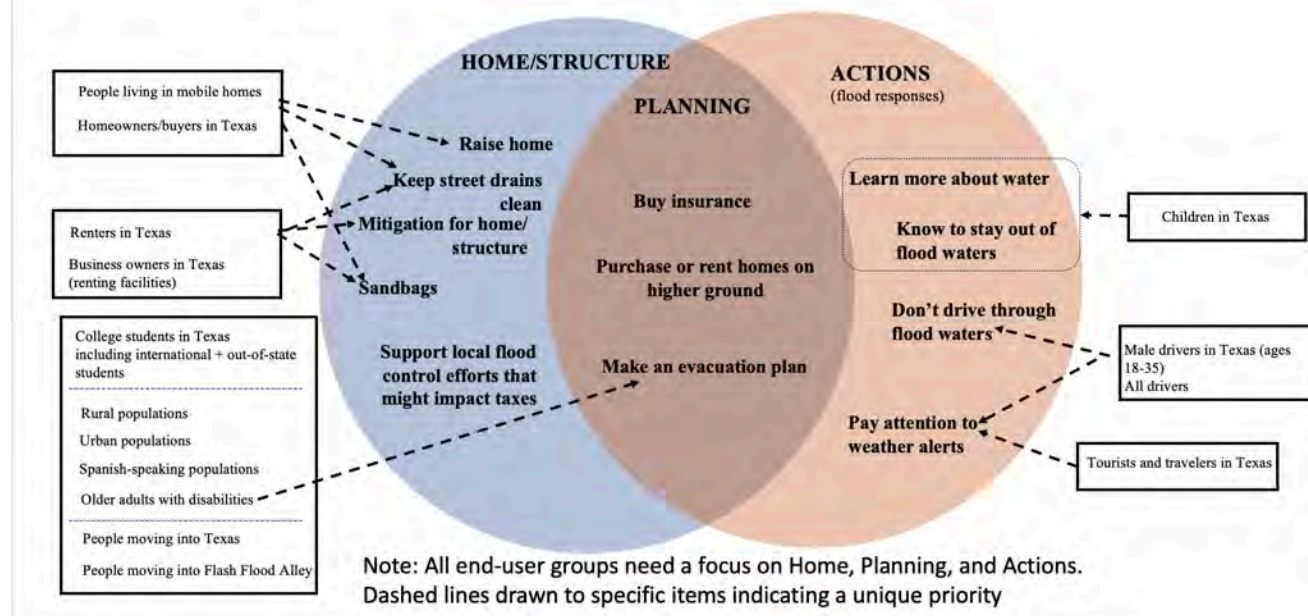
Figure Information: A diagram showing the prioritized decisions of different public end-user groups.

To better understand why we chose each of the four end-user groups, we provide more details about them next.

7.3.1   End-User Group #1: Spanish Speakers in Texas

Demographic Data About Spanish Speakers in Texas. Many different languages are spoken in Texas, and the research we have compiled suggests that we should prioritize developing messages in two languages — English and Spanish — for this first project. We used data from the U.S. Census and Texas Demographic Center which provide the most accurate publicly available data for analyzing language-spoken demographics. Spanish continues to be the second-largest language (after English) spoken at home in the state. Among Texans who are age 5 years and over (29,903,358), 64.9% (17,460,783) speak only English at home, followed by Spanish (28.7%, or 7,717,053 people), Asian and Pacific Islander languages (3.0%, or 809,812 people), Indo-European languages (2.3%, or 627,133 people), and other languages (1.1%, or 288,577 people; see U.S. Census Bureau's Language Spoken at Home and 2021 ACS 5-Year Estimates Data Profiles). Table 7.2 provides a ranking of counties in Texas with the largest population of people 5 years of age and over — only listing counties that have at least 15,000 people who are 5 years of age and over and with at least 30% of their population speaking Spanish at home. The counties are located throughout the Southern and Western regions of Texas and scattered along the coastline and in the Lower Rio Grande Valley. Six of the top 28 counties are on the Texas coastline (see U.S. Census Bureau's list of all coastline counties for Texas's 17 coastline counties), and all 4 of the Lower Rio Grande Valley counties (Hidalgo County, Cameron County, Starr County, Willacy County) rank in the top 28. Additionally, the Hispanic population in Texas is projected to continue growing to nearly 14.5 million by 2030 (Texas Demographic Center, 2019).

Table 7.2 Counties in Texas With the Highest Percent of Spanish Speakers (2021)

County	Population 5 Years and Over	Percent of People Who Speak Spanish at Home	Number of People Who Speak Spanish at Home	County	Population 5 Years and Over	Percent of People Who Speak Spanish at Home	Number of People Who Speak Spanish at Home
1. Harris^	4,356,094	35.2%	1,535,028	15. Caldwell*	42,529	35.2%	14,978
2. Dallas*	2,416,813	34.5%	834,040	16. Jim Wells	36,451	46.3%	16,861
3. Bexar*	1,854,261	34.4%	638,131	17. Hale	30,742	36.3%	11,164
4. El Paso	798,226	67.5%	539,182	18. Bee	29,479	33.4%	9,849
5. Hidalgo^Δ	791,444	81.0%	640,961	19. Kleberg^	28,990	33.4%	9,685
6. Cameron^Δ	387,931	70.7%	274,302	20. Titus	28,946	36.8%	10,665
7. Nueces^	330,734	31.8%	105,199	21. Uvalde	23,120	52.1%	12,056
8. Webb	243,206	89.0%	216,530	22. Hockley	20,206	30.3%	6,116
9. Ector	146,856	45.0%	66,087	23. Moore	19,470	44.2%	8,602
10. San Patricio^	63,852	31.4%	20,040	24. Willacy^Δ	19,135	60.8%	11,629
11. Starr^Δ	59,192	92.3%	54,612	25. Gonzales	18,331	30.5%	5,585
12. Maverick	52,574	88.0%	46,247	26. Frio	17,224	54.2%	9,327
13. Atascosa	45,176	38.0%	17,167	27. Deaf Smith	17,062	53.2%	9,082
14. Val Verde	43,844	66.0%	28,932	28. Andrews	16,652	38.2%	6,369

Table Information: *County is located in Flash Flood Alley. ^County is located on the coastline. ΔCounty is located in the Lower Rio Grande Valley. Cameron County and Willacy County are located on the coastline and in the Lower Rio Grande Valley. The Table only shows counties that have at least 15,000 people who are 5 years and over and with at least 30% of their population speaking Spanish at home. *Sources: https://www.census.gov/acs/www/about/why-we-ask-each-question/language/, https://data.census.gov/table?tid=ACSDP5Y2021.DP02&g=0400000US48&hidePreview=true, and https://data.census.gov/table?g=0400000US48,48$0500000&tid=ACSDP5Y2021.DP02 (using 2021 ACS 5-Year Estimates Data Profiles/Social Characteristics)*

Interview Data About Spanish Speakers in Texas. The full analysis of the focus group and interview data is included in Part 2 of this report. However, it is important to share the findings that helped narrow the recommendations to the following four end-user groups.

We interviewed 18 people who predominately speak Spanish in three locations of the state: the Lower Rio Grande Valley (LRGV), Upper Rio Grande Valley (URGV), and in Central Texas. Interviews with end-user group #1, people who predominately speak Spanish, revealed the following key themes, which further support our decision to choose them as a priority group:

- They have seen very few signs warning them about dangerous water levels and they have never seen a road sign in Spanish.
- In the LRGV, they have a general lack of knowledge surrounding how to evacuate in case of a hurricane or flooding.
- In the URGV, especially the rural areas, only an inch of rain can cause a flash flood and they have limited local weather forecasts (less localized forecasting and less localized data collection due to fewer rain/stream gauges) and often only know rain is coming when the clouds in the sky become dark.
- There is a lack of knowledge surrounding flood insurance — if they need it, where to get it, and how to determine the cost.

7.3.2   End-User Group #2: New Residents Moving Into Flash Flood Alley

Demographic Data About New Residents Moving Into Flash Flood Alley. New residents — or people moving into or within Texas — *are relocating to highly populated urban areas, concentrated in counties located in Flash Flood Alley* (Census Flows Mapper; refer to Table 3.2 and Figure 3.10 of this report). Flash Flood Alley is a geographical location in the central part of Texas that is particularly susceptible to flash flooding due to the collapse of warm and cool air masses in this location, along with shallow soil, steep terrain, and rivers that run along the region (LCRA, n.d). Population growth and high urbanization areas are locations for high flood risk. Furthermore, many of the deaths and water rescues in Texas have occurred in Flash Flood Alley (Han & Sharif, 2020; Shah et al., 2017).

In 2020, approximately 1,846,041 people moved into and within Texas. This figure includes 542,290 new residents from out-of-state, 206,117 new residents from abroad, and 1,097,634 new residents moving from one Texas county to another county (within state; Census Flows Mapper). These end-user groups have children and tend to have a higher level of education than current Texas residents (Texas Demographic Center, 2022, using U.S. Census Bureau's American Community Survey (ACS) 5-year Public Use Microdata Sample (PUMS) files). People relocating from other parts of the country may not be familiar with flood risks. Even when people might be accustomed to a particular kind of flood event, such as coastal flooding, relocating inland may provide a false sense of security for those who are not familiar with the type of flooding that happens in their new area.

Previous research has shown that the public has many misconceptions about flash flooding, and they often do not realize dangerous water speed, that water often carries debris and hazardous materials, and the potential for trapping or sweeping away vehicles (Lazrus et al., 2017). In fact, newcomers have been shown to engage in lower household disaster preparedness behaviors (e.g., building an emergency kit) than residents from the area, although this difference largely depends on cultural background and previous disaster experiences (Green, 2020). New residents are not equipped with the knowledge on how to prepare or what to do in case of an emergency, oftentimes because they do not yet feel they are part of the community (i.e., they are not acquainted with long-term residents and locals), they lack experience with local emergencies (e.g., they do not know how long the neighborhood roads can be accessible for evacuation), and they are not involved in their local communities (e.g., they have not yet built relationships with the local fire department; McGee, 2003; see also Seebauer & Winkler, 2020).

There is ambiguity around when a person relocating to Texas is no longer considered a new resident. The Texas Administrative Code classifies a Texas resident as a person who has maintained residence continuously in the state for 12 months. However, the definition used by the Texas Department of Public Safety says that for a person to verify for Texas Residency, they are only required to show proof of living in the state for at least 30 days. As we further develop message toolkits to reach this end-user group and make recommendations to reach this group, we might suggest partnering with the Texas Department of Motor Vehicles, real estate agencies, or banks.

Interview Data About New Residents Moving Into Flash Flood Alley. We conducted 12 interviews with people new to Texas or who have relocated to another city in Texas. Those

interviews revealed the following key themes, which further support our decision to choose them as a priority group:

- People moving into Texas who have prior flooding experience bring with them their views on flooding that can be quite different from Texas floods. For example, people moving to Texas from Bangladesh, Pakistan, and areas that flood frequently often believe they will no longer experience flooding in the United States. They believe that in the unlikely case that they do go through a flood, American infrastructure will be able to handle high water and related disasters.
- Many new residents — whether they are from out-of-state/country or in-state — have never experienced hurricanes or floods, and they do not think they are at risk of flooding in their new location.
- Newcomers are not aware of the history of their area (e.g., if it has ever flooded in the past).
- New residents oftentimes do not know where to look for local information that is specific to their risk of flooding.
- While in-state movers are sometimes familiar with Turn Around Don't Drown®, they have rarely seen a "Low Water Crossing" sign. Out-of-state/country movers have largely never seen any messaging around flood prevention, preparedness, or risk since moving into Texas.

Related Groups That Need Priority in the Future. As indicated in section 4.3.5 of this report, Harris County is also experiencing rapid growth. We initially considered addressing flood awareness and communication for hurricanes and coastal flooding because this type of flooding constitutes the most damage, economic consequences, and deaths (due to specific hurricanes). However, that approach does not help with the goal of targeting messages so they will be most relevant to specific end-user groups. We believe it is essential to develop better messages for coastal areas — especially Harris County and the Lower Rio Grande Valley — but there are several efforts currently underway that target coastal flooding, and we do not believe it is helpful to dilute the TWDB efforts or to interfere with existing flood message development projects. Furthermore, developing toolkits for both flash-flooding and coastal areas would require developing different messages; efforts beyond the scope of the current project. FEMA is prioritizing coastal communities in their outreach efforts around the NFIP Program. You will also notice many of the programs and messages we identified focus on coastal flooding. Specifically, Harris County and other counties who have received considerable federal funding to rebuild post-Hurricane Harvey have heavily invested in flood-specific awareness and messaging, and once they have their messages developed, it would be ideal to partner with them to learn about the fruits of their efforts before designing additional message campaigns.

7.3.3   End-User Group #3: Male Drivers Between the Ages of 18 and 35

Demographic Data About Male Drivers Between the Ages of 18 and 35. Male drivers aged approximately between 18 to 35 represent an end-user group that has a need for increased awareness and communication for flood risk. The research compiled in this report revealed that in Texas most deaths occur by driving into flooded waters, and young men constitute many of these deaths. Of the flood fatalities that tracked gender in Texas between 1959 and 2008, *males were more than twice as likely to die in a flood than were females* (68.4% versus 31.6%, respectively). Of the flood fatalities that documented age during this same timeframe in Texas, *nearly 50% of victims were below the age of 30* (Sharif et al., 2015). Similarly, ***Texas males***

were nearly twice as likely to die in vehicle-related flood accidents than were females between 1959 and 2019 (63% versus 37%, respectively), and *the 20-29 age group carried the highest number of vehicle-related flood fatalities* for both males and females (Han & Sharif, 2020). While Turn Around Don't Drown® already has a campaign for drivers, it does not specifically focus on drivers under 30. The data often differ in how they group the ages (e.g., 20-29 or 18-35). We are choosing a slightly larger age group of 18-35 because prior message campaigns in Texas have found this to be a reliable age grouping to bracket (e.g., TxDOT's Don't mess with Texas® anti-littering campaign also targeted this age group and was very successful; see Don't mess with Texas® for more information).

Interview Data About Male Drivers Between the Ages of 18 and 35. Interviews with 15 members of end-user group #3 — young male drivers aged between 18 and 35 — revealed the following key themes, which further support our decision to choose them as a priority group:

- The attitudes of young men in our focus group reflect much of what the literature would say: they feel invincible, wouldn't turn their car around if they saw water because they believe they can make it through the water, and they have very little knowledge of flooding at all.
- While young women tend to respond to a Turn Around Don't Drown® message by saying it is important to save their lives, both young men and women who own cars mention how important it is to keep their car from getting damaged because their insurance is expensive.
- Note that interviews for this project have raised potential concerns that the signage around flooded roads might be one of the most important things to study if our goal is to reduce deaths, injuries, and rescues due to flooded roads. In the Lower Rio Grande Valley, only one focus group participant out of 30 mentioned ever seeing a road sign warning them about dangerous water.
- As also mentioned in this report, interviewees have expressed confusion around the sign saying "Low Water Crossing"; they oftentimes say that the sign signifies a safe area because only a little bit of water can cross the road in this location. Another interviewee in a related project discussed the yellow and black striped signs that are on many of the county roads to indicate caution, and she mentioned that people have no idea what these signs mean. We will be recommending these signage issues for future studies beyond the current project.

Projects and Groups That Need Priority in the Future. Turn Around Don't Drown® (TADD) already has an established nationwide campaign with existing outreach materials to target drivers. We have found variations in TADD signs that include more details about when you need to turn around (see Figure 7.4 for examples of specific TADD signs found in Texas). Nonetheless, our research uncovered only one formal effort that evaluated TADD, and it suggested the campaign has not been very effective (Bryant, 2021; cf. Balke et al., 2011; Dudek et al., 2006; Higgins et al., 2012 for details on studies that have evaluated signing strategies for flood-prone roads conducted by the Texas A&M Transportation Institute (TTI) and funded through TxDOT). While re-doing a full driving in flood water campaign is beyond the scope of the current project, we believe a separate study on roads and water concerns would be prudent. This would require coordination with TxDOT, TTI, and other transportation-safety related institutes and organizations. We have included details about how this type of study could be conducted in Part 4 of this report. In the current project, we will develop a toolkit to target young men with the hopes of reducing those fatalities.

Figure 7.4 Turn Around Don't Drown® Sign Examples

a. b.

Figure Information: Examples of different TADD signs, including (a.) "When Flooded Turn Around Don't Drown" and (b.) "Turn Around Don't Drown". *Sources: https://medium.com/@kg4giy/turn-around-dont-drown-d727c00cf4a2 and https://hsierra.com/applications/flood-warning/*

We also have two members of our research team who recently took the Texas driving exam to get their license, and they noted there were no questions on the exam around flooding. While it does appear that there is some information in the Driving Programs of Texas, we will be recommending this as a priority area for future research and opportunities to improve education and save lives.

Another important sub-group of people under 30 are higher education students at trade schools, community colleges, and universities because approximately 50% of that group will fall into the category of men 18-35 years of age. The young adult end-user group attending post-high school education tends to be younger than 30 years old, living away from home for the first time, and they rely on information provided by universities (Postingel et al., 2019). Young adults tend to have a lower risk perception than older adults because they are less likely to have experienced a flood in Texas. This end-user group is more likely to be renting and lacks flood insurance (e.g., 60% of College Station residents live in rental housing; see Fiscal Notes for more details).

More privileged and private universities have a higher percentage of international and out-of-state students. In contrast, students enrolled in regional and community colleges stay closer to home (see Table 7.3 for class profiles from a selection of Texas universities and colleges). Community colleges also have a higher percentage of students from marginalized and socially vulnerable backgrounds (e.g., Fike & Fike, 2008; Terriquez, 2015). Even with students staying closer to home, a case-study conducted at Texas State University indicated that students still have low levels of flood awareness and engage in low levels of flood preparedness behaviors. Results demonstrated that nearly 75% of students had experienced floods in San Marcos; yet only 13% stated that they were "Extremely Knowledgeable" about flood events and their consequences. Thus, the majority of the students thought they were not sufficiently prepared for floods and did not have enough knowledge about floods if they experienced one in the future (Ponstingel et al., 2019).

Table 7.3 International, Out-of-State, or In-State Students Enrolled in Texas Universities

University/College	Geographic Location	% of Enrolled Students
Rice University[1]	International Outside of Texas	14.0% 50.0%
Baylor University[2]	International Outside of Texas	5.0% 41.0%
The University of Texas at Austin[3]	International Outside of Texas	9.8% 10.3%
Texas A&M University at College Station [4]	International Outside of Texas	8.0% 7.0%
*Southwestern University[5]	Outside of Texas and Global	15.0%
Prairie View A&M University[6]	International Outside of Texas	2.0% 10.7%
*Huston-Tillotson University[7]	International Outside of Texas	2.6% 4.1%
^The University of Texas at San Antonio[8]	International Outside of Texas	2.0% 3.0%
Texas State University[9]	International Outside of Texas	1.8% 3.08%
**Galveston Community[10] College	International Outside of Texas	1.2% 2.0%
Austin Community College[11]	International Outside of Texas Out of District	0.6% 2.2% 18.4%
The University of Texas Rio Grande Valley (UTRGV)[12]	International Outside of Texas Other Texas Residents	1.0% 0.6% 4.8%

Table Information: The universities are listed in order of highest number of international + out-of-state students to lowest number of international + out-of-state students. Unless otherwise noted, all percentages are for Fall 2022.

Sources:
[1]*https://admission.rice.edu/apply/class-profile*
[2]*https://www.baylor.edu/ir/doc.php/398952.pdf*
[3]*https://reports.utexas.edu/spotlight-data/students*
[4]*https://dars.tamu.edu/Student/Enrollment-Profile*
[5]*https://www.southwestern.edu/admission/*

[6]https://public.tableau.com/views/DT_EnrollmentStatistics_FA15/EnrollmentbyResidency?:embed=y&:display_count=yes&:showTabs=y&:showVizHome=no
[7]https://htu.edu/offices/institutional-research/common-data-sets
[8]https://www.utsa.edu/_files/about/pdfs/fast-facts-enrollment.pdf
[9]https://www.ir.txst.edu/student/public-student-reports/enrollment-by-geographic-region.html
[10]https://gc.edu/wp-content/uploads/2020/08/2019-Fact-Book-20200820.pdf
[11]https://oira.austincc.edu/data-and-reports/factbook/acc-fact-book-fall-2022/
[12]https://www.utrgv.edu/sair/data-reports/fall-2022-student-profile.pdf
**2019 class profile
*2021 class profile
^2023 class profile

The increase in international students at privileged universities can be explained by what scholars in the higher education industry call "the demographic cliff." After the Great Recession left people traumatized with uncertainty and unemployment, many decided to stop having kids (Cherlin et al., 2013). Specifically, fertility declined by 9 to 11 percent, depending on states' varying unemployment rates (Cherlin et al., 2013). But even as we climbed out of the recession, declining birth rates combined with rising costs of college education and difficulties in paying off student loans has led to today's lower enrollment rates. In April 2018, Carleton College economist Nathan Grawe published a study on how this demographic shift will continue to impact college and university enrollment. His model — the Higher Education Demand Index — projected steep declines by the year 2029 (see Figure 7.5 for more details; Grawe, 2018). While the United States is seeing an overall decline in college and university enrollment, it is important to note that the Mountain and West South Central Census Divisions are experiencing a slight increase (e.g., Houston is seeing the largest increase). To combat this general decline, U.S. colleges and universities view international students as one of their best opportunities to boost enrollment. To continue addressing the enrollment cliff, colleges will likely pursue larger numbers of international students (Copley et al., 2020). This projection lends additional credence to our choices of younger males 18-35 and people moving into Texas.

Figure 7.5 Forecasted Change in College Student Attendance

Forecasted change in number of students who will attend post-secondary institution from 2012 to 2029, by Census division and areas of largest increase and decrease

	Pacific	Mountain	West North Central	East North Central	West South Central	East South Central	Middle Atlantic	New England	South Atlantic	Total
Initial number of students	467,166	191,075	201,563	418,114	315,072	147,203	403,109	115,841	468,584	2,727,728
Absolute change	-44,067	3,429	-22,773	-90,443	7,365	-29,736	-72,208	-28,117	-15,523	-292,073
Percent change	-9%	2%	-11%	-22%	2%	-20%	-18%	-24%	-3%	-11%

The columns above are grouped under the heading "Census Division".

Areas of largest decrease				Areas of largest increase		
New York City	-32,619	-16%		Houston	11,222	20%
Los Angeles	-22,843	-13%		Texas	7,255	8%
Chicago	-16,868	-18%		Atlanta	5,167	12%
New York	-16,103	-28%		Utah	3,730	13%
Boston	-15,615	-23%		Colorado/Wyoming	3,575	18%

Figure Information: There will be a precipitous reduction of enrolled U.S. college-going students by the year 2029. The national pool of 1st-year students will fall by 20% or more in some regions. *Source: Grawe, N. D. (2018). Demographics and the demand for higher education. https://ngrawe.sites.carleton.edu/demographics-and-the-demand-for-higher-education/*

7.3.4   End-User Group #4: Older Adults With a Disability

Demographic Data About Older Adults With a Disability. The final audience we propose as a focus is *older adults with disabilities*. The latest statistics show that roughly 12% of the Texas population falls into this category, and *approximately 35.2% of the Texas civilian noninstitutionalized population 65 years and older have at least one disability* (i.e., 1,345,667 people out of a total of 3,826,912 people; using U.S. Census Bureau, 2021 American Community Survey, 1-Year Estimates Data Profiles). The term "noninstitutionalized" refers to individuals who are not residing in institutions such as nursing homes, jails, prisons, and mental hospitals (see the U.S. Census Bureau's terms and definitions page for more information). Disabilities include difficulty with hearing, vision, cognition, ambulation, self-care, or running errands/independent living.

Older adults are one of the fastest growing age-group demographics, especially in Texas and Flash Flood Alley (Texas Demographics, 2019). Table 7.4 displays a ranking of counties in Texas with the largest population 65 years and over in 2021.

Table 7.4 Counties in Texas With the Largest Population 65 Years and Over (2021)

County	Total Population ≥ 65	County	Total Population ≥ 65	County	Total Population ≥ 65
1. Harris^	499,278	11. Montgomery	79,895	21. Jefferson^	36,834
2. Dallas*	281,157	12. Williamson*	72,207	22. Comal*	28,236
3. Bexar*	239,878	13. Cameron^Δ	56,638	23. Hays*	25,946
4. Tarrant*	237,541	14. Nueces^	51,331	24. Webb	25,117
5. Travis*	126,480	15. Galveston^	50,121	25. Johnson*	24,640
6. Collin*	113,824	16. Brazoria^	43,652	26. Ellis*	23,932
7. El Paso	104,690	17. Bell*	39,799	27. Grayson*	23,600
8. Hidalgo^Δ	95,099	18. Lubbock	38,230	28. Guadalupe*	23,555
9. Denton*	92,300	19. Smith	38,168	29. Parker	22,288
10. Fort Bend	91,379	20. McLennan*	37,054	30. Brazos	21,632

Table Information: *County is located in Flash Flood Alley. ^County is located on the coastline. ΔCounty is located in the Lower Rio Grande Valley. Cameron County is located on the coastline and in the Lower Rio Grande Valley. *Source: https://data.census.gov/table?g=0400000US48,48$0500000&tid=ACSST5Y2021.S0101 (using 2021 ACS 5-Year Estimates Subject Tables/Age and Sex)*

Table 7.5 provides a ranking of counties in Texas with the largest civilian noninstitutionalized population 65 years and over with a disability in 2021. In both Tables 7.4 and 7.5, *15 of the top 30 counties in Texas are located in Flash Flood Alley*, including Bexar County, Dallas County, Tarrant County, Travis County, Collin County, and Denton County. Six of the top 30 counties in Texas are located on the coastline — including Harris County, Nueces County, Galveston County, Jefferson County, and Brazoria County (see U.S. Census Bureau's full list of coastline counties in Texas) — and 2 of the top 30 counties in Texas are located in the Lower Rio Grande Valley, including Hidalgo County and Cameron County.

Table 7.5 Texas Counties With the Largest Population 65 Years and Over With a Disability

County	Total Population ≥ 65 With a Disability	County	Total Population ≥ 65 With a Disability	County	Total Population ≥ 65 With a Disability
1. Harris^	162,389	11. Montgomery	24,045	21. Webb	12,035
2. Bexar*	94,664	12. Cameron^Δ	21,774	22. Smith	11,486
3. Dallas*	93,758	13. Williamson*	20,775	23. Comal*	8,893
4. Tarrant*	75,874	14. Nueces^	18,853	24. Guadalupe*	8,847
5. Hidalgo^Δ	44,446	15. Galveston^	18,811	25. Ellis*	8,598
6. El Paso	44,305	16. Jefferson^	15,655	26. Grayson*	8,364
7. Travis*	33,977	17. Bell*	15,591	27. Hays*	8,145
8. Collin*	30,446	18. Lubbock	15,019	28. Johnson*	7,897
9. Denton*	26,074	19. Brazoria^	14,765	29. Taylor	7,883
10. Fort Bend	25,044	20. McLennan*	14,223	30. Wichita	7,497

Table Information: *County is located in Flash Flood Alley. ^County is located on the coastline. ΔCounty is located in the Lower Rio Grande Valley. Cameron County is located on the coastline and in the Lower Rio Grande Valley. *Source: https://data.census.gov/table?g=0400000US48,48$0500000&tid=ACSDP5Y2021.DP02 (using 2021 ACS 5-Year Estimates Data Profiles/Social Characteristics)*

Research shows that older adults have more risk factors related to physical and mental health compared to younger people (Bei et al., 2013; Haq, 2019). Nonetheless, older adults do not consider themselves at risk of weather-related dangers. Low risk perception — and ultimately low hurricane preparedness — is due to a wide range of factors, such as ***believing in local myths, having no recent memory of hurricanes, being complacent, feeling powerless, or lacking financial and social support from family or community organizations*** (e.g., Abrahamson et al., 2008; Lou et al., 2021; Walkling & Haworth, 2020; Wang, 2016). This highlights the need for improved awareness and information dissemination among older age groups as well as their caregivers. Current flood messaging rarely targets people with disabilities including mobility disorders, and recent flooding events in Texas (e.g., hurricane flooding) revealed the lack of planning and resources people had to evacuate safely (Chakraborty et al., 2019).

Due to a ***lack of planning and preparation, as well as inaccessible facilities, services, and transportation,*** people with disabilities are more likely to be left behind or abandoned when there is an evacuation during disasters and conflicts (see United Nation's Department of Economic and Social Affairs). Research shows that individuals with disabilities are at higher risk of death, support network disruption, injury, loss of property, and evacuating and sheltering challenges during floods. A survey of 2,252 respondents found that both individuals with disabilities and caregivers were more likely to have their homes flooded. Respondents reported difficulty receiving clear and simple flood warning information, disruptions to essential services, and limited access to safe housing post-flood. After accounting for sociodemographic factors, individuals with disabilities and caregivers also were at greater risk of probable post-traumatic stress disorder compared to other respondents (Bailie et al., 2022).

Part 5 of this report includes detailed information around TDEM's State of Texas Emergency Assistance Registry (STEAR), where anyone with a disability or anyone who requires transportation assistance in an emergency can enter their information, and emergency responders will have access to that information. While the availability of that service might be good to

communicate, there are also considerable limitations to that program that we discuss in detail later in this report.

When we designed the toolkit targeted for this demographic, we reviewed FEMA's current efforts targeting older adults and preparedness. We considered the messages they are sending, but our research to date suggests that targeted messages to older Texans — particularly those with disabilities — are important, so that is our focus in the toolkit.

Interview Data About Older Adults With a Disability. Fifteen interviews with end-user group #4, older adults — especially those with mobility disabilities — revealed the following key themes, which further support our decision to choose them as a priority group:

- Emergency Management Coordinators expressed concern that STEAR is not an adequate resource for the state. People have to register every year and not all counties participate.
- Older adults in focus groups regularly said they do not have an evacuation plan if their home floods and they would not know where to go.
- Older adults residing in senior living communities have endured major life-altering experiences (e.g., lost a spouse, sold their home, diagnosed with dementia), and flooding is not considered a highly threatening or concerning risk to them.
- Older adults residing in senior living communities are indifferent towards their own personal safety because they are largely dependent on the center's staff to take care of them. They now take a more passive role in caring for themselves.

7.4   End-User Needs Around Models, Datasets, and Visualization

7.4.1   Best Practices in Presenting Data to the Public

The focus groups and interviews data collected as part of this project have revealed that most people who have not been directly affected by flooding have no awareness at all that they need to pay attention to this type of information. Therefore, it appears that awareness must be a first step before we can identify the best way to communicate data to end-users.

As described previously in the report, flooding is a continuous cycle, and messages need to be frequently communicated if the goal is to improve risk awareness (Rufat & Botzen, 2022). Flood communication formats should allow people to more easily and clearly understand the patterns associated with graphic or tabular statistical data. Context should also be provided in maps, graphs, or tabular data (e.g., Stieb et al., 2019). Educational awareness campaigns can include personal narratives to assist selected end-users in their decision-making process, as seen in the approach that Mexico is using to educate their public audiences. Visualization methods to be developed can include narratives or context that end-users find relatable to their own flood risk. Language in models, datasets, and visualization methods should be simple and communicate across various backgrounds and educational levels. Confusing terminology should be avoided (see Figure 7.6 for an outline of best practices in engaging with community members on flood map use).

Figure 7.6 Best Practices in Using Flood Maps for Community Flood Risk Communication

1. **Tailor maps for specific audience and purpose** – the public needs "easily understandable and accessible maps with a lower density of information" to enhance readability of the map and clarity of the information (Meyer et al., 2011).

2. **Pair flood maps with local information that the community can relate to,** such as overlaying flood-prone areas on orthophotos/community plans and showing street names and local features (Meyer et al., 2011).

3. **Include information about historical floods**, which can offer a local context and remind people of past experiences with flooding ("event maps") (de Moel et al., 2009).

4. **Consider cartographic aspects for ease and speed of comprehension**, and avoid overly technical language without supporting explanations (e.g., 1% chance of flood in any given year, 1:100-year flood, high-to-low flood risk). A clear legend and meaningful colours to represent flooded areas (shades of blue representative of water) are particularly useful for public users (Kellens et al., 2009). Special considerations must be made for addressing color-blindness to ensure that maps are interpreted as intended by all audiences.

5. **Provide flood maps online and promote them regularly as a continuous reminder of flood hazards**, particularly for communities who have not been recently impacted by flooding and it is not a part of recent public memory (Kellens et al., 2009).

6. **Use real-time gauge levels**, if available, to help contextualize historic or extreme water levels shown on maps.

7. **Use property-specific, searchable Web mapping services** to allow citizens to look up their address or postal code and receive information on their property in relation to flooded areas. These efforts are primarily conducted at national and regional levels, and are common in comparable nations to Canada (Kellens et al., 2009).

8. **Complement flood maps with information about the consequences of flooding and tangible protective actions** to move from identifying a problem to motivating homeowners to act. This can include stories from survivors, information on private insurance, self-protection measures, evacuation routes, etc. (Kellens et al., 2009).

Figure Information: Recommended characteristics for flood maps designed to raise awareness about flooding and communicate risks to the public. *Source: https://uwaterloo.ca/partners-for-action/sites/default/files/uploads/files/using_flood_maps_for_community_flood_risk_communication_24jan18_fnl_3.pdf*

One recent research article compared the types of information available for the public and other stakeholders. Mostafiz et al. (2022) compared over 20 different Flood Tools (e.g., FEMA Flood Maps, Flood Factor (located on Risk Factor), the Virginia Flood Risk Information System), and they found that only Flood Factor had community information, mitigation options, and flood damage and loss information. There were several tools that contained flood property details such

as inundation areas, depth, and flood zones, including Flood Factor, FEMA Flood Maps, Aqueduct Global Flood Analyzer, Virginia Flood Risk Information System, and selected other state programs and international resources. Other flood tools that were not included in Mostafiz et al.'s (2022) evaluation are Community Health and Resource Management (CHARM) and Base Level Engineering (BLE) Interactive Maps. Essentially, this study suggests there are so few models and visualization methods currently available that we cannot necessarily rely on either academic or grey literature (i.e., non-conventional published material — such as market research reports or government reports — produced by professional organizations, think tanks, research institutes, and government agencies; see the University of Michigan Library Guide for more information) to guide our recommendations.

7.5   Examples of Other Tools/Maps Designed for the Public

In Texas, many larger metropolitan areas make flood maps available, but our review has revealed they are often difficult to locate on websites and they tend to overload people with information. More rural communities sometimes do not even have maps available for their own emergency response coordinators to use (identified through Dr. Stephens' interviews as part of Texas A&M's Institute for a Disaster Resilient Texas' Digital Risk Infrastructure Program). The following are additional tools found and used in Texas.

7.5.1   Damage Plain (Texas A&M Institute for a Disaster Resilient Texas)

This product is under development by the Texas A&M Institute for a Disaster Resilient Texas, and the UT Communication Team has already conducted and published one study with this product (Stephens et al., 2023). Like Flood Factor, The Damage Plain tool can be described as a probabilistic flood model / machine learning algorithm based on factors other than just the regulatory floodplain. Unlike Flood Factor, it is being developed by a Texas university to be specific to Texas. It is also earlier in development phase than Flood Factor.

Users want to find information quickly when using data visualization tools. If finding data takes more than a few clicks, it can lead to frustration and reduced engagement. Therefore, designing visualizations to be easily accessible, logical, intuitive, clear, and actionable is important. The following screenshots and descriptions provide a basic UX (user experience) analysis of the Institute for a Disaster Resilient Texas's (IDRT) Damage Plain map:

User Experience (UX) Review: This is the opinion of the MA student focused on UX who was part of this research team. The data on the map takes a long time to load and hence shows empty gaps on the map — this can be confusing for the user (see Figure 7.7). The members on our team with UI/UX experience recommend including filters so the user can select a few options before opening the map view; this will reduce the amount of data on the first load.

Figure 7.7 Damage Plain Loading Time

a.

b.
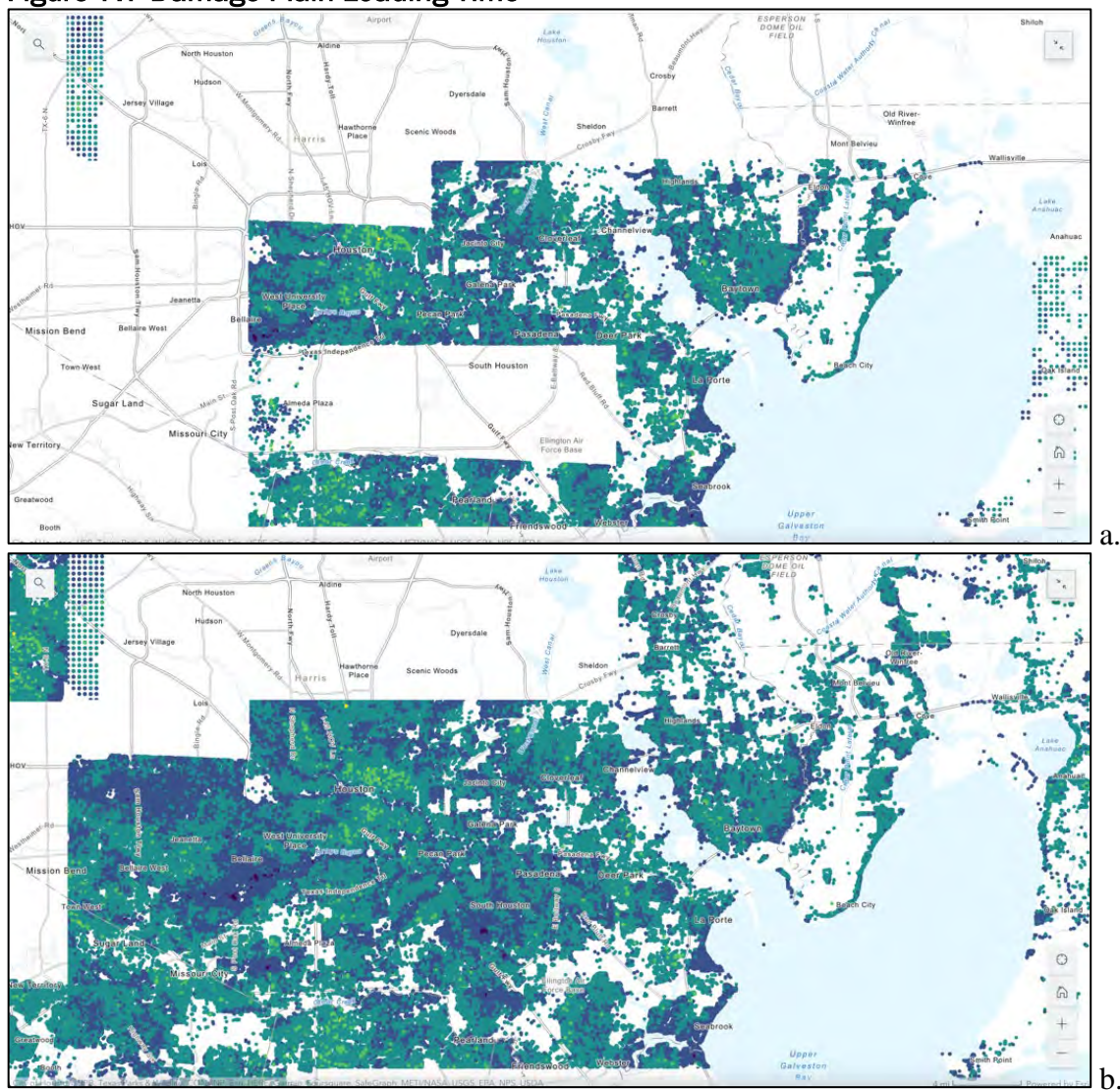
Figure Information: These two screenshots show how the Damage Plain's data takes a long time to load: (a.) the map is still downloading, (b.) the map is fully downloaded. *Source: https://storymaps.arcgis.com/stories/42200da93a7a493e99be11b790c19d81*

UX Review: This is the opinion of the MA student focused on UX who was part of this research team. The data on the tooltip — or the text box that displays information when hovering or clicking on a screen element — is technical and the user might not be able to interpret the data shown. Altogether, the map, search box, zoom icons, and tooltip have very low contrast which makes the image appear dull, blurry, and difficult to visualize (see Figure 7.8). Tooltip data should show data that is quick and easy to understand, and color contrast between items should be a 4:5:1 ratio between the background color and foreground colors (e.g., text, links) according to accessibility guidelines (see the W3C Recommendation for more details).

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Figure 7.8 Damage Plain Tooltip and Color Contrast
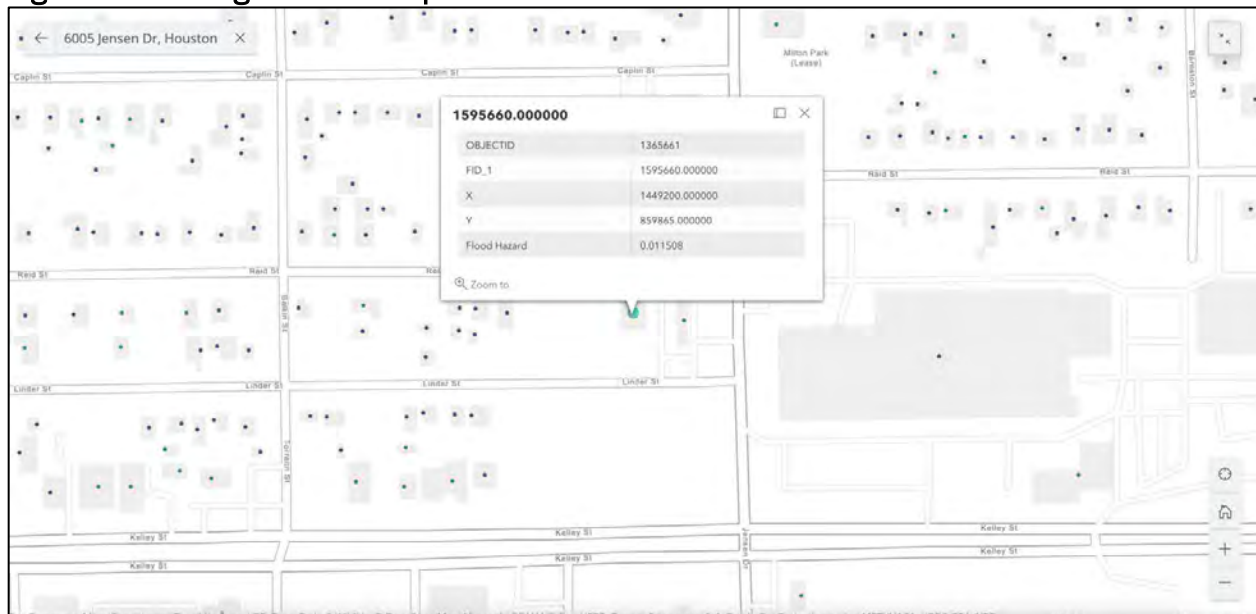
Figure Information: The Damage Plain's tooltip is difficult to understand, and the different screen elements have very low contrast. *Source: https://storymaps.arcgis.com/stories/42200da93a7a493e99be11b790c19d81*

7.5.2   Flood Factor (located on Risk Factor)

Flood Factor (located on Risk Factor), developed by the non-profit First Street Foundation, focuses on home and property owners and allows individuals to type in specific addresses to better understand *individualized flood risk*. Flood Factor is based on a probabilistic flood model that integrates and explains flood risk from all risk types: riverine, rainfall (pluvial), and coastal storm surge. They make some of their models and assumptions publicly available, and they do not rely strictly on FEMA flood maps, like most other models do.

UX Review: This is the opinion of the MA student focused on UX who was part of this research team. Compared to the Damage Plain, Risk Factor asks the user to select a property before loading the details in the map view (see Figure 7.9 below). This reduces the amount of data presented and ensures a faster load time.

Figure 7.9 Risk Factor Loading Time
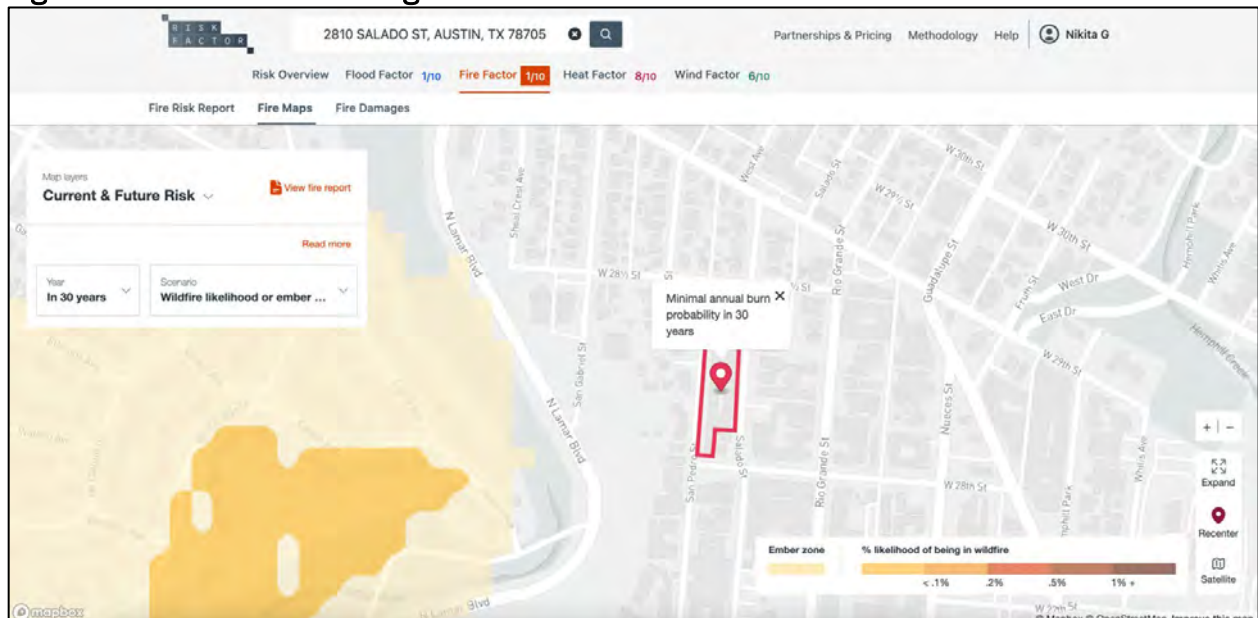
Figure Information: This diagram depicts a process where the user inputs an address into the search bar, and this triggers a search for data. As a result, the load time is relatively quick. *Source: https://riskfactor.com/*

UX Review: This is the opinion of the MA student focused on UX who was part of this research team. Risk Factor explains what a moderate risk means in simple language targeted for the end-users. The data can also be refined by narrowing down options, including at a county, neighborhood, zip code, and city level. Filters can be applied to sort data according to different kinds of risk (such as current and future risk), providing users flexibility to access and analyze the data they need quickly and easily (see Figure 7.10).

Figure 7.10 Risk Factor Filters

a.

b.

c.
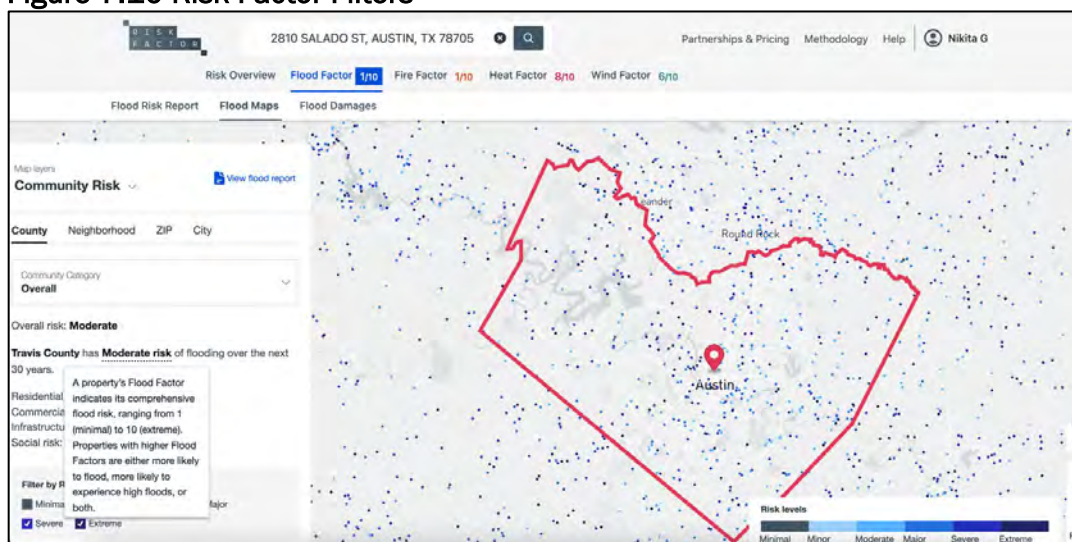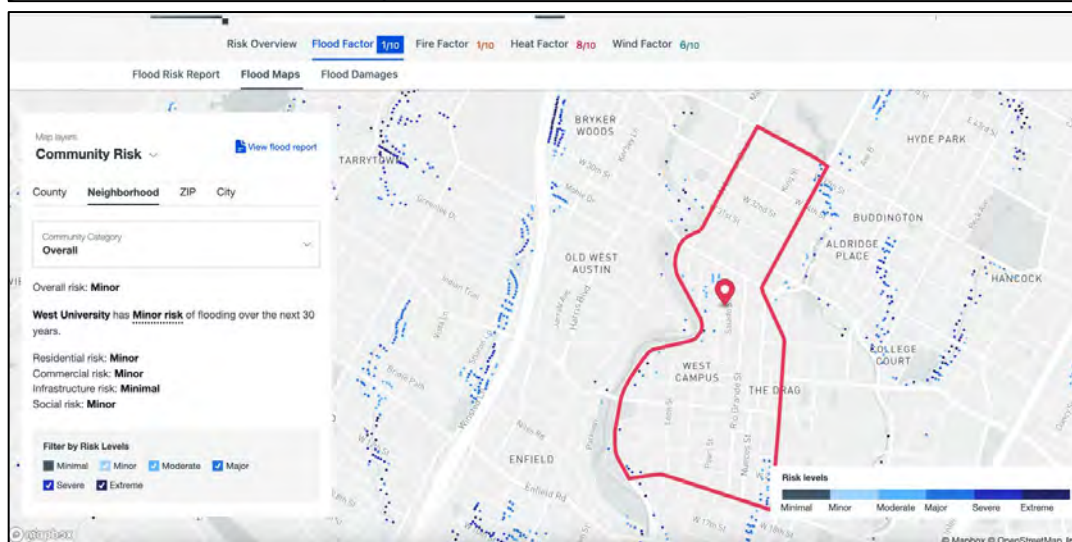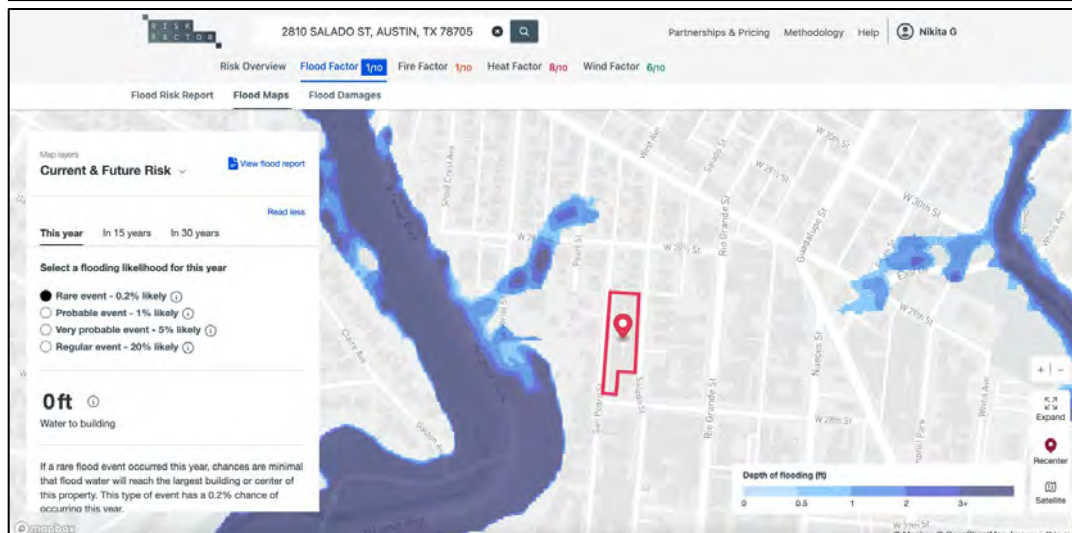
Figure Information: (a.) Risk is defined in simple language, (b.) Data can be viewed at a county, neighborhood, city, or zip code level, and (c.) Data can be sorted according to different kinds of risk. *Source: https://riskfactor.com/*

7.5.3   MAAPnext

Harris County, in collaboration with FEMA, has introduced [MAAPnext](), an innovative initiative aimed at enhancing flood awareness. MAAPnext utilizes advanced methodologies and technologies to gain a deeper understanding of flood risks, marking a significant advancement in floodplain management and regulation within the county. The approach focuses on personalized flood communication and education, specifically tailored to the unique flood risks faced by individuals, local communities, and emergency managers in Harris County. See Figure 7.11 for sample screenshots of MAAPnext.

Figure 7.11 MAAPnext Examples

a.

b.

c.
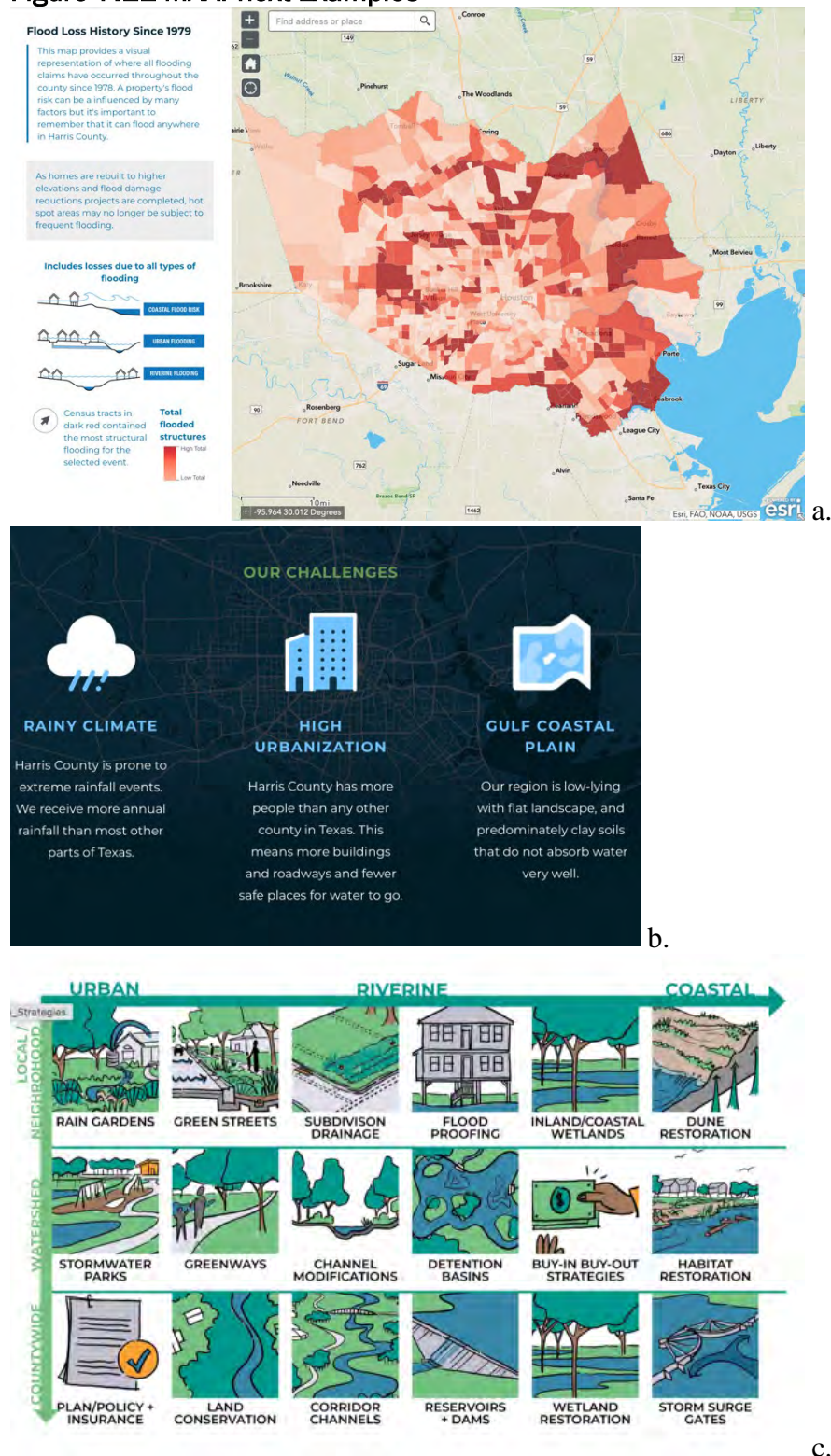
Figure Information: (a.) A historical account of structural flooding in Harris County, (b.) the challenges that Harris County faces, including high levels of rain and rapid development, and (c.) Mitigation strategies against different sources of flooding (e.g., coastal flooding caused by high tides) and at different levels (e.g., local or neighborhood level). *Source: https://www.maapnext.org*

MAAPnext is still being developed, and since its inception in 2019, it has implemented targeted communication and prevention strategies, with a focus on communities within Harris County. MAAPnext's initiatives and outcomes are being reviewed by FEMA (details can be found in the website report titled "Public Review of Data Collection and Implementation"). To ensure effective message customization, MAAPnext adopts a community-based approach that includes in-person education and exposure to relevant resources. This approach allows for the delivery of news, data, and recommendations that align with the specific flood risk assessment for individuals and community members. Note, this information is either publicly available or was obtained during an interview for this current project.

Using both local knowledge and national resources, MAAPnext ran flood risk analyses for all 22 of Harris County's watersheds — including riverine, coastal, and urban flooding. Residents living in Harris County can use the mapping tool to designate their properties as coastal, 100-year, or 500-year floodplains, and they have easy access to the FEMA Risk map, the FEMA Flood Map Service center, as well as the Harris County Flood warning page (see Information Resources).

The following screenshots and descriptions provide UX analysis of MAAPnext and its information resources, including the Harris County Flood Warning System and the Harris County Flood Education Mapping Tool:

Figure 7.12 Screenshot of the Harris County Flood Warning System
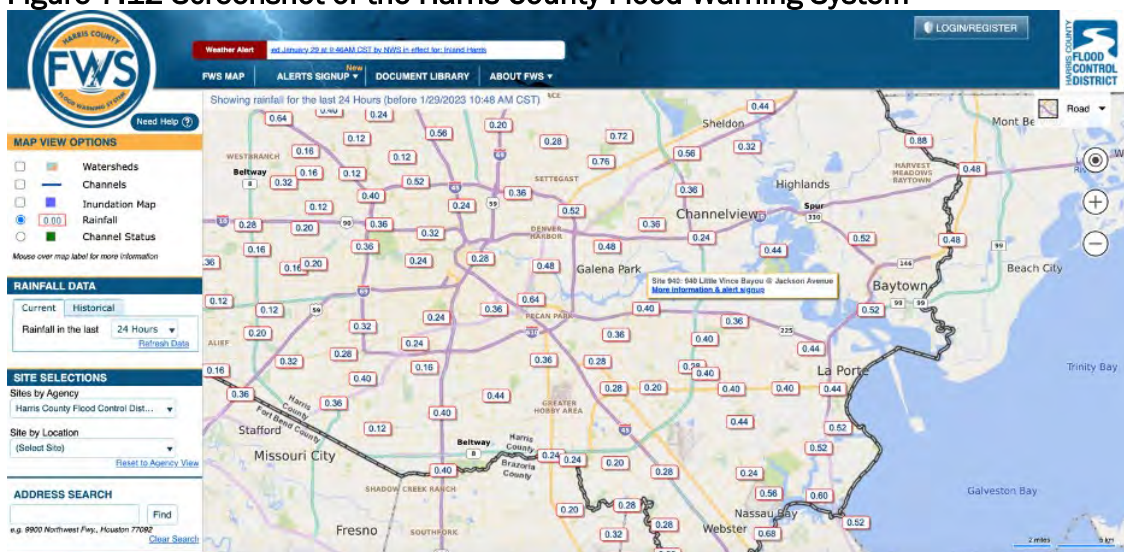
Figure Information: The rainfall amounts are not explained to the end-user. *Source: https://www.harriscountyfws.org*

UX Review: This is the opinion of the MA student focused on UX who was part of this research team. On the Harris County Flood Warning System, the user can see numbers indicating rainfall. However, there is no direct message indicating whether this number will lead to a flood (see Figure 7.12 above).

Figure 7.13 Screenshot of the Harris County Flood Education Mapping Tool
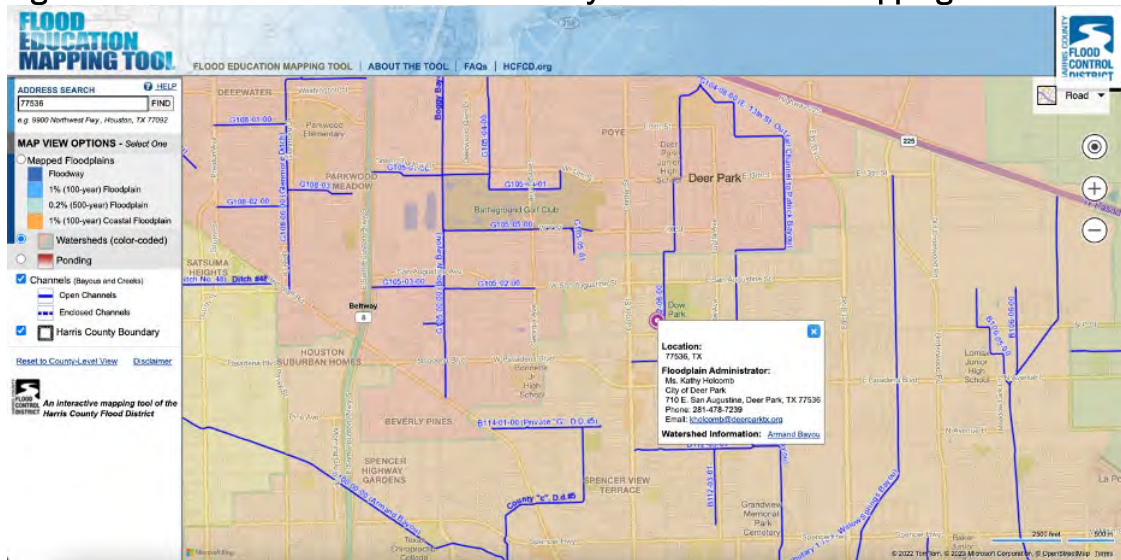
Figure Information: The website does not provide any advice to the end-user for how to use the tool. *Source: https://www.harriscountyfemt.org*

UX Review: This is the opinion of the MA student focused on UX who was part of this research team. The Harris County Flood Education Mapping Tool is straightforward and easy to use with just a few options, including mapping floodplains, watersheds, and ponding. Additionally, information on the floodplain administrator is displayed by zip code. However, the user should have some basic knowledge about reading maps and technology use (e.g., ability to select filters). The website does not provide any recommendations, so the user must make their own analysis or contact the floodplain administrator for guidance (see Figure 7.13). MAAPnext also provides risk information messages via their Facebook and Instagram social media pages, as shown in Figure 7.14 below.

Figure 7.14 Screenshot of MAAPnext's Instagram Page

Figure Information: MAAPnext shares several risk awareness graphic posts on Instagram. *Source: https://www.instagram.com/maapnext/?hl=en*

Conclusions based on the UX analysis of MAAPnext:

- The website displays maps, but it does not clearly explain the relationship between the floodplain and rainfall maps.
- The website displays generic risk messages.
- MAAPnext has a strong presence on Facebook and Instagram with targeted messages.
- There is no targeted communication regarding flood insurance based on the provided maps. Instead, the website states that every house needs flood insurance in Harris County.
- The website does not provide users with explicit steps to take in the event of a flood in their neighborhood. However, this information is available on MAAPnext's Facebook and Instagram social media pages.

7.6   Summary of UX Review

The maps reviewed above could help members of all four of the prioritized end-user groups if their members are trying to make home-related decisions. Along with FEMA's current NFIP messaging efforts, we do caution that Texans might be confused about the difference between regulatory maps and flood potential maps. A future effort may need to focus specifically on these types of differences. None of these tools address flood safety, flood preparedness, or other types of decisions people need to make concerning flooding in Texas. The website TexasFLOOD.org does try to address these issues, and it has the potential to be developed even more in the future.

Part 2: Outreach Campaign Plan Development

8   Part 2 Overview

Based on the research conducted in Part 1 of this report, we developed an outreach campaign plan to enhance Texans' awareness of flood risks and inform their decision-making in preparing for flood events. Project activities included focus group research as well as a state-wide survey to better understand the selected end-user groups.

These are the steps taken to develop the outreach campaign plan.

1) Monitored flood-related social media messaging in Texas during the 2023 Texas Flood Awareness Week as well as recent hurricanes and storms. Social media content analyses showed that most posts provided flood awareness information or preparedness tips based on materials from the Texas Floodplain Management Association (TFMA) or the Federal Emergency Management Agency (FEMA). Results confirmed that recent messaging during hurricanes and tropical storms frequently featured image or video footage of the events along with messages about their risks that included warnings to avoid downed power lines, and to avoid driving through floodwater. Most posts were English-only.

2) Conducted a state-wide survey focused on our recommended four critical end-user groups (described previously in this report). Those prioritized groups include: **Spanish speakers** (28.7% of Texas citizens in 2021), **new Texans in Flash Flood Alley** (638,401 people moving into the highest-ranking Flash Flood Alley counties in 2020, accounting for 34.6% of people moving into/within Texas), **young adult male drivers aged 18-35** (2,653,941 male drivers between the ages of 18 and 34 in Texas in 2019, approximately 30.0% of all licensed male drivers), and **older adults with disabilities** (a rapidly growing state demographic, with 35.2% of the Texas civilian noninstitutionalized population 65 years and older having at least one disability in 2021).

   The survey focused on three regions of the state: coastal zip codes, Flash Flood Alley zip codes, and the rest of the state. We collected and analyzed relevant data for each of the four critical end-user groups. We found that Spanish speakers who took our survey in Spanish were less knowledgeable of flood information and had seen fewer road signs related to flooding. We found support for our focus on Flash Flood Alley because people in those zip codes have a lower perception of flood risk, but so do newcomers, in general, and therefore, all newcomers in the state can benefit from the messages designed. While young-adult males did show a lower level of knowledge and a belief they did not need a lot more knowledge, there were no meaningful differences between young men and young women. Older adults with disabilities do have particular needs, but so do older adults in general.

3) Assessed the most effective media types and platforms to reach our four end-user groups. The five media types we examined were print media, traditional television and radio, digital and social media, outdoor advertising, and community outreach. Analyzing social data revealed Facebook drives the most relevant content traffic.

4) Created marketing personas – fictional characters representing each target group to gain insights into their technology habits, interaction opportunities, education needs, and unique challenges. The personas enabled us to take the prioritized end-user groups' perspectives for message development. We developed unique and detailed personas to describe the key things important for each of the four prioritized end-user groups.

5) Developed campaign themes and messaging through an iterative process that included designing content and getting feedback from focus groups that contained members from the four prioritized end-user groups. Results yielded resonant images and phrases for each group. Concise and long message formats were created for all groups as part of each toolkit.

- As an outcome of our team's efforts, we developed the **General Audience**, overarching theme for the TWDB Flood Awareness Outreach Campaign and it includes these messages: "Texans Fight Floods, Together" and "Texanos unidos contra las inundaciones." This emphasizes both state pride and community collaboration, and is suitable for all target groups.

- As an outcome of our team's efforts, we developed messages and graphics for each of the prioritized end-user groups and they were developed in both English and Spanish.

    o The messages targeting **Newcomers to Texas**, especially those in Flash Flood Alley, are "Check Your Flood Risk" and "Revisa tu riesgo de inundación." These messages capitalize on a newcomer's need for information and their acknowledgement that they do not have as much information about floods as they believe they need.

    o The messages targeting **Young-adult male drivers** are "Keep Your Car High and Dry" and "Mantén tu carro elevado y seco." These messages focus on the most prized personal possession for a young adult: their car. It emphasizes that flood waters can damage their cars in an attempt to make young-adult males realize driving through flooded roads is not worth the risk.

    o The messages targeting **Older adults**, especially those with mobility disabilities, are "Take 5 Prep 5" and "Toma 5 prepara 5." These messages break down the process of flood preparation into manageable steps that begin with choosing five items that can help an older adult be prepared for floods.

9   Overview of Outreach Campaign Plan

The outreach campaign plan is designed to enhance Texans' awareness of flood risks and inform their decision-making in preparing for flood events and responding to the hazards these events can bring. The plan has three specific goals:

- to educate and empower Texans to better prepare themselves, their families, their businesses, and their communities for flood events;
- to strengthen relationships among stakeholders within communities to improve public messaging before, during, and after flood events; and
- to increase TWDB's visibility as a trusted resource for issues regarding flood event preparedness, response, and recovery.

Five key features of the plan are outlined below and described in detail in subsequent sections.

1) **Environmental Scanning:** For message development preparation, we monitored and analyzed social media messages from various local, state, and national organizations during Texas Flood Awareness Week (May 22-26, 2023). We conducted content analyses to understand the specific information these messages conveyed regarding flood risks, causes, warning signs, and potential consequences. During major weather events like Hurricane Idalia and Tropical Storm Hilary in August 2023, as well as Hurricane/Post-Tropical Cyclone Lee in September 2023, we captured and analyzed social media messages. This allowed us to see how different stakeholders communicated during these times. From these analyses, we proposed ways to enhance social media messaging content and strategies.

2) **Targeted Messaging:** We identified four end-user groups to be prioritized, assessed their flood information needs, and gained a better understanding of their flood-related decisions. These high-impact, broad-reach priority groups include a) people who predominantly speak Spanish, b) new residents in Flash Flood Alley, c) young male drivers aged 18-35, who represent the largest percentage of flood deaths from driving through floodwaters, and d) older adults with disabilities. This last group is a rapidly growing demographic in Texas and is particularly vulnerable. For our outreach campaign, we plan to craft messages that directly address the needs and objectives of these groups, ensuring "targeted messaging" for each segment.

3) **Persona Construction:** In modern marketing, creating "personas" is crucial. These characters represent the target groups a campaign aims to engage. While personas are fictional, we base them on real data — in this project the team evaluated data from interviews, focus groups, and surveys about our four prioritized groups. By crafting these personas, we gain insights into the distinct needs, experiences, behaviors, and objectives of our priority group members. This approach, which emphasizes perspective-taking, directs our design of targeted messaging effectively.

4) **Place-Based Messaging:** Personas help us understand the "characters" we aim to engage, but we must also recognize the context of their lives and work. To make our flood awareness messaging "place-based," we incorporate local terms, "dichos" (Spanish idioms and proverbs), and references to unique Texas customs and concepts. This approach serves three vital persuasive goals. First, it boosts the credibility of the

messenger, like TWDB representatives and other flood-messaging stakeholders, showcasing their connection and understanding of regional nuances. Second, presenting messages in culturally resonant terms enhances the chance that regional audiences will grasp, recall, endorse, and act on the message's advice. Lastly, this tactic taps into Texan pride, acknowledging that Texans stand out from the rest of America, a sentiment shared by many residents and their governmental representatives.

5) **Iterative Message Development:** For our outreach campaign, we crafted messages grounded in evidence and theory about flood-related events. These messages, tailored for the personas of our priority groups, incorporated place-based language and symbols to resonate with the community identities of group members. We used an iterative process to develop these messages. We began by creating message drafts based on communication theory and our research on the priority groups. We then tested these drafts on focus group participants from each group, assessing their comprehension of flood risk and their intent to act protectively. Feedback from these focus groups guided message refinements.

9.1   Research Approach

Our team approached the outreach campaign plan and interview research using the following process:

9.1.1   Social Media Activities During Texas Flood Awareness Week, May 22-26, 2023

We closely monitored and captured social media activities from participating organizations, city and county departments, businesses, official city social media accounts, and official county social media accounts during Texas Flood Awareness Week, May 22-26, 2023, including:
- National Weather Service (NWS) Fort Worth,
- North Central Texas Council of Governments (NCTCOG),
- Association of Water Board Directors (AWBD),
- La Porte Office of Emergency Management (OEM),
- Trinity River Corridor,
- Corpus Christi Public Works and Engineering,
- Athens Texas Public Safety,
- Calhoun County Texas Emergency Management,
- Harris County Development Services & Permits,
- Anderson County Texas Emergency Management Office,
- Bandera County River Authority & Groundwater District,
- Guadalupe County Texas Emergency Management and Fire Marshal,
- Recover Montgomery County,
- Lamb-Star,
- Shield Engineering Group,
- Halff,
- Texas-New Mexico Power, and
- Lockwood, Andrews & Newnam, Inc. (LAN Engineering).

See Table 9.1 for a list of counties and cities we found who participated via their official social media accounts. We have included examples of their X (formerly known as Twitter) and Facebook posts (via hyperlinks) where they were still available on their social media pages. To the best of our knowledge, none of the official social media accounts for the most populous Texas cities, including Houston (population of 2,302,878), San Antonio (population of 1,472,909), Dallas (population of 1,299,544), and Austin (population of 974,447), participated in Texas Flood Awareness Week 2023. However, we did find social media posts from their various city departments, including the City of Houston's Office of Emergency Management (OEM) and Austin Watershed.

Table 9.1 Participating Cities and Counties in Texas Flood Awareness Week 2023

Participating Cities and Counties
Cities: Abilene, TX; Arlington, TX; Cedar Park, TX; Cleburne, TX; Corinth, TX; Denton, TX; Garden Ridge, TX; Grand Prairie, TX; Jersey Village, TX; League City, TX; Leander, TX; Live Oak, TX; Manvel, TX; Marshall, TX; Seguin, TX; Simonton, TX
Counties: Hays County

Social media posts can be categorized into two distinct categories: flood awareness and flood preparedness. Flood awareness posts were primarily used to inform and educate the public about the risks, causes, warning signs, and potential consequences of floods, with the goal of reaching a wider audience. For example, the TFMA 'Wear Blue' initiative garnered significant traction and engagement on social media from various organizations and engineering firms. Flood awareness posts have the potential to foster a sense of community involvement and responsibility. By encouraging discussion and dialogue around floods, sharing personal anecdotes, and promoting collective knowledge, they motivate individuals to take flood-related risks seriously.

On the other hand, flood preparedness posts provided practical insights and guidance on specific steps individuals could take to prepare for and mitigate potential floods. These posts often carried a sense of public authority. Such messages can be particularly effective when shared by authoritative organizations because of the added value of credibility and trust. People are more likely to follow advice from recognized experts and institutions, especially those they trust.

Both types of posts aimed to disseminate information and promote community engagement. Figure 9.1 shows an example of a flood awareness and preparedness post (see **Appendix A** for several other examples of these different varieties of social media posts). In summary, flood awareness and flood preparedness messages play a crucial role in flood-related communication. While flood awareness posts focus on educating the public, flood preparedness posts stress the importance of taking proactive actions to minimize flood risks and protect one's property and life.

Several social media posts were borrowed from the Texas Floodplain Management Association (TFMA), and the most frequently used hashtag was #TFMA. This was followed by hashtags like #floodawarenessweek, #floods, #WearBlueWednesday, and #FloodSafety. Interestingly, TFMA organized their Texas Flood Awareness Week posts into specific themes:
- Day One focused on flood facts, aiming to enhance the public's understanding of floods.
- Days Two and Four emphasized flood safety and preparedness.

- Day Three encouraged people to participate in "Wear Blue Wednesday."
- Day Five served as a reminder of historical floods and their impact on Texas communities and lives.

Figure 9.1 Screenshots of Flood Awareness Social Media Posts

a.

Figure Information: Figure (a.) is an example of a flood awareness Facebook post asking the public to familiarize themselves with important flood information sources/resources. *Source: https://www.facebook.com/cityofcleburne/*

Figure Information: Figure (b.) is an example of a flood preparedness Facebook post providing actionable and concrete steps to prepare for floods, such as purchasing flood insurance to protect one's property and following maintenance/construction guidelines to make one's home flood-resistant. *Source: https://www.facebook.com/CityofDenton/*

Table 9.2 provides a summary of our key observations regarding social media activities during Texas Flood Awareness Week, May 22-26, 2023, and outlines potentially untapped opportunities for improvement. By implementing these improvements, we believe that Texas Flood Awareness Week can be enhanced to better serve Texas communities, increase engagement, and ultimately raise awareness about flood risks. Incorporating a year-round strategic plan for disseminating content will enhance awareness among end-user groups. For instance, using specific timeframes associated with flood risk potential (March-July; August-October) can effectively engage users in flood prevention initiatives, especially given the increased flooding activity during the warmer

parts of the year. This approach can potentially prepare audiences, including authorities and other stakeholders, on ways to participate in prevention and enable them to share information with others.

Table 9.2 Observations and Opportunities During Texas Flood Awareness Week 2023

Observations	Opportunities for Improvement
Content was largely borrowed from the national level (e.g., Federal Emergency Management Agency (FEMA)). Therefore, infographics were not original, customized, or engaging. Hashtags were predominantly general and not specific to Texans (e.g., #floodawarenessweek, #floods).	Create customized, original, and Texas-specific content that is relevant to Texans and resonates with the local communities (e.g., messages, infographics, and hashtags that are geared towards Texans). Flood Awareness Week should happen more than once a year. For example, tapping into the different seasons of the year (e.g., Spring #floodawarenessweek, May/June #hurricaneawarenessweek, Fall or Back-to-School #floodawarenessweek). Other ideas include, akin to TFMA's approach, creating a content calendar with a different theme and hashtag for each day of the week (e.g., dedicate a day to Texas flood history or community support). Content should be posted at least 1-3 times a day on social media. This strategy helps maintain engagement with the public and offers a variety of content throughout the week. For example, using the messages our team has developed: Monday – #TexansFightFloods, #TexansSupportFloodSafety; Tuesday – #TexasFloodHistory; Wednesday – #TexasWearsBlueWednesday; Thursday – TexansLoveTheirNeighors.
Hashtags included #TFMA / #tfma, #floodawarenessweek, #floods, #WearBlueWednesday, and #FloodSafety.	#TurnAroundDontDrown is a powerful hashtag that displays the persuasive impact and memorability of a catchy slogan, serving as an example of recall and effectively raising awareness. It demands more promotion and the launch of additional awareness campaigns to enhance public communication. The hashtag could also be expanded to help raise awareness around children/adults not playing in floodwater as well as pets not drinking or swimming in floodwater.

Content was not in Spanish (i.e., out of the 5 days of Texas Flood Awareness Week, some cities and counties only had 1 post in Spanish).	Create <u>all</u> posts in both English and Spanish.
Facebook and X (formerly called Twitter) posts contained helpful information, but their reach was very low (e.g., an average post had a maximum of 2 to 5 likes). While the content on Facebook and X was largely the same, we found that Facebook had more posts than X.	While all prioritized end-user groups will not be reached through social media, it is a valid and low-cost option. For public awareness campaigns, it is important to engage and collaborate with influential public figures in Texas (e.g., Mayors) so that they share and promote the campaign's messages and have a wider reach. Local agencies (who have the resources) and TWDB's future efforts can encourage public engagement by creating interactive and relatable posts (e.g., design activities, challenges, quizzes, or discussions that allow individuals to actively participate in the campaign).
To our knowledge, the public was not engaging with the content (we found the greatest engagement was on LinkedIn). We monitored engagement through likes and comments. Impressions can be considered engagement, but they are not available on all platforms and are usually only seen by the posting organization.	Collaborate and partner with local communities/governments, organizations, cities, and counties to amplify the campaign's reach and impact. These entities can act as liaisons between TWDB/campaign organizers and the public, helping to disseminate customized messages through their social media channels and engaging with their community members. By providing toolkits (developed elsewhere in this report), local partners will not need to create their own content, but they will still need the capacity to post created content.

9.1.2   Social Media Activities Around Recent Hurricanes and Tropical Storms

Hurricane Harvey. The use of social media during hurricanes has been studied for some years. For example, during Hurricane Harvey, there was widespread use of smartphones, apps, and social media to request rescue, tap into shared community identities, and help one another, especially as 9-1-1 was overwhelmed. In the aftermath of the hurricane, people shared health information and participated in public conversations about it, and others narrated their experience, cited credible sources, and shared Public Service Announcements (Stephens et al., 2018; Stephens et al., 2020). Specifically, a combination of mobile phones and social media made rescue needs visible (Stephens et al., 2020) and connected people to help (Smith et al., 2018). Studies showed that the use of smartphones provided locatability and reachability when

water obscured street signs, and it allowed survivors to bounce information in ways that improved their risk perception. Some people believed that keeping their phones on was a lifeline to staying connected to their loved ones and receiving emotional support, which compensated for the material limitations of technology. Phones and their features allowed people to signal their belonging to groups that provided intercultural support (Li et al., 2019; Stephens et al., 2020). Technology also helped emergent digital volunteerism organize. People became knowledge workers who used social media to play the roles of rescuers, dispatchers, or information compilers (Smith et al., 2018; Smith et al., 2021; Stephens et al., 2018).

Using social media for rescue activities is not a perfect task, as it can potentially leave some people out and may not always be the preferred media choice. A survey of social media use after Hurricane Harvey found that X (formerly Twitter) use was especially common among people with high education levels, those who were employed, homeowners, as well as those who did not wish to move. These groups received better responses after calling relatives and assistance organizations, which helped them feel more certain about getting help (Mihunov et al., 2020). Social media, apps, and smartphones have also been shown to produce communication that is difficult to navigate through, particularly when noise is produced by a high volume of messages. However, a combination of the power of machine-learning classification methods and human coders, or supervised machine-learning models, can help find relevant content and provide solutions to the noise problem (Johnson et al., 2020; Robertson et al., 2019; Stephens et al., 2023). In this next section, we summarize more current uses of social media during storms.

While we do focus on social media use in this report, there is a method to access archived TV/radio messages. Campaigns, whether from state or federal agencies, often store their featured content for public access and use. For instance, NPR archived real-time events for their radio listeners during Hurricane Harvey. These recordings provide detailed descriptions and information, enabling radio listeners to better understand and navigate the impact of the hurricane. Unfortunately, this varies with each agency and locating this information is often difficult.

Hurricane Idalia. As Hurricane Idalia made landfall, our team tracked and captured social media activities from various Florida organizations, including local police departments (e.g., St. Petersburg Police, Clearwater Police Department), local fire departments (e.g., Clearwater Fire & Rescue Department), National Weather Service (NWS) Tampa Bay, Tampa International Airport, cities (e.g., St. Petersburg, Clearwater), and counties (e.g., Pinellas County). Figure 9.2 shows an example screenshot of a tweet (see **Appendix B** for several other Hurricane Idalia tweet examples). Our observations revealed the following key themes:
- Images or video footages were oftentimes used in conjunction with text to communicate the severity or danger of the situation to local residents.
- Social media posts warned residents to keep away from downed power lines or flooded areas and streets.
- Messages cautioned people to never drive their vehicles through floodwater or standing water.
- Other posts updated residents about the response efforts that were currently underway.
- Some posts provided the contact information for city and county services (e.g., the contact number to report storm-related power outages).

- Tweets also asked residents to change their water consumption behaviors (e.g., to conserve water during the storm).
- Bilingual messages were not very common, at least during the first few hours after the hurricane made landfall. We came across one tweet that posted the English and Spanish version of a National Oceanic and Atmospheric Administration (NOAA) graphic.

Figure 9.2 Sample Screenshot of a Hurricane Idalia Tweet

Figure Information: A screenshot of a tweet during Hurricane Idalia cautioning against the dangers of live wires. *Source: https://twitter.com/StPetePD*

Tropical Storm Hilary. During Tropical Storm Hilary's landfall in Nevada and California, we monitored social media activities from various entities. While the content was largely the same across X (formerly known as Twitter) and Instagram, we chose Instagram because we found that there was more engagement (likes and comments) on this social media platform as opposed to X during Tropical Storm Hilary. Thus Instagram best represented how cities and organizations communicated during Tropical Storm Hilary. In Nevada, we analyzed communications about the storm from public radio, the Bureau of Land Management, and official town or city accounts like Mt Charleston. Meanwhile, in California, we observed posts from city official accounts like the City of Findio, Mayor Karen Bass, parks and recreation departments, and news agencies like NBC. Refer to Figure 9.3 for a sample Instagram screenshot (see **Appendix C** for several other Tropical Storm Hilary Instagram posts). Our analysis yielded these observations:
- Posts primarily cautioned residents to avoid floodwaters and refrain from driving through them, while also updating people about ongoing response actions.

- To convey the storm's gravity, many posts used visuals alongside text, including on-scene photos of areas like inundated streets. Canva was a frequent tool for creating graphics.
- There was minimal direct response from the organizations or individuals to public queries on their posts. Instead, community members often replied to one another. This could be due to limited capacity for the posting agency to respond to messages.
- Posts from elected officials tended to attract more likes and interactions.
- Entities not typically active on Instagram, but who posted during the storm, received little to no engagement.
- There was a noticeable absence of content guiding residents on post-flood actions.
- Bilingual posts were rare.

Figure 9.3 Sample Screenshot of a Tropical Storm Hilary Instagram Post
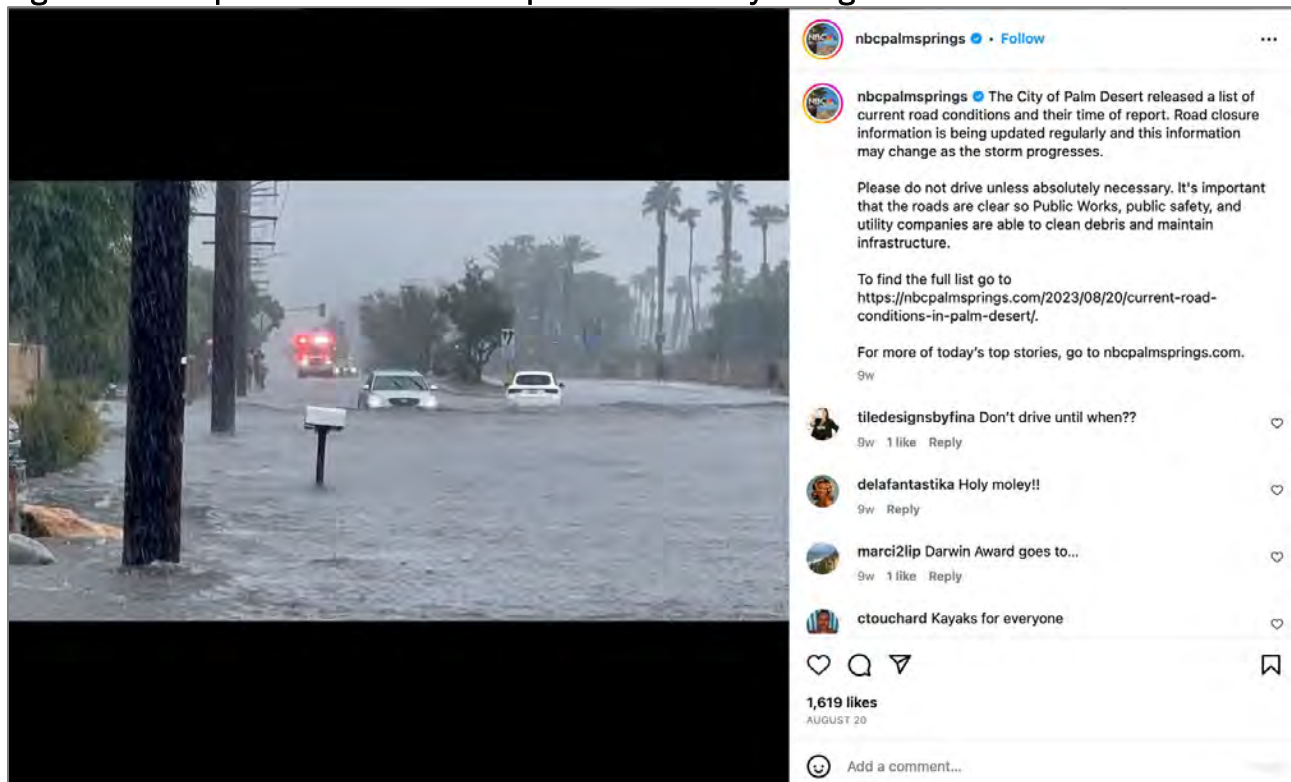
Figure Information: A screenshot of an Instagram post during Tropical Storm Hilary cautioning against driving through flooded waters. *Source: https://www.instagram.com/nbcpalmsprings/*

Hurricane/Post-Tropical Cyclone Lee. During the landfall of Hurricane/Post-Tropical Cyclone Lee, we monitored social media activities on X's platform (formerly referred to as Twitter). We observed the interactions and posts of various city mayors and organizations, specifically NYCEM – Notify NYC, City of Newark, City of Orlando, FEMA, and entities like the National Weather Service. Please refer to Figure 9.4 for sample tweets. Our key findings included:
- The National Weather Service regularly posted updates about Hurricane Lee, and these were frequently shared by prominent mayors to amplify their reach.
- Initial observations hint at posts with visual content having a potential edge in visibility over purely textual ones, but more research is needed to confirm this.
- Data analysis from the Tweets suggests that posts by influential figures generally have a higher reach compared to those shared exclusively by institutional accounts.

- Mayors who communicate information about unique provisions and readiness for disasters tend to experience greater visibility.
- Using standardized graphic toolkits can enhance coherence in communications related to weather phenomena like flooding, rainfall, and disaster preparedness.
- Having toolkits available in Spanish can assist influential personalities in disseminating messages more effectively.
- Among influential users, resharing or reposting is a prevalent practice.

Figure 9.4 Screenshots of Hurricane Lee Tweets

a.

Figure Information: Figure (a.) is a screenshot of a tweet during Hurricane/Post-Tropical Cyclone Lee warning local residents against heavy rain and flash flooding. *Source: https://twitter.com/NotifyNYC*

b.

Figure Information: Figure (b.) is a screenshot of a tweet during Hurricane/Post-Tropical Cyclone Lee warning local residents against wind and hail. *Source: https://twitter.com/NotifyNYC*

10 Media Platforms to Communicate Flood Risk to Selected Target Audiences

As of October 1, 2023, Facebook was the dominant player in the social media space providing the most traffic to content creators (e.g., organizations that pay to have ads placed). Although TikTok generated headlines in the last months of 2022 for producing $350 million in revenue (Wong & Bottorff, 2023), at the time of this report, Facebook continues to be the most used social media platform in the digital environment with 2.9 million monthly users worldwide. It is followed by YouTube, Instagram, and TikTok (Wong & Bottorff, 2023). Facebook leads traffic statistics when considering the number of page views from the platform over total page views (defined as the number of times people click on an ad to view it). It has 6.27% of page views, according to data gathered from more than a hundred content creators internationally (Echobox, 2023). Most importantly, 53% of all social media site visits from desktop, mobile, and tablet devices in the United States are on Facebook (Wong & Bottorff, 2023), making it an indispensable platform when planning to diffuse flood-related information. It is noteworthy that Wong and Botorff (2023) used a summary of statistics from a wide variety of sources, including Statista, Sprout Social, Forbes, and DemandSage.

X (the platform formerly known as Twitter) dispenses traffic with a percentage of only 0.64% of page views. This is considerably more than Instagram, LinkedIn, Pinterest, and Reddit — which are also leaders — but with only 0.22%, 0.03%, 0.04%, and 0.01% respectively. Overall, traffic provided by all platforms shows a descending trend compared to the 2022-2023 timeframe (Echobox, 2023). Aggregated data shows that the average click-through rate (CTR; i.e., the percentage of people who click on a social post, advertisement, or other piece of content to read more or make a purchase) on all platforms slightly declined between 2021 (1.3%) and 2022 (1.21%); however, it is still relevant to create compelling social media content that maximizes engagement. Because short videos (i.e., less than one minute long) on mobile phones capture the attention of 66% of consumers (Wong & Bottorff, 2023), this is important to consider developing in future outreach efforts.

The best way to increase engagement is through sponsored ads, which typically cost between $1,000 and $3,000 (Wong & Bottorff, 2023), but costs vary. Although each platform has various metrics to show engagement with specific posts over time (e.g., X tracks impressions, or the number of people who view a post), we chose numbers that provide a common parameter to compare across social media platforms. Other metrics can be utilized in the future by contracting private analytics services (see PostHog's list for examples) or databases such as Statista.

While most advice is to keep video content brief (e.g., Wong & Bottoroff, 2023), there are still times audiences will seek video content to help them learn about information that interests them.

The only age demographic still showing a preference for television as their primary news source is those over 65 (Pew Research Center, 2022, September 20a). This age demographic is also still fine receiving postcards in the mail and getting flyers, so there is still an important need for these print-based media.

Spanish speakers can be reached through Latino/a/e-owned media, including newspapers, that cater to these audiences by providing news and information that aligns with their cultural

identity, language preferences, and news consumption behaviors. For example, Ethnic NewsWatch, a database, offers insights into the types of Latino/a/e-owned media outlets.

While we have reviewed the major media where our research suggests would help in a flood awareness campaign, we will discuss how these media apply directly to the prioritized end-user groups in the next section.

11   Key Themes and Messages To Be Used for Outreach Efforts

11.1   Key Message Development

Our approach to message design followed a four-phase process. The first phase involved developing user personas to better understand the prioritized end-user groups. The second phase involved message development and testing. This helped us craft and emphasize messages using visual icons and words, ensuring they capture attention and provoke responses from members of the prioritized end-user group. The third phase was centered on message processing. Here, we collected feedback and suggestions from the end-user group through interviews and focus group. This stage was vital for formulating messages that not only communicate effectively but also engage the audience in meaningful conversations about flood mitigation. Through this method, we collaboratively produced a collection of vetted images and phrases that resonate with the target group. These components paved the way for innovative message development and engagement techniques, all tailored to the preferences and feedback of the end-user group, specifically addressing flood mitigation. Finally, we conducted a Texas-wide survey to better understand the prioritized groups and to inform the specific needs of each group. We used Centiment, a research platform, to collect survey responses from our target audiences.

In the section that follows, we present the survey data along with the persona data to provide a comprehensive understanding of all the research conducted about each prioritized end user group. To contextualize the survey data, we provide an overview of that research first, before addressing each prioritized end user group.

11.1.1   Survey Data Overview

The survey was conducted to better understand the research-based decisions around Flash Flood Alley, as well as the prioritized four end-user groups: Spanish-speakers, newcomers to Texas (especially in Flash Flood Alley), young-adult males, and older adults with disabilities.

Sample with Quotas

A Centiment panel with quotas was used to ensure that results gathered from the participants represented the demographics of communities in Texas. This sample included Texas residents 18 and over with 40% from the 18-35 years of age group, 40% from 35-65, and 20% from 65+. Gender was 50% male and 50% female, and race/ethnicity included 41% Non-Hispanic White, 40% Hispanic, 12% Black and 7% Other. We had a geographic quota including 33% Flash Flood Alley zip codes, 33% coastal zip codes, and 34% being the rest of the state.

Online Survey

The survey was soft launched on November 21, 2023, and the final collected sample was sent to UT Austin on January 4, 2024.

The online survey took people 12.25 minutes (as a median) to complete. To weed out bots and scams, participants were presented with a rigorous attention check that mirrored a thought-listing exercise (Cacioppo, Hippel, & Ernst, 1997) where they were asked to type in three words that came to mind when thinking about floods in Texas. If the words provided did not make sense, or a word repeated, those participants were removed from the sample. Additionally, responses were screened for other problematic indicators, namely duration (taking too little time) and straight-lined responses. This was a rigorous process that removed 35 responses not meeting the attention check requirements.

Gender and Age Demographics

The resulting sample was 1,086 participants. With only 5.4% ($n = 59$) of the participants taking the survey in Spanish, we have not included those responses in the overall demographics. While that sample is too small to make reliable estimates of any differences, a comparison table is found in section 11.1.3 of this report. The resulting sample was 52.8% ($n = 542$) female, 46.7% ($n = 480$) male, and .05% ($n = 5$) nonbinary/third gender. The sample had an average age of 47 (standard deviation = 18.2), which broke down to 31.5% ($n = 324$) in the 18-35 age range, 44.4% ($n = 456$) in the 36-64 range, and 24.1% ($n = 247$) 65 and older.

Race/Ethnicity and Languages Spoken Demographics

The Hispanic/Latinx/Spanish origin sample was 46.6% ($n = 479$) of the total, and of that sample, 38.9% ($n = 399$) were Mexican/Mexican American, 1.2% ($n = 12$) Puerto Rican, 1.1% ($n = 11$) Cuban, 5.1% ($n = 52$) other Latinx or Spanish origin, and 0.5% ($n = 5$) multiple origins. Of the remaining sample, 34.7% ($n = 356$) were Non-Hispanic White, 10.8% ($n = 111$) were Black, and 7.9% ($n = 81$) were other race/ethnicities.

We asked if people spoke Spanish in addition to English, and among participants who took the survey in English, 49.0% ($n = 503$) said not at all, 25.1% ($n = 258$) said yes but not very well, 11.3% ($n = 116$) said yes and well, and 14.6% ($n = 150$) said yes and very well. The remaining sample did not answer this question. Finally, 95.2% ($n = 978$) of the sample were people born in the U.S. and 4.8% ($n = 49$) were not born in the U.S.

We also asked about languages spoken because one of our recommended prioritized end-user groups is Spanish speakers. In the full sample, 94.8% ($n = 1,029$) spoke English as a primary language and 4.9% ($n = 53$) spoke Spanish. There was an option to take the survey in Spanish, and 5.4% ($n = 59$) of the participants chose that option.

Home Ownership and Household Demographics

While we did not specify quotas for any of these demographics, they generally reflect what research suggests is representative of people living in Texas. In this section, people were allowed to skip questions, so they do not add up to the total sample. Of the sample responding to the question, 44.8% ($n = 448$) of the people rent their place of residence, 29.4% ($n = 294$) own their residence outright, and 25.9% ($n = 259$) own their residence and are paying a mortgage. 19.0%

(n = 195) live alone, 36% (n = 370) are in a household with 2 people, 33.1% (n = 340) are in a household with 3-4 people, and 11.9% (n = 122) have 5 or more people in their household. 63.2% (n = 649) have no children, 16.4% (n = 168) have 1 child, 12.1% (n = 124) have 2 children, and 8.4% (n = 86) have 3 or more children. Annual household income falls into these categories: 52.7% (n = 541) make less than $50,000/year, 33.9% ($n$ = 348) make $50,000-$100,000/year, and 13.4% (n = 138) make more than $100,000/year. Interestingly, this means that the sample was slightly overrepresented in people who make under $50,000 (according to the Texas Comproller, 41% of Texans were at this level in 2019), and underrepresented in people making more than $100,000 (in 2019, 29% of Texans were at this level). In 2019, Texas had a median income of $61,874. While we did not specify this sample demographic, it could be explained by people who sign up to be part of a panel survey being of lower income.

Region (Flash Flood/Coastal/Other) and Flood History

To identify coastal zip codes, we considered zip codes that touched the Gulf of Mexico, while also broadening our scope to include counties in designated coastal areas by using this map. The full sample (including those taking the survey in Spanish) included 36.1% (n = 392) participants living in coastal zip codes, 30.5% (n = 331) in Flash Flood Alley zip codes, and 33.4% (n = 363) in other areas of Texas. Most people did not live on an identified floodplain 53.6% (n = 550), 20.8% (n = 214) did live on a floodplain, and 25.6% (n = 263) did not know their floodplain status. Most people said their area had experienced flooding, 53.3% (n = 547), with 33.7% (n = 346) saying it had not, and 13% (n = 134) not knowing if their area had experienced flooding.

Core Findings Directly Related to Each End-User Group & Regions of Texas: Message Fatigue

In Stephens et al.'s (2023) survey identifying differences in how people seek flood-risk information in Texas, they concluded there was a lack of flood information and education in Texas, but they could not rule out that their findings were due to people being overloaded and/or simply tired of hearing about their flood risk. For this study, our team found measures for a concept called message fatigue (So et al., 2017) consisting of items asking about unnecessary redundancy and perceived overexposure of the messages. We included this six-item measure in this study and found no statistical differences between any of the variables related to our end-user groups and message fatigue. The average amount of message fatigue was in the mid-range of the 7-point Likert-like scale (Mean of 3.90, standard deviation of 1.27), and no groups felt more or less fatigue than others. This finding further supports Stephens et al.'s (2023) claims that flood education and information is not widespread in Texas.

Differences Between Coastal, Flash Flood Alley, and Other Parts of the State

One of the main goals of this survey was to have a suffcent sample size to better understand how different areas of the state perceive their flood risk and have knowledge about flooding causes and consequences. While we did ask respondents to what extent they understood what a flash flood was, we did not ask a specific question about whether they thought they were at risk of flash floods. We instead asked about their risk for floods in general. When comparing these three regions (based on zip codes), we find that Coastal residents perceive the highest probability of flooding (M = 2.78), followed by other areas of the state (M = 2.48), and then Flash Flood Alley (M = 2.22). Coastal residents report having the most knowledge (M = 73.67 out of 100), with

other areas of the state and Flash Flood Alley being similar with a M = 68-69. People living in coastal and Flash Flood Alley zip codes are more knowledgeable around how flooding can occur (around rivers and the coast). An interesting trend emerges around knowledge that not picking up leaves from yards can lead to drains clogging and flooding. Specifically, people in coastal zip codes are most aware of this (M = 4.61), followed by people in other areas of the state (M = 4.26) and then Flash Flood Alley (M = 3.88). When asked if flooding only happens on designated floodplains, there is no significant difference between the three regions, and they are all less knowledgeable about this than they are on the other knowledge questions.

11.1.2   Personas to Guide Message Development

The essence of creating personas lies in tailoring messages that deeply resonate with and captivate diverse user groups. By understanding their technology habits, interaction opportunities, educational needs, and unique challenges, we can craft precise communication strategies. Our focus is on disseminating information on preparedness and resources, especially for groups vulnerable to flooding — as evidenced by the literature we have reviewed and insights from interviews. User personas offer a comprehensive view, enabling us to deeply understand our target audiences based on the data we have amassed. These insights help in formulating strategies that cater to their specific needs. We have included personas for each of our four end-user groups in the sections that follow below.

One such demographic is young adults, many of whom might be unaware of the hazards and complications arising from flood situations. This lack of cognizance, and/or experience with floods, not only jeopardizes their possessions but also inflates repair costs. A significant portion of this segment tends to underestimate the severity of floods, leading them to overlook warnings and sometimes make perilous decisions post-flooding. Notably, they are well-versed with various technological tools, from laptops and mobile devices to platforms like Facebook, Instagram, and X (formerly known as Twitter) (see section 14 for more details). Tapping into these platforms allows us to engage them using vivid real-world examples, highlighting potential challenges. This tech-centric approach ensures we connect with young adult end-users in an intuitive and impactful manner.

11.1.3   People Who Predominantly Speak Spanish

Even though Spanish is the second most spoken language after English in Texas (see United States Census Bureau's Languages Spoken at Home for more details), our interview data has shown that Spanish speakers living in Texas rarely see warning signs in Spanish on the roads and they lack knowledge about evacuation and flood insurance. This communication environment is detrimental to their risk assessment and lowers the possibility that they engage in protective behavior. Nevertheless, there are several opportunities to use different media channels to reach them.

According to data by Pew Research Center (2022a), Spanish speakers prefer digital devices to get news. They are the second largest group of Americans who use their phones, computers, or tablets to stay current on national and world events. Spanish speakers are also the second largest group that gets their news from the radio. Print publications are their least favorite option. In the digital environment, Spanish speakers find information on topics of interest to them by using social media and conducting web searches. This audience uses mostly TikTok, Snapchat, and

Instagram, but they can also be reached through YouTube, Facebook, and Reddit. A minority of Spanish speakers use news apps and listen to podcasts. According to data by Abrajano and colleagues (2022), because Hispanics share information on messaging apps that don't control the content (such as WhatsApp), they are often exposed to misinformation about topics like COVID-19. According to a Pew Research Center publication (2024), 54% of Hispanic adults in the U.S. reported using WhatsApp in a 2023 survey. This is much higher than Americans in general, with only 20% of all U.S. adults saying that they used WhatsApp in a 2019 survey and 29% in a 2023 survey.

Our team interviewed Spanish speakers and found that even though there are some resources in Spanish that would help them prepare for floods, they are often unaware of them. Even when there is information available, it might be difficult to understand because a literal translation of technical terms results in words that do not have enough semantic difference to help Spanish speakers understand the different preparedness needs for varying risk levels. To mitigate the issues surrounding literal translation, we recommend using Spanish that is approved by the Real Academia Española (RAE, or the Royal Spanish Academy). This institution works with national language academies across 22 Spanish-speaking nations to recognize both linguistic unity and uniqueness. We also recommend engaging people who live in different parts of Texas to tailor to specific language dialects. As mentioned above, our interviewees in urban and rural areas expressed that they had trouble finding messages in Spanish, especially on street signs. They were confused about the meaning of signs such as "Low Water Crossing." In rural areas, Spanish speakers have not been sufficiently targeted with awareness messages.

See Figure 11.1 for the developed persona for this end-user group.

Figure 11.1 Persona for People Who Predominantly Speak Spanish
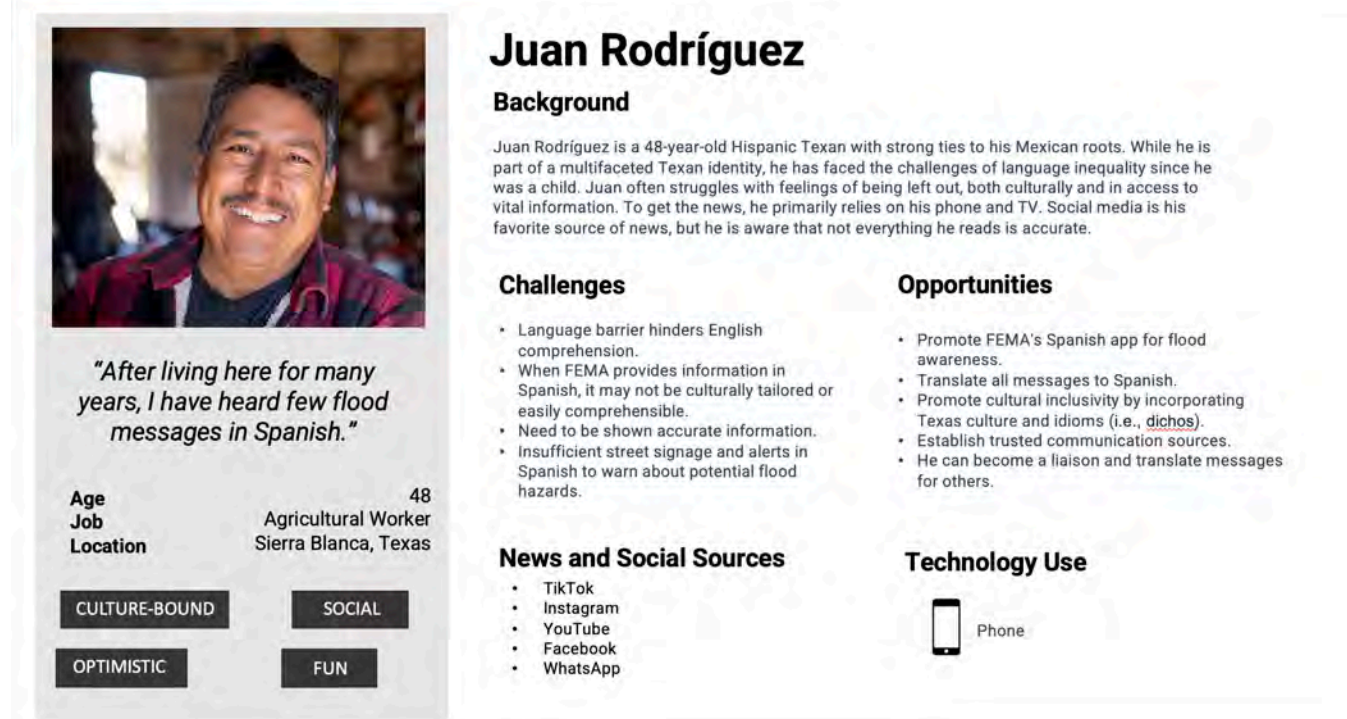
Figure Information: This persona combines research on this prioritized end-user group. Translated materials that are also culturally tailored to specific regions are very important.

Survey Data. The survey data from the Texas-wide survey confirms that this prioritized end-user group has specific needs around flood awareness. There were 59 people who took the survey in Spanish. Table 11.1 compares their responses to others who took the survey in English. Some of the most striking differences between the groups concerns their awareness of flood resources and flood signs.

Table 11.1 Comparison of Spanish-Language and English-Language Survey Participants

	Spanish-language participants	English-language participants
Heard of FEMA	57.6% ($n = 34$)	86.6% ($n = 889$)
Heard of STEAR	32.2% ($n = 19$)	42.6% ($n = 437$)
Seen Turn Around Don't Drown	40.7% ($n = 24$)	64.4% ($n = 661$)
Seen Low Water Crossing	35.6% ($n = 21$)	66.9% ($n = 687$)
% Correctly identified that 5-7 inches of water or more is a dangerous level on the road	40.8% ($n = 20$)	57% ($n = 585$)
Perceived Current Knowledge	M = 65.76, SD = 24.6	M = 70.73, SD = 23.1

The comparison indicates lower awareness of flood-related resources, signage, and indicators of flood risk among people who took the survey in Spanish than others who took it in English. The Spanish respondents also perceived their current knowledge of flooding to be lower than the English respondents.

11.1.4   New Residents Moving Into Flash Flood Alley

Data shows that Flash Flood Alley is becoming more populated, especially around urban areas (see Table 4.2 and Figure 4.12 for more details). People who are moving from other U.S. states and Texas counties may not be familiar with flood zones and the measures they need to take to protect themselves and their properties from flash floods. Furthermore, they often do not know where to find flood information that is tailored to their new neighborhood. To reach new residents, we first needed to understand what platforms or resources they use when moving to a new area. We came across several websites that advise incoming residents how to adjust to their new neighborhoods. Libraries, chambers of commerce, and churches are oftentimes the first places residents visit to make new friends, join free community groups, learn about local events, or find activities for their children (Bartolone, 2019). Therefore, it might be helpful to utilize their social media pages to communicate with new residents. Hard-copy brochures could also be distributed throughout city hall, library branches, chambers of commerce, tourist centers, and places of worship.

People new to an area also need to start mapping out a daily routine in their new neighborhoods, such as locating a bank (to open a new bank account), a post office (to change their mailing address), the Department of Motor Vehicles (DMV) office (to get a new driver's license or update their voter registration), service providers (to transfer water or power utilities to their new home address, to set up their internet or television), an insurance agent's office (to buy homeowner's insurance), a nearby gym (to continue their workout regimen), a family doctor and pharmacy (in case they or their family gets ill or injured), and a veterinarian (to take care of their pets; e.g., Bartolone, 2019; Greenfield, 2015; Patterson, 2020; Ryan, 2020). Oftentimes, the post office sends new residents a "Change of Address Welcome Kit" that confirms the customer's new address and provides them with helpful information about their new community (e.g., coupons or special offers for local businesses). It might be helpful to include a flood flyer or postcard in this Welcome Kit.

Presenting simplified information about flooding on utility bills can also be a good way to help newcomers understand their risk. This strategy equals an informational "nudge" as studied in behavioral economics and policy literature — i.e., a small change in people's decision environment that can influence behavior by respecting freedom of choice (Carlsson et al., 2021; Ruokamo et al., 2022; Thaler & Sunstein, 2009). Rendering information salient and reducing people's costs to search for information themselves increase the likelihood for people to pay attention to recommendations and take preventive actions. Although the evidence to support this claim is mixed (Carlsson et al., 2021), some field experiments show that this type of nudging can be effective in changing behavior, depending on information content, delivery mode, and iteration (Ruokamo et al., 2022). Presenting visual heuristics can also be helpful (Cooke, 2014, February 8). Overall, there are good reasons to consider that salient, simple, and visual messages — occurring once or multiple times — can be effective in helping newcomers.

Community Facebook groups (Lopez, 2021) — such as Facebook Neighborhoods (currently only available in Canada and a few U.S. cities) — or applications like Nextdoor (see also McLaughlin, n.d.) and BuyNothing, can also be vital resources for residents to connect with their neighbors and ask about neighborhood events, home repair or maintenance issues, and safety concerns. Lopez (2021) also recommended that new residents review their local newspaper or magazine — whether it is online or in print — to learn more about small businesses in the

neighborhood, school districts, and local farmer's markets. For example, Community Impact is a free newspaper that offers hyperlocal news and information to residents and businesses every day online and every month by mail. Hence, these hyperlocal platforms can all be utilized for outreach to people moving into a new area.

It is important to consider that access to some mobile phone applications is restricted for newcomers to the U.S. For example, Google Play determines the type of content available according to each country. Newcomers must wait 12 months after initially creating a payment profile before they can change the country where they live on Google Play, and they can only do so once a year (Google Play Help, 2023). If they wish to keep their account from their home country, they will not have access to content in the United States. While apps like NOAA's Clime or The Weather Channel can be downloaded from a phone with a system based in Mexico, the FEMA app cannot, as shown in the following image (see Figure 11.2 below).

Figure 11.2 Google Play's FEMA App for Newcomers
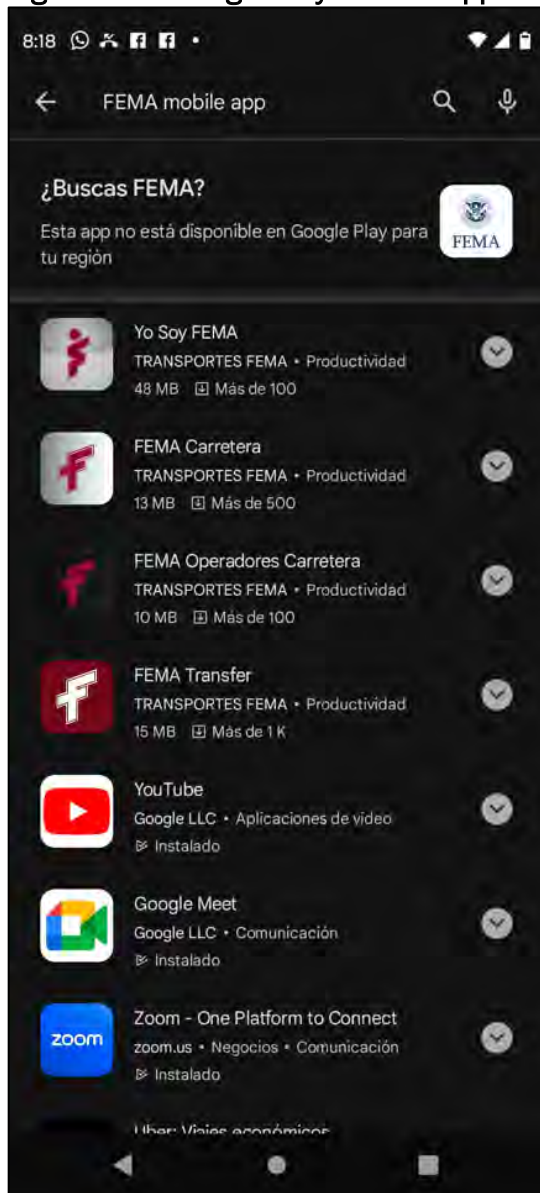
Figure Information: The image shows the result of a search for the FEMA app from the phone of a newcomer from Mexico living living in the United States for less than 12 months. "¿Buscas FEMA? Esta app no está disponible en Google Play para tu region" translates to "Are you looking for FEMA? This app is not available in Google Play for your region." This suggests newcomers need to live in the U.S. for some time before they can have access to this FEMA app. *Source: https://play.google.com/store/apps?hl=en_US&gl=US*

The persona for the end-user group of newcomers to Texas is seen in Figure 11.3 below.

Figure 11.3 Persona for New Residents Moving Into Flash Flood Alley
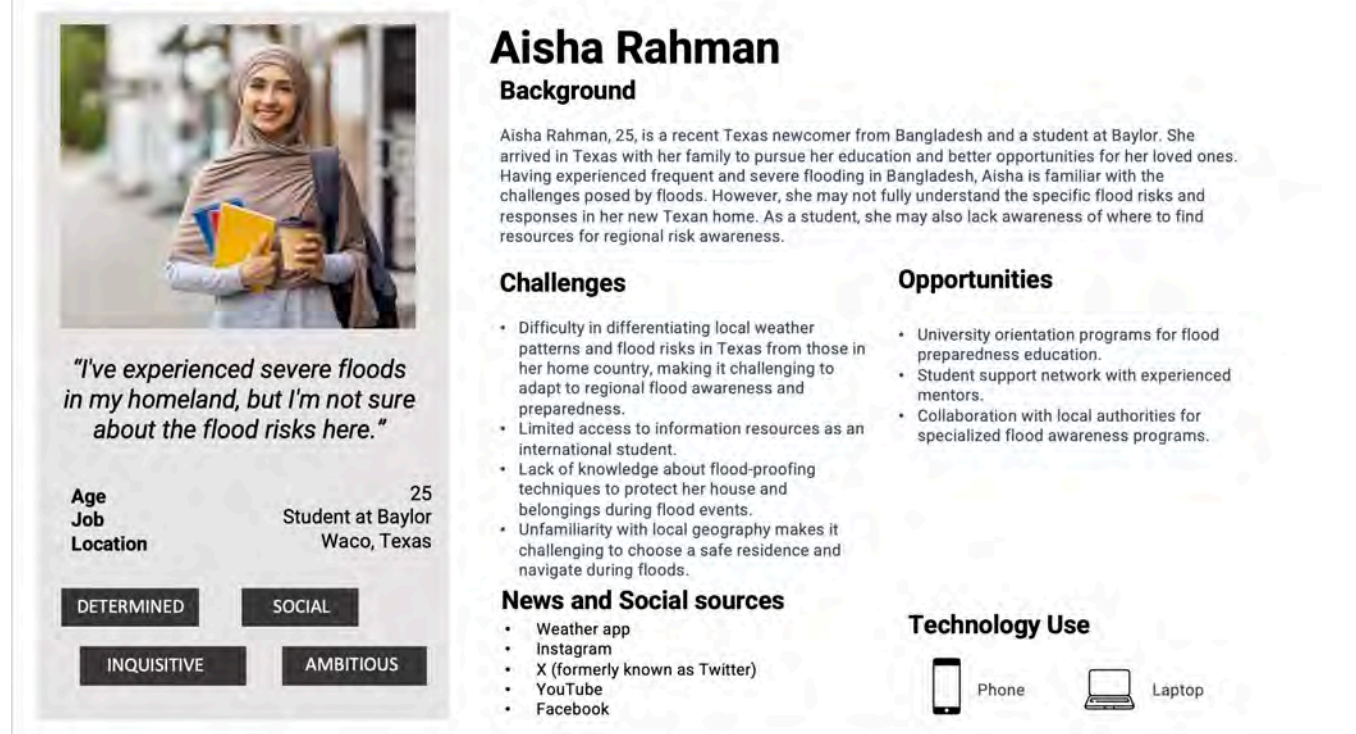
Figure Information: Persona of a newcomer, Aisha, who had experienced flooding in her previous home, but is unaware of the regional flood risks in her new city of Waco, Texas.

Survey Data. The survey data from the Texas-wide survey confirms that this prioritized end-user group has specific needs around flood awareness. While the data also suggest that people in Flash Flood Alley have lower risk perception, newcomers in general—not only those in Flash Flood Alley—may benefit from the messages designed in this project.

There were 99 people in the dataset (9.1%) who have lived in Texas for less than 1 year. These newcomers believe they have a **higher probability** of risk from floods (M = 2.69, SD = 0.91; on a scale of 1-7) than people with a longer tenure in Texas (M = 2.49, SD = 0.96). They also report significantly **lower** perceived understanding of what the term "flash-flood" means (M = 5.67, SD = 1.5), vs (M = 5.90, SD. 1.27) than others with longer tenure in Texas. Finally, when asked to rate their current knowledge of floods on a scale of 0 to 100, they rate their **knowledge of floods lower** (M = 64.53, SD = 26.27) than people with a longer tenure (M = 71.39, SD = 22.67). Furthermore, there is evidence that these newcomers might be receptive to receiving flood information because they say their need for this information is around 75.6 on that 100-point scale; a rating similar to people with a longer tenure in Texas. Having a 10-point discrepancy in the amount of knowledge people believe they have and believe they need is a striking difference not often seen in these types of studies.

Of those 99 newcomers, 41.4% (*n* = 41) are living in coastal zip codes, 27.3% (*n* = 27) in Flash Flood Alley zip codes, and 31.3% (*n* = 31) in other zip codes in the state. The age of this newcomer sample is younger than the full sample (M = 40, with a M = 47 in the full sample), there is a higher percentage of women (65%), a higher percentage of people who are Black (21%), and a higher percentage of renters (75.3%).

When asked to characterize the community they lived in before, most reported having lived in an inland community 52.5% (*n* = 52). Before they moved 58.6% (*n* = 58) said they did not consider the impact a flood could have on their home, and after they moved, 71.7% (*n* = 71) said they had not heard any information about flooding in their new area. Roughly half of these newcomers said that disclosure that their property is in a flood hazard area would have influenced their decision to buy or rent a home.

11.1.5   Young Male Drivers Aged Between 18-35

Young males are usually at higher risk of driving through floodwaters. Studies have shown that they most frequently engage in active behaviors (i.e., deliberately decide to interact with floodwaters) because of their risk-taking attitudes and emergency sector-related jobs (Diakakis, 2020; Harris et al., 2006; Špitalar et al., 2020). This accounts for a higher number of vehicle-related flood fatalities in Texas (e.g., Maples & Tiefenbacher, 2009), and is the reason why targeting messages to this group is key (Han & Sharif, 2020). Younger males are also vulnerable because they lack insurance and disaster experience (Edey et al., 2022; Ponstingel et al., 2019).

Communicating serious messages in today's diverse media environment is challenging when it comes to seeking flood risk or flood awareness information. However, certain insights can help us understand which channels people might use to seek flood-awareness information. For instance, recent analyses indicate that while individuals often search for information on lifestyle, celebrities, and sports, they are also interested in hard topics such as politics, social issues, crime, public safety, mental health, and practical COVID-19 updates. Interestingly, traffic, transportation, and weather are the subjects most consistently followed by at least 21% of the Millennial and Gen Z populations, with variations based on educational attainment (Media Insight Project, 2022, November 17; see Figure 11.4 for the persona for this end-user group).

Local TV remains the primary traditional news source for 36% of Americans who most frequently seek news about traffic and weather (Media Insight Project, 2022, November 17). However, the landscape for television is evolving, as overall news consumption has seen a significant shift towards digital platforms, especially in the wake of the pandemic. In 2022, 82% of U.S. adults accessed news via a digital device at least occasionally, favoring them over radio or print publications (Pew Research Center, 2022, September 20a). A mere 9% of individuals between the ages of 18 and 29 prefer television for news, with a staggering 81% favoring **digital devices** (Pew Research Center, 2022, September 20a).

For individuals over 30 and those with higher education and income levels, news websites or apps remain the preferred choices. However, there has been a slight decline in this preference since 2020. In contrast, younger Americans are more inclined towards social media over news websites. This preference for social media as a news source has seen a slight uptick in the past two years (Pew Research Center, 2022, September 20a). Specifically, 31% of adults regularly turn to Facebook for news. Though X (formerly known as Twitter) has a smaller audience base, it held the position as the most frequently used app for news until 2022, prior to its transformation into X. A quarter of U.S. adults consistently source their news from YouTube. In comparison, only 13% use Instagram, 10% turn to TikTok, and 8% favor Reddit (Pew Research Center, 2022, September 20b).

Teenagers arguably exhibit the most significant variation in digital media preferences over time. In 2014, Facebook was their platform of choice. However, by 2022, YouTube, TikTok, Instagram, and Snapchat had considerably surpassed Facebook in terms of usage. X (formerly known as Twitter), WhatsApp, and Tumblr registered even lower usage than Facebook in that year. It is worth noting that in 2022, 95% of teenagers in the U.S. had access to a smartphone, engaged with the Internet daily, and over half (54%) believed it would be challenging to relinquish social media. That said, there are distinct demographic differences in platform preferences. Males gravitate more towards YouTube, Twitch, and Reddit, while females predominantly use TikTok, Instagram, and Snapchat. Additionally, TikTok, Instagram, X (formerly known as Twitter), and WhatsApp sees higher usage rates among Black and Hispanic teens (Vogels et al., 2022).

Figure 11.4 Persona for Young Male Drivers Aged Between 18-35
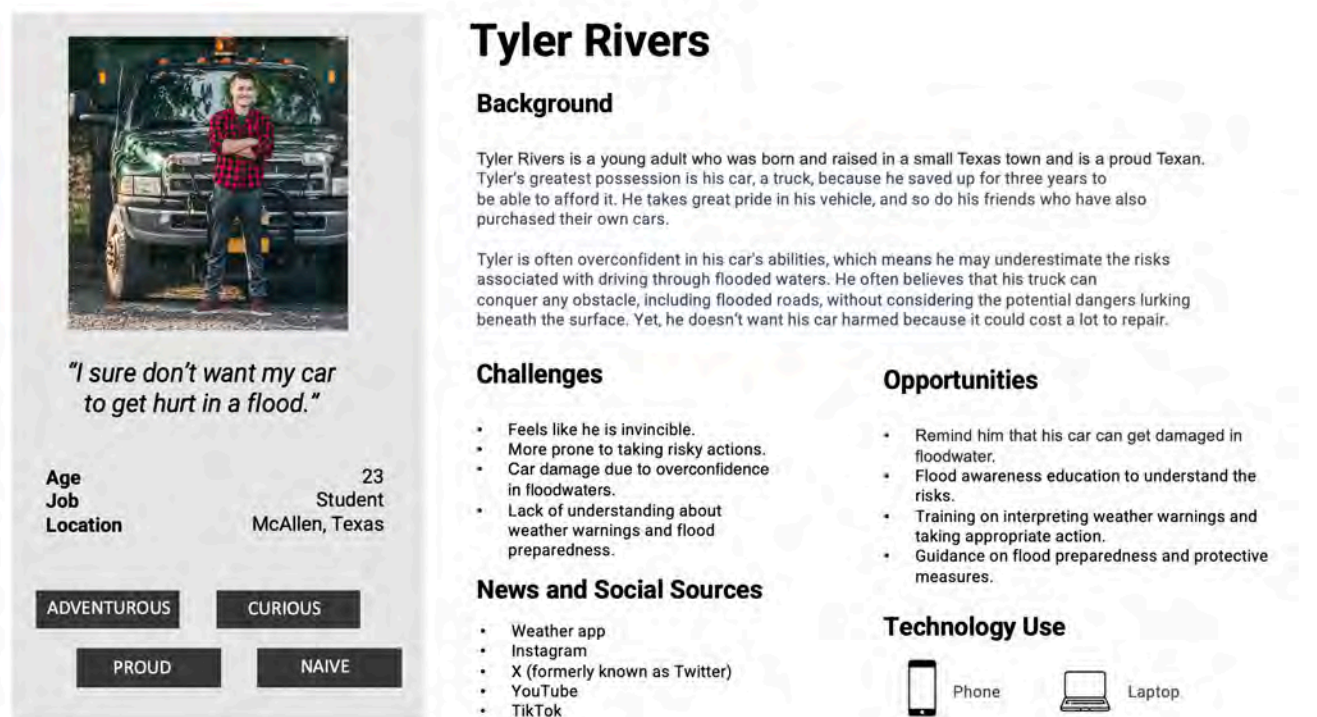
Figure Information: The persona for the young adult male was developed through our research and it includes Tyler's personal story and educational needs.

Survey Data. The survey data from the Texas-wide survey confirmed that this prioritized end-user group has specific needs around flood awareness, but it also suggests that young-adult women may also benefit from receiving flood awareness messages.

When comparing the three age categories—18-35, 36-64, and 65 and up—younger adults perceive the risk of floods (M = 2.71) to be higher than the middle age category (M = 2.55) or the older adult category (M = 2.16). Knowledge around flooding increases with age ranging from the younger adults (M = 62.24 on a 100-point scale) to older adults (M = 77.36). **However, younger adults do not believe they need as much information to be ready to handle floods** (M = 68.96) than middle aged people (M = 78.47) or older adults (M = 79.67). These findings also speak to the importance of flood awareness and education.

Young-Adult Men

In this sample, we had 132 participants who were male and between the ages of 18-35. When comparing young men and young-adult women (*n* = 188) on risk perception, flood knowledge, and driving behavior, we found **almost no significant differences**. There were no differences on risk perception and perceived flood knowledge, and the only difference in driving behavior is that young-adult men report driving more miles than young adult women (this was a categorical measure, so the means are not helpful). Furthermore, while both groups could be more knowledgeable about how floods happen, there were no significant differences in their accuracy in answering the actual knowledge questions. While there could be more subtle differences in the full dataset, and detailed message focus groups would be needed to confirm our conclusions, these findings suggest that the messages designed for young-adult men may also work well for young-adult women.

11.1.6   Older Adults With Disabilities

Older adults with disabilities frequently have low risk perception consistent with lack of preparation and preventive behavior. Oftentimes they dismiss weather-related and flood risks because these issues are not as salient as troublesome life experiences (e.g., lacking social or financial support, memory loss) (e.g., Abrahamson et al., 2008; Walkling & Haworth, 2020). They depend on others and sometimes inhabit assisted living facilities, which might explain why some older adults have a low perception of control. Helping older adults with disabilities surmount these challenges and take protective action is important to reduce their risk, and there are several strategies to do so.

The utilization of technology among older adults in the United States displays significant variation based on sociodemographic and health characteristics. According to data from the U.S. Census Bureau, more than 40 million individuals in the country are living with a disability. However, a noticeable digital divide exists between older adults with disabilities and those without. Many older adults face physical or health challenges that impede their adoption of new technologies (Smith, 2014). This particular group is notably less likely than older adults without physical or health challenges to engage in online activities (49% versus 66%), have broadband internet access at home (38% versus 53%), or own common digital devices (Smith, 2014). According to a 2021 survey by the Pew Research Center, 62% of adults with disabilities own a desktop or laptop, as opposed to 81% of adults without disabilities (Perrin et al., 2021). In fact, the level of internet use among older adults with disabilities is lower than older adults without disabilities (Yang et al., 2022). Operational skills regarding mobile devices, internet use skills, motivation to use digital devices, and attitudes towards new technology is also lower among older adults with disabilities (Yang et al., 2022). Some websites and mobile application designs and functions are less intuitive for older adults with disabilities, which can cause them to use the internet less (Baumgartner et al., 2023; Yang et al., 2022). There is also a lack of knowledge and confidence in using new technologies. In Baumgartner and colleagues' (2023) study, older adults with disabilities found new technologies and devices to be complex and highly time-consuming to learn.

Interestingly, the only age demographic still indicating a preference for television as their primary news source is those over 65 (Pew Research Center, 2022, September 20a). Other forms of media usage, such as print newspapers, played a vital role for people with hearing impairments but were less important to people with learning, visual, and motor impairments (Baumgartner et al., 2023).

The Federal Emergency Management Agency (FEMA) has recently launched a targeted campaign for older adults in September of 2023 (see their [website](#) for more details). As part of our focus group research, we tested these materials by printing the FEMA emergency kit and preparation instructions, in 14-point font, and delivered a workshop to a Senior Living Facility, Brookdale, in Austin, Texas. We had nine people attend. One person just moved to Austin from the San Francisco Bay Area of California three months ago, and three other people had lived in Austin for less than 1 year. Their kids moved them to Brookdale, a location close to where they live. Therefore, four of the nine participants were newcomers in the room. They commented that they were not familiar with the different kinds of weather issues happening in Texas, so they were glad to learn more about them.

They looked at our overall message, "Texans Fight Floods, Together," and said, "That fits with what I've heard about Texas. Lots of pride, and they think they are better than other places." The Texans said it looked good with little other comments. The message highlights strategies for preventing flood-related impacts on the daily lives of Texans. By using the slogan "Texans Fight Floods, Together," it centers Texas culture in the messaging. This mirrors other Texas-related slogans, such as "Don't Mess with Texas," reinforcing state pride in addressing a universal challenge like flooding.

The FEMA workbook for older adults was too overwhelming (which our team had suspected and adjusted how to use it in advance), and the large font size was important. Participants commented that the instructions were too long and detailed and they wanted us to help them prioritize what was most important. During the focus group, we discussed the importance of having some bottled water, a couple of cans of pop-top food, lists of their medication, a pin drive (they didn't know what that was) with their important documents that their family members are holding for them, a flashlight, and an extra cell phone battery charger. They had not heard of the battery chargers, so we discussed it extensively. They also mentioned that less than half the people in the facility have their own personal cell phone, which we had anticipated. This was due to cost and capability to handle a cell phone. One person mentioned she could not remember to keep her phone charged, so we talked about ways to routinize device charging and other preparation-related activities.

Our team stressed having bi-directional conversations with friends and family and suggested they initiate those conversation about being prepared for disasters and explain that they attended a session learning about this. We suggested they say things like, "Let's compare what you have prepared to what I have prepared and let's be sure we know who our primary contacts will be." We even suggested that if they have friends at Brookdale who do not have a cell phone, and they did, they might agree to be one of their contacts and use their own cell phone to contact their friend's loved ones for them.

This focus group/training was important for this project for several reasons. First, it helped us shape a message for this target audience that focuses on not being overwhelmed with getting prepared (see section 17.3 for a description of our "Take 5 Prep 5" message). Second, we realized the target audience needs to be older adults living independently, not those residing in formal living centers. While our messaging should be good for both of these audiences, after conducting a total of 12 interviews with older adults in senior living facilities, we learned that they often have limited control over their own environment and they rely on others to care for them. For example, their medicine is not with them, but instead housed in a central location and someone brings their medicine to them as needed. Our subsequent focus groups with six participants living independently confirmed they are the ideal end-user group to prioritize, and the designed message resonates well with them.

Therefore, see Figure 11.5 for our persona for this end-user group, older adults with disabilities.

Figure 11.5 Persona for Older Adults With Disabilities
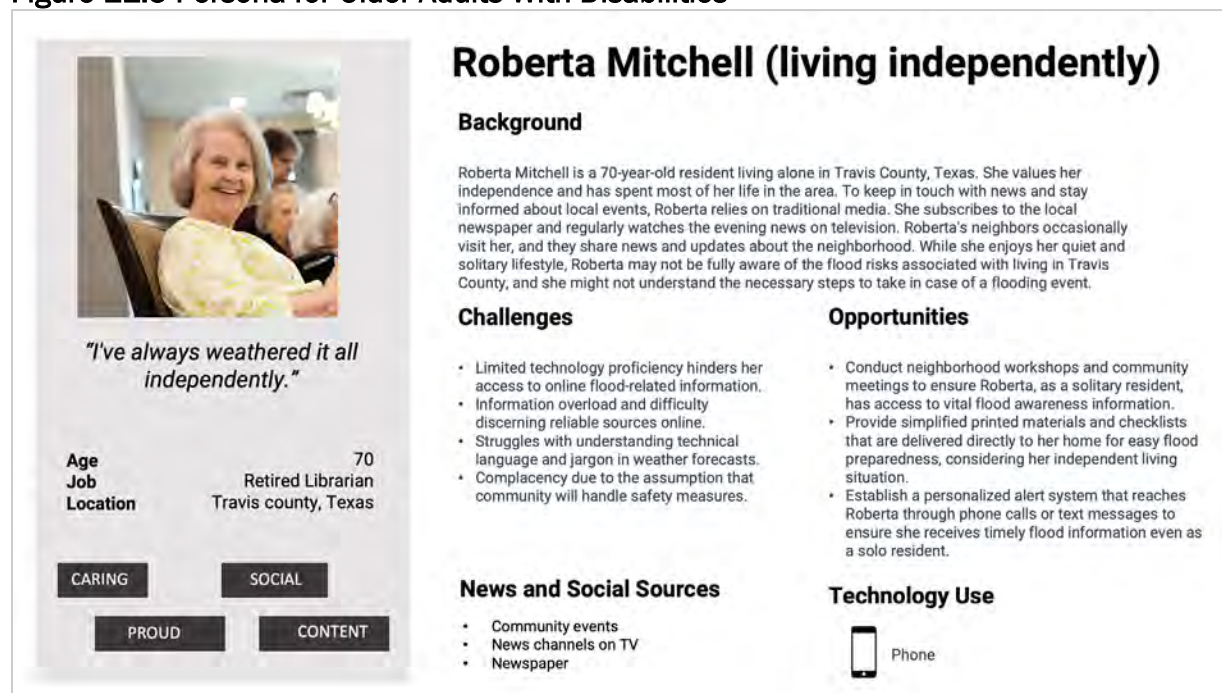
Figure Information: The persona for older adults with disabilities depicts Roberta's preferences.

Survey Data. The survey data from the Texas-wide survey shed considerable light on the differences between flood knowledge and perceptions when people are over 65. Sixty-one participants who were over the age of 65 considered themselves to have a disability. This sample was 77% ($n = 47$) male, had an average age of 71.2 (with a range of 65 to 90), and was over 70% White. Only 14.8% ($n = 9$) of this sample had a caregiver, and 39.3% ($n = 24$) had a health problem that required the use of a cane, wheelchair, a special bed, or a special telephone. Only 37.7% ($n = 23$) had heard of STEAR, 41% ($n = 25$) said they would need help if they needed to evacuate in a flood, and of those people, all but 2 said they would have someone to help them evacuate.

While this is a small sample, and it is difficult to make broad claims from these data, the findings indicate a few practical differences between older people with a disability and older people in general. Additionally, the data suggest that we should be able to focus our flood awareness messages on older adults, in general, because as people age, they often have a mobility disability. It would be ideal to reach older adults with these targeted messages and help them become prepared for floods before they need help to evacuate. While we recommend more research on older adults with disabilities, they are a difficult population to reach.

11.2   Key Themes Used for Outreach

Figure 11.6 contains an overview of the final versions of the messages and graphics developed for the TWDB Flood Awareness Campaign. In the following section we elaborate more on each of these key themes.

Figure 11.6 Messages and Core Graphics in the TWDB Flood Awareness Campaign

Figure Information: Overview of all the major graphics in English. Note that Spanish versions are also available in the toolkits.

We formulated the central theme, "Texans Fight Floods, Together," to reflect public messages that emphasize flood prevention and education in Texas. By weaving Texas culture into our messaging, especially with "Texans Fight Floods, Together," we underscore the joint initiatives of state leaders and the community in flood safety, education, and prevention. Our July 12, 2023 online discussion with TWDB highlighted the success of iterative message testing, especially in Texas where messages incorporated local culture, like "Don't Mess with Texas." Drawing inspiration from "Don't Mess with Texas," our team crafted the targeted theme "Texans Fight Floods, Together." This central theme underscores the power of messages that resonate with Texans, driving them toward optimal flood prevention decision-making. Along with this central theme, we evaluated various messages tailored for our target user groups. This approach ensures that all groups, including newcomers, independent-living seniors, young-adult men, the Spanish-speaking population, can meaningfully engage with flood prevention data and resources.

11.2.1 Targeted to the General Texas Audience

We tested several different iterations of "Texans Fight Floods, Together" (see Figure 11.7), changing color, design, and word choices. In the process of iterative message testing in the field with potential end-user groups in the Upper and Lower Rio Grande Valley (RGV), several key findings emerged. The slogan "Texans Fight Floods," conveying a sense of community and collaboration, resonated positively among participants. Focus group participants did, however, express concerns about the graphics, with some perceiving the red and blue graphic (Figure 11.7 a.) as having political connotations. Additionally, participants did not think Figure 11.7 (b.) fully represented their region because of the space between the LRGV and the rest of the state, but they did appreciate the inclusion of the lone star and the concept of "home." Interestingly, no participants associated the slogan with political notions. To be more inclusive of the LRGV, we modified the spacing of the line in Figures 11.7 (d.-m.), and this adjustment was generally well-received among people from the region. Participants also thought the blue color symbolized water but felt that the dark blue in Figure 11.7 (c.) conveyed a higher flood risk. We modified the graphic using a single shade of blue to symbolize unity across the state (Figures 11.7 f., h., i., j., k., l., and m.).

We also tested different translated versions of "Texans Fight Floods," including "Tejanos contra los inundaciones" ("Texans Against Floods"), "Los Tejanos pelean contra las inundaciones" ("Texans Fight Against Floods"), and "Tejanos peleando contra las inundaciones" ("Texans Fighting Against Floods"). Participants unanimously agreed on the first version, "Tejanos contra los inundaciones" (Figures 11.7 g.-h.). To convey a positive sense of community and unity, we added the word "Together" (see the final English iteration, Figure 11.7 i.). For the equivalent Spanish message, we tried the word "juntos" (see Figure 11.7 j.), and decided to go with the word "unidos" ("united") to convey a more precise meaning of unity in Spanish (see Figure 11.7 k.).

Figure 11.7 (l.) was designed after receiving feedback from TWDB in December of 2023. It showcases multiple swooshes (i.e., lines or waves) across the state shape. While we have not tested this graphic in focus groups, we have provided it here in case TWDB or another organization would like to test it in the future. The final Spanish iteration (see Figure 11.7 m.) was designed after receiving a suggestion from TWDB in February 2024 that we substitute the word, "Texanos" for the word "Tejanos." According to the Spanish Royal Academy of Language, both "Tejas/Tejanos" and "Texas/Texanos" are correct translations of "Texas/Texans." However, using an "x" in the translation is more culturally relevant for the Spanish speakers in Texas since they are more influenced by Mexican Spanish speakers. The phonetics of the words "Mexico/Mexicanos" and "Texas/Texanos" are indeed more similar.

Figure 11.7 Design Evolution of "Texans Fight Floods, Together"

a.

Figure Information: An iteration of our English message "Texans Fight Floods." Focus group participants perceived the blue and red colors to be political.

b.

Figure Information: An iteration of our English message "Texans Fight Floods." We added both the "lone star" and "home" elements.

c.

Figure Information: An iteration of our English message "Texans Fight Floods." Focus group participants thought the darker shade of blue meant a higher flood risk.

d.

Figure Information: An iteration of our English message "Texans Fight Floods." To differ from Figure 3.1 (b.), we adjusted the spacing of the line.

e.

Figure Information: An iteration of our English message "Texans Fight Floods." This graphic is a similar iteration of Figure (d.).

f.

Figure Information: An iteration of our English message "Texans Fight Floods." We decided to make the graphic a single shade of blue.

g.

Figure Information: The Spanish version of the same English iteration, Figure (e.).

h.

Figure Information: The Spanish version of the same English iteration, Figure (f.).

i.

Figure Information: The final English iteration using the word "Together."

j.

Figure Information: The design using the word "juntos."

k.

Figure Information: Another Spanish iteration using the word "unidos."

l.

Figure Information: One additional iteration, not tested, but suggested by TWDB during December, 2023 meeting.

m.

Figure Information: The final Spanish iteration, not tested, but suggested by TWDB in an earlier version of this report.

11.2.2 Targeted to Newcomers

Creating a message like "Check your Flood Risk" showed great promise in our focus group testing (see Figure 11.8 below). This message is designed to encourage information-seeking as a decision, and it sparked curiosity from almost every participant. The graphic idea, which features a house damaged by floods, resonated with the focus group participants and invoked a sense of urgency to take action. The participants also suggested adding a website link or QR code to the phrase. This would enhance the message's effectiveness by pointing end-users in the right direction for flood risk information. Along with the graphic, we have included www.texasFLOOD.org as the source of information. In the future there could be a QR code added to this graphic, or a combination of the QR code and URL. These resources can be customized for various geographic audiences — e.g., "Waco Residents, Check Your Flood Risk" — making it a valuable tool in flood risk awareness and prevention efforts. For Spanish-speaking populations living in Texas, the message "Revisa tu riesgo de inundación" could be paired with resources that are culturally tailored to these groups. We have created the graphic iteration in Spanish as well (see Figure 11.8 i.).

Figure 11.8 Different Message Iterations of "Check Your Flood Risk"

a.

Figure Information: Depicts iterative testing of the potential efficacy of website links in piquing participants' curiosity to access further information about flood risk.

b.

Figure Information: Depicts iterative testing of the potential efficacy of QR codes in piquing participants' curiosity to access further information about flood risk.

c.

Figure Information: Illustrates one of our design iterations of the message "Check Your Flood Risk."

d.

Figure Information: Illustrates one of our design iterations of the message "Check Your Flood Risk."

e.

Figure Information: Illustrates one of our design iterations of the message "Check Your Flood Risk."

f.

Figure Information: Illustrates one of our design iterations of the message "Check Your Flood Risk."

g.

Figure Information: Illustrates another design iteration for "Check Your Flood Risk."

h.

Figure Information: The final English iteration of "Check Your Flood Risk."

i.

Figure Information: The final Spanish iteration of "Revisa tu riesgo de inundación."

11.2.3 Targeted to Young Male Drivers Between 18 and 35

After extensive iterations, we determined the message, "Keep Your Car High and Dry," resonates with young-adult male drivers. This message aims to discourage men from driving through floodwaters. It highlights the benefits of preventing vehicle damage, saving lives, and avoiding financial losses due to flooding. Our study found that men primarily receive information from social media and mass media.

We have included the different iterations of the developed "Keep Your Car High and Dry" graphic in Figure 11.9. During focus group sessions in the LRGV, participants thought the water in version (a.) looked like a beach. They also found the water level in version (a.) unclear or too deep. This led us to make versions (b.) and (c.). We tested graphics (b.) and (c.) in our end-user group focus groups. Overall, participants preferred a red car over a green one because red symbolizes danger and is more attention-grabbing. End-user groups have also reported liking the clouds and rain because these weather symbols provide context, such that severe rain can lead to flooded roads. Because it is considerably more expensive to produce print materials in multiple colors, Figure (d.) is a later design iteration using a single color (blue) that is uniform with the other graphics designed for other end-user groups. We also made the depth of the water appear deeper below the car. Because there are Spanish versions of all the outreach materials, we also created a graphic for the Spanish equivalent message of "Keep Your Car High and Dry" — "Mantén tu carro elevado y seco" (see Figure 11.9 e.).

Figure 11.9 Different Message Iterations of "Keep Your Car High and Dry"

a.

Figure Information: Focus group participants perceived the water level to be either unclear or too deep in this iteration of "Keep Your Car High and Dry."

b.

Figure Information: Focus group participants offered positive comments about the rain and cloud details.

KEEP YOUR CAR HIGH
AND DRY

c.

Figure Information: Focus group participants preferred the red car in Figure (b.) more than the green car in this iteration of "Keep Your Car High and Dry."

KEEP YOUR CAR
HIGH AND DRY

d.

Figure Information: The final English iteration of "Keep Your Car High and Dry" using a single color.

Figure Information: The final Spanish iteration of "Mantén tu carro elevado y seco."

11.2.4 Targeted to Older Adults With Disabilities

The message "Take 5 Prep 5" is a focused and compassionate approach to encourage older individuals to prepare their emergency kits (see Figure 11.10 a. and b. for the two English design iterations). In the development of this message, we recognized the unique needs and challenges faced by older people during emergencies. This message empowers them by providing a handy checklist that encourages taking only 5 minutes to prioritize their top 5 most essential items for their safety and well-being, and then taking 5 more minutes later to continue identify items they need to prepare. The initial 5 items could include food, water, important documents, communication devices, and medications. By simplifying the process and acknowledging that not everything may be possible to take, the message aims to alleviate stress and ensure older individuals can access the critical items they value most in times of crisis. This message, designed as a social communication tool, serves to create awareness about the importance of building an emergency preparedness kit tailored to the specific needs of older adults, fostering a sense of self-reliance and resilience in the face of adversity. We also created a graphic for the Spanish equivalent of "Take 5 Prep 5" — "Toma 5 prepara 5" (see Figure 11.10 c.). This project included limited testing of the final graphic in both the English and Spanish messages.

Figure 11.10 Graphics for "Take 5 Prep 5"

a.

Figure Information: The first iteration of "Take 5 Prep 5."

b.

Figure Information: The final English iteration of "Take 5 Prep 5." The 5 items include food, water, important documents, communication devices, and medications.

c.
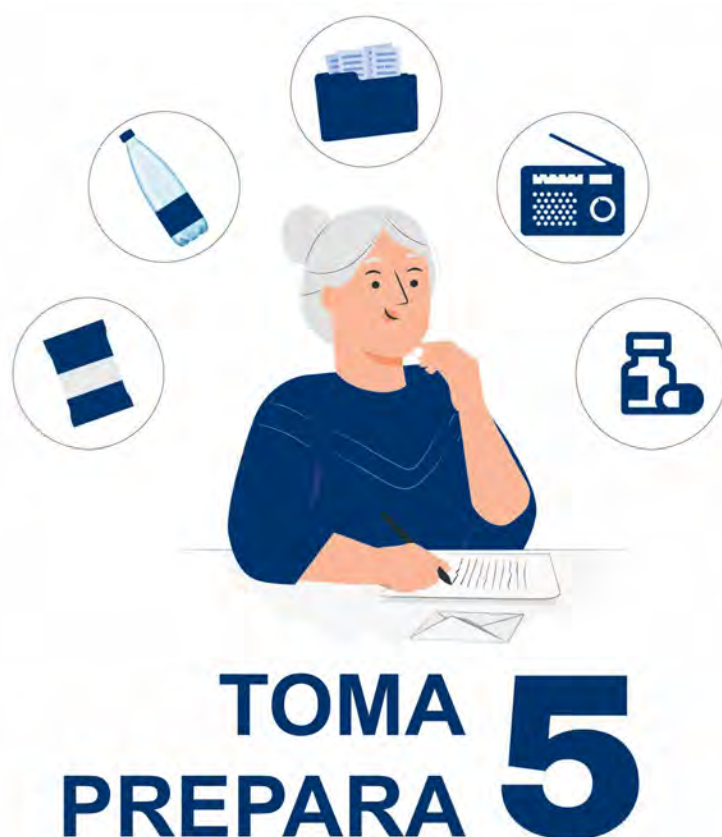
Figure Information: The final Spanish iteration of "Toma 5 prepara 5."

11.4   Longer Format for Messaging

In addition to the graphics and concise message formats designed for each of the prioritized end-user groups, we also developed a longer format brochure called "The Sandbag Story" ("El cuento de los sacos de arena" in Spanish). It is a longer message presented in narrative style and it is appropriate for all audiences. This brochure was adapted from another project, funded by IC^2 at UT Austin, that focused on small business owners. With that project we conducted over 50 interviews and focus groups to develop this content, and we printed these brochures and delivered them to the interview participants, fire stations, and several local Chambers of Commerce. We provide a copy of that brochure here (see Figure 11.11), and a more detailed overview of "The Sandbag Story" in Part 3 of this report.

Figure 11.11 Graphics for the Longer Format Brochure "The Sandbag Story"

English

Misconception about sandbags
- Sandbags do not keep water out, they only slow its entry into your home.

Best usage
- Sandbags offer greater protection against moving water.

Know your sandbag distribution center
- Counties, cities, and municipalities each have their own method of distributing sandbags. Know who is responsible for sandbag distribution in your area.

- Know how many sandbags are offered per household. This number may not be enough to cover all your home entries. Plan accordingly.

Know your home's flood history
- Have sandbags ready if you live in a flood prone area. You may not be able to get them during an unexpected event.

Sandbag usage

- Know how to properly stack sandbags.
- Dispose of sandbags if they were used during a flood.
- If any sandbags were not used, you can store them in dark trash bags or dark bins for future use.

Contactos importantes | Important contacts

9-1-1
Para emergencias. Puede requerir una llamada para solicitar ayuda policial, de bomberos o para una urgencia médica.

For emergencies. A call may be necessary for situations where law enforcement, firefighters, or medical help is needed immediately.

3-1-1
Para situaciones no urgentes. Puede requerir una llamada en situaciones que no son una emergencia, por ejemplo, un semáforo roto.

For non-emergencies. A call may be necessary for situations that do not warrant an emergency response, such as a broken traffic light.

2-1-1
Para obtener información sobre la comunidad y los servicios sociales locales. Por ejemplo, dispensarios de alimentos y lo que puede hacer durante un desastre.

For information on the local community, social services, such as food pantries, and what you can do in a disaster.

Sitios web del condado | County Websites
Add County/City name here
Add URL for the County/City

Numeros del condado | County Numbers
County: 1-XXX-XXX-XXXX

El cuento de los sacos de arena | The Sandbag Story

El evento de lluvia | The rain event

Una tormenta de lluvia precipitó varias pulgadas de agua en muy poco tiempo. An unexpected rainstorm poured several inches of rain in a short amount of time.

La preocupación | The worry

Sandy se preocupó porque el agua podía inundar su hogar. Sandy worried about water flooding her home.

Los sacos de arena | The sandbags

Sandy sabía que los sacos de arena podían retardar la entrada de agua si los llenaba a 2/3 de su capacidad y los ataba en la parte superior. Sandy knew that sandbags could help to slow down the entry of water if filled **2/3 full** and **tied at the top.**

Apilamiento | Stacking

Los sacos deben colocarse horizontalmente, escalonados como una pared de ladrillo y juntando los bordes. Se puede colocar una bolsa de plástico debajo antes de apilar para tener proteccion adicional. Bags should be placed horizontally along your home, staggered (like a brick wall). A plastic bag can be placed underneath before stacking for extra protection.

Preparada | Prepared

Afortunadamente, Sandy entendió su riesgo de inundacion y se preparó con anticipacion. ¡Tenía sacos de arena listos para proteger su hogar! Luckily, Sandy understood her flood risk and prepared ahead of time. She had sandbags ready to protect her home!

Uso de sacos de arena / Using sandbags

Español

Concepto erróneo sobre los sacos de arena
Los sacos de arena no mantienen el agua fuera, solo retardan su entrada al hogar.

Mejor uso
Los sacos de arena ofrecen mayor protección contra el agua en movimiento.

Conozca su centro de distribución de sacos de arena
- Cada uno de los condados, ciudades y municipios tiene su propio metodo de distribución de sacos de arena. Sepa quién es responsable de repartirlos.
- Sepa cuántos sacos de arena se ofrecen por hogar. Este número puede no ser suficiente para cubrir todas las entradas. Planifique en consecuencia.

Conozca el historial de inundaciones de su hogar
Tenga sacos de arena listos si sabe que está en una área propensa a inundarse. Es posible que no pueda obtenerlos durante un evento inesperado.

Uso de sacos de arena
- Aprenda a apilarlos correctamente.
- Deséchelos si ya se usaron durante una inundación.
- Si no se usaron, guárdelos en bolsas de basura oscuras o contenedores oscuros para uso posterior.

Figure Information: "The Sandbag Story" is written in Spanish first and English second.

Part 3: Communication Campaign Toolkit and Implementation Strategy

12   Part 3 Overview

Part 3 of this report outlines the development of the TWDB Flood Awareness Campaign consisting of the following specific toolkits:
1. General audience message: Texans Fight Floods, Together
2. Newcomers to Texas (especially in Flash Flood Alley) message: Check Your Flood Risk
3. Young-adult male drivers message: Keep Your Car High and Dry
4. Older adults (especially those with mobility disabilities) message: Take 5 Prep 5

Each toolkit contains editable and customizable graphics, suggested social media hashtags, and prepared example postcards and flyers for each of the messages. Copies of all graphics and toolkit materials are available for download here. There is also a brochure, called the Sandbag Story, suitable for distributing to a general audience. All materials are in English and Spanish.

Implementation Strategy: The strategy discussed in this part of the report includes a plan for the Texas Water Development Board (TWDB) and Texas communities to disseminate the toolkit materials across various media types, and throughout the calendar year, ensuring the messages reach the targeted audiences effectively.

13   Overview of the Campaign and Toolkits

Figure 13.1 provides an overview of the messages, graphics, and toolkits provided as part of this deliverable. For electronic copies of toolkit materials, you can find them here.

Figure 13.1 Overview of the Messages, Graphics, and Toolkits

TWDB Flood Awareness Campaign

TEXANS FIGHT FLOODS, TOGETHER

General Texas Audience Toolkit

CHECK YOUR FLOOD RISK www.texasflood.org

Newcomer to Texas Toolkit

KEEP YOUR CAR HIGH AND DRY

Young-Adult Males Toolkit

TAKE PREP 5

Older-Adult Toolkit
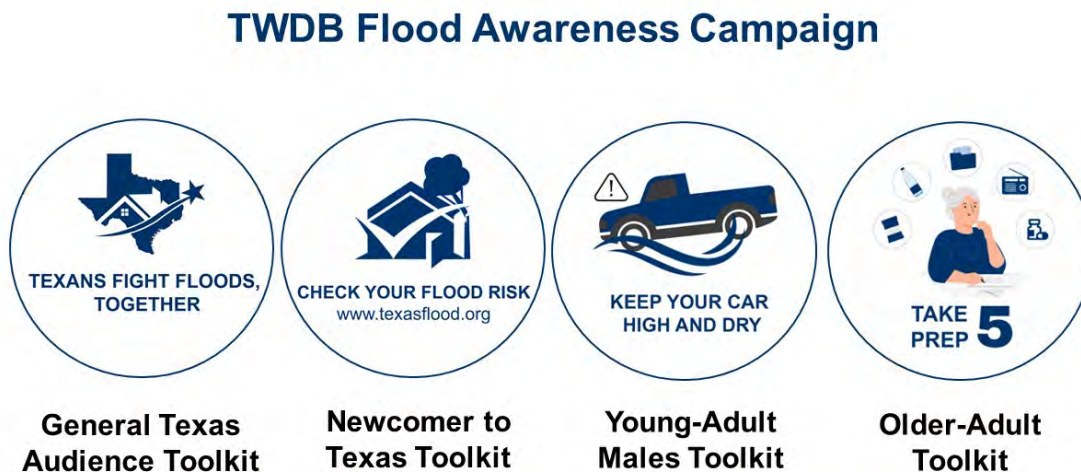
All toolkits contain English and Spanish versions and editable and customizable graphics. Also included: suggested timelines for distribution, media, social media hashtags, and postcards.

Blue color used is standard in PowerPoint: Hex #003366 (0 Red, 51 Green, 102 Blue). Font is Arial

Figure Information: All messages and toolkits are provided in English and Spanish.

The campaign, as a whole, unifies the messages targeted to the four prioritized end-user groups and the general audience. Figure 13.2 provides an overview of how the website can be constructed to contain the graphics and toolkits.

Figure 13.2 Website Structure for Campaign and Toolkits
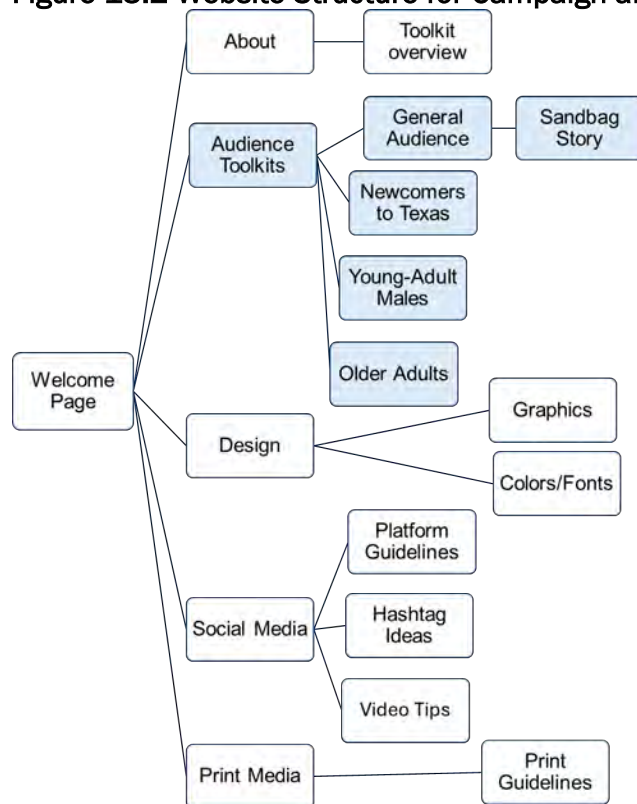
Figure Information: The toolkits are highlighted in blue.

Considering the goal of making these toolkits usable by a range of communities—even those without any graphics personnel—we chose a color of blue available as a standard choice in Microsoft PowerPoint and we provided the full color profile for designers who might want to do more with the graphics. We also used a standard font, Arial, that is available in most standard computer software programs. See Figure 13.3 for a copy of the instructions provided inside the postcard toolkits:

Figure 13.3 Instructions Provided Inside the Postcard Toolkits
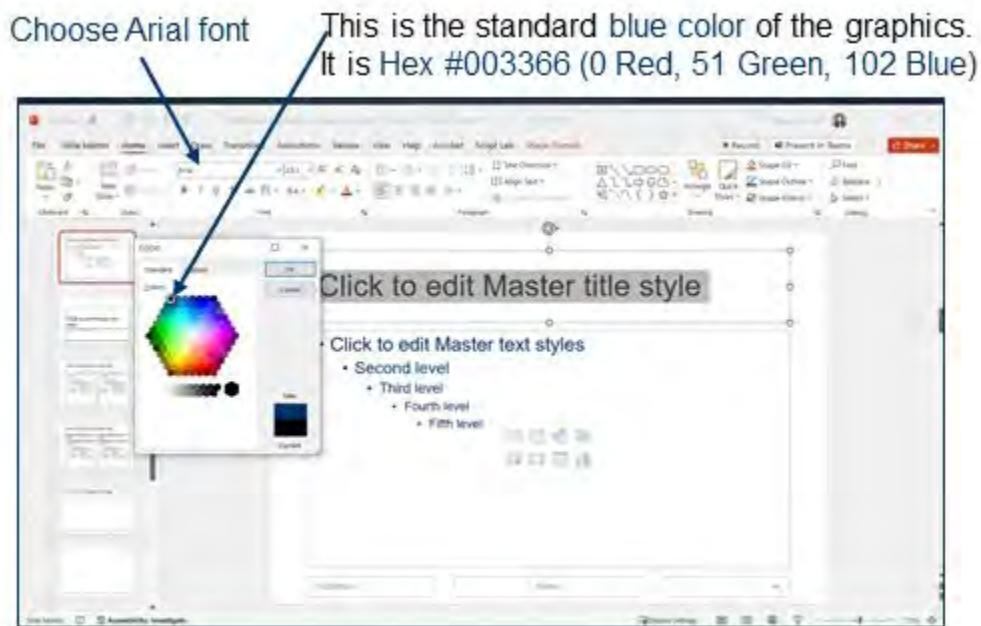
Figure Information: The graphics in the toolkits use standard color and font.

Each of the four toolkits contains the primary graphic, the primary concise message/slogan in English and Spanish, example postcards and flyers, including how to customize them, recommendations for social media hashtags, and suggested timelines for distributing each of the toolkits. Here is a link to all those graphics. Next, we share some overarching advice and guidelines when using social media to disseminate these messages. These tips for social media could appear in the community-portion of the website that TWDB creates on www.texasFLOOD.org, using the website structure we presented in Figure 13.2.

14   Advice for Using Social Media

Social media serves as a pivotal communication channel for reaching a broad and diverse audience quickly and effectively, which is crucial in disaster preparedness and response scenarios such as flood prevention. We have recommended using social media with each of the toolkits because it is the lowest cost way to reach audiences, and all prioritized end-user groups, other than older adults, are engaging regularly with social media. See Appendix D for our guidelines on image sizes and resolutions, character word limits, hashtag usage, video strategies, and ways to monitor and evaluate effectiveness across social media platforms (Instagram, X, LinkedIn, and Facebook). WhatsApp isn't included because it uses an internet connection for messaging, unlike Facebook, which functions as a social networking platform utilizing both cellular and internet networks. Essentially, WhatsApp serves as a messaging app without the social networking features like information sharing (via timelines, feeds, and post likes), content promotion, and user profiles. It is also not possible at this time for organizations to send messages to different users like is possible on social networking sites.

15   Rationale for Using Postcards and Flyers Within All Toolkits

Having postcards and flyers prepared and available for communities to share at events, advertise in different locations (e.g., community/recreation centers, places of worship), or send through mail is another part of these toolkits. Print media remains a highly effective communication channel for seniors, many of whom may not be as engaged with digital platforms and thus could be at risk of missing crucial online emergency broadcasts. While this is a preferred way to reach older adults (see justification in Part 2 of this report), it is also a low-cost way to share information at any type of community event.

The postcards and flyers were designed in PowerPoint, and that file is available online for easy dissemination. See Appendix E for 3 example postcards and Appendix F for four example flyers using the tailorable Texas-wide messages "Texans Fight Floods, Together" / "Texanos unidos contra las inundaciones." We have included example postcards and flyers (in both English and Spanish) for each of our end-user groups in later sections of this report.

16   Overarching and Community Tailorable Texas-Wide Audience Message

16.1   Rationale for a Tailorable Texas-Wide Message

To develop targeted messages for the prioritized end-user groups, we began by developing a message suitable for being the face of TWDB's Texas flood efforts (see Figure 16.1). This message is not meant to direct end-users to make specific flood-related decisions, but instead it reflects the culture of Texas and serves as a unifying awareness message. When tested in Spanish, focus group participants said this overarching message enhances ideas of unity and action facing flood risk and has appeal to a wide number of Spanish-speakers using different dialects.

Key Concise Messages: "Texans Fight Floods, Together" and "Texanos unidos contra las inundaciones"

Figure 16.1 Toolkit Graphic for the Message "Texans Fight Floods, Together"

a.

b.

Figure Information: Figure (a.) and Figure (b.) showcase the English and Spanish graphic versions for "Texans Fight Floods, Together," respectively.

This message is not only a state-wide message, but it is also tailorable to specific geographies. For example, The City of Brownsville might decide to tailor the message and say: "Brownsville Fights Floods, Together." This tailorable message works a lot like resilience messages that became popular after Hurricane Harvey, specifically messages like "Houston Strong" and "Katy Strong." Note that in Part 2 of this report we outlined the user testing and iteration process used to design this message and how it taps into Texans' sense of pride.

The graphic is also provided online without the key message (also known as the concise message or slogan) to allow communities to tailor the message directly to their own needs. For example, in the postcard toolkit, we provide instructions to go into PowerPoint (the program most non-graphic designers have access to), use Arial font (chosen because it is readily available in most programs and on most computers), choose the blue color available in PowerPoint (it is also called Hex #003366 containing 0 Red, 51 Green, and 102 Blue), and tailor the graphic and message for a specific geographic community (see Figure 15.5). These graphics and toolkit materials could appear in the community-portion of the website that TWDB creates on www.texasFLOOD.org, using the website structure we presented in Figure 16.2.

Figure 16.2 Example of the Toolkit Graphic Easily Customized

RAYMONDVILLE FIGHTS FLOODS, TOGETHER

Figure Information: The graphic and message can be easily customized for any community. This is an example tailored to Raymondville.

16.2   Texas-Wide Audience Brochure-Format Sandbag Use Message

"The Sandbag Story" – Long Message

As part of the deliverable, longer message formats are important. Here we provide a graphic "Sandbag Story" brochure that can be printed and shared with all the prioritized end-user groups, as well as a broader Texas audience. Figure 16.3 is a photo of the printed materials created for that project to show an example of how "The Sandbag Story" brochure can look when printed on nice paper and in color.

Figure 16.3 Photo of the Printed Small Business Flood Preparedness Materials

Figure Information: Photo taken by Keri Stephens of small business flood preparedness materials that include a copy of "The Sandbag Story" brochure.

We have adapted that brochure to a general audience format which works well as part of the General Audience toolkit. This story-format brochure is designed to educate residents on effective sandbag usage, something that is currently lacking in Texas. "The Sandbag Story" can be implemented by printing out brochures and handing them out at events, or the content can be used for a longer-format series of social media posts. This brochure can also facilitate collaborations with local influencers (like public officials and emergency response personnel) to foster a culture of preparedness and communal protection against floods. This brochure is presented as Spanish first, a strategy that is particularly culturally appropriate for areas in the state, like the Upper Rio Grande Valley and the Lower Rio Grande Valley, where Spanish is often spoken. Figure 16.4 shows the two sides of "The Sandbag Story" trifold brochure.

Figure 16.4 Toolkit Graphic for "The Sandbag Story"

El evento de lluvia | The rain event

Una tormenta de lluvia precipitó varias pulgadas de agua en muy poco tiempo. An unexpected rainstorm poured several inches of rain in a short amount of time.

La preocupación | The worry

Sandy se preocupó porque el agua podía inundar su hogar. Sandy worried about water flooding her home.

Los sacos de arena | The sandbags

Sandy sabía que los sacos de arena podían retardar la entrada de agua si los llenaba a 2/3 de su capacidad y los ataba en la parte superior. Sandy knew that sandbags could help to slow down the entry of water if filled 2/3 full and tied at the top.

Apilamiento | Stacking

Los sacos deben colocarse horizontalmente, escalonados como una pared de ladrillo y juntando los bordes. Se puede colocar una bolsa de plástico debajo antes de apilar para tener proteccion adicional. Bags should be placed horizontally along your home, staggered (like a brick wall). A plastic bag can be placed underneath before stacking for extra protection.

Preparada | Prepared

Afortunadamente, Sandy entendió su riesgo de inundacion y se preparó con anticipacion. ¡Tenía sacos de arena listos para proteger su hogar! Luckily, Sandy understood her flood risk and prepared ahead of time. She had sandbags ready to protect her home!

Uso de sacos de arena | Using sandbags

Español

Concepto erróneo sobre los sacos de arena
Los sacos de arena no mantienen el agua fuera, solo retardan su entrada al hogar.

Mejor uso
Los sacos de arena ofrecen mayor protección contra el agua en movimiento.

Conozca su centro de distribución de sacos de arena
- Cada uno de los condados, ciudades y municipios tiene su propio metodo de distribución de sacos de arena. Sepa quién es responsable de repartirlos.
- Sepa cuántos sacos de arena se ofrecen por hogar. Este número puede no ser suficiente para cubrir todas las entradas. Planifique en consecuencia.

Conozca el historial de inundaciones de su hogar
Tenga sacos de arena listos si sabe que está en una área propensa a inundarse. Es posible que no pueda obtenerlos durante un evento inesperado.

Uso de sacos de arena
- Aprenda a apilarlos correctamente.
- Deséchelos si ya se usaron durante una inundación.
- Si no se usaron, guárdelos en bolsas de basura oscuras o contenedores oscuros para uso posterior.

a.

English

Misconception about sandbags
- Sandbags do not keep water out, they only slow its entry into your home.

Best usage
- Sandbags offer greater protection against moving water.

Know your sandbag distribution center
- Counties, cities, and municipalities each have their own method of distributing sandbags. Know who is responsible for sandbag distribution in your area.
- Know how many sandbags are offered per household. This number may not be enough to cover all your home entries. Plan accordingly.

Know your home's flood history
- Have sandbags ready if you live in a flood prone area. You may not be able to get them during an unexpected event.

Sandbag usage
- Know how to properly stack sandbags.
- Dispose of sandbags if they were used during a flood.
- If any sandbags were not used, you can store them in dark trash bags or dark bins for future use.

Contactos importantes | Important contacts

9-1-1
Para emergencias. Puede requerir una llamada para solicitar ayuda policial, de bomberos o para una urgencia médica.

For emergencies. A call may be necessary for situations where law enforcement, firefighters, or medical help is needed immediately.

3-1-1
Para situaciones no urgentes. Puede requerir una llamada en situaciones que no son una emergencia, por ejemplo, un semáforo roto.

For non-emergencies. A call may be necessary for situations that do not warrant an emergency response, such as a broken traffic light.

2-1-1
Para obtener información sobre la comunidad y los servicios sociales locales. Por ejemplo, dispensarios de alimentos y lo que puede hacer durante un desastre.

For information on the local community, social services, such as food pantries, and what you can do in a disaster.

Sitios web del condado | County Websites
Add County/City name here
Add URL for the County/City

Numeros del condado | County Numbers
County: 1-XXX-XXX-XXXX

El cuento de los sacos de arena | The Sandbag Story

b.

Figure Information: Figure (a.) and Figure (b.) showcase the two sides of a brochure, "The Sandbag Story," in the culturally appropriate format of Spanish first (for many areas of Texas).

17 Toolkits Segmented by End-User Group

In addition to the General Audience Toolkit, we created three more toolkits targeted to the prioritized end-user groups with messages in both English and Spanish:

1) Newcomers to Texas: "Check Your Flood Risk" / "Revisa tu riesgo de inundación" Toolkit. We designed this toolkit for newcomers to Flash Flood Alley and it could also be effective for many other end-user groups. We also included a Spanish version of the toolkit.

2) Young-adult male drivers: "Keep Your Car High and Dry" / "Mantén tu carro elevado y seco" Toolkit. This toolkit specifically targets young male drivers between 18 and 35 years of age. We also included a Spanish version of the toolkit.

3) Older adults: "Take 5 Prep 5" / "Toma 5 prepara 5" Toolkit. We designed this toolkit for older adults, especially those with disabilities living independently. A Spanish version of the toolkit is also included.

We provide a detailed overview of each toolkit next.

17.1 Newcomers to Texas "Check Your Flood Risk" Toolkit

To create a toolkit with the theme "Check Your Flood Risk," specifically targeting *newcomers to Flash Flood Alley — but will likely work for newcomers in general —* we considered a multilingual approach with a focus on media commonly used by newcomers (see Part 2 of this report for details on appropriate media for each prioritized end-user group). This toolkit emphasizes ease of understanding, visual appeal, and shareability. See Figure 17.1 for copies of the graphics and concise messages targeting newcomers.

Figure 17.1 Toolkit Graphic for the Message "Check Your Flood Risk"

a.   b.

Figure Information: Figure (a.) and Figure (b.) showcase the English and Spanish graphic versions for "Check Your Flood Risk," respectively.

Objectives of Using This Message

- Raise awareness about the potential for flooding in various regions of Texas.
- Educate newcomers on how to check and understand flood risks in local areas.
- Encourage proactive steps to prepare for flood scenarios.

Target Audience

- Newcomers to Flash Flood Alley, including immigrants, refugees, as well as in-state and out-of-state movers.
- Survey and focus group data suggest this message will likely resonate with newcomers throughout the state.
- Customizable to specific geographic areas of Texas.

Social Media Strategies to Disseminate Messages

- Use popular hashtags like #TexasFloodAwareness, #CheckYourFloodRisk, #SafeInTexas, and #TexansFightFloodsTogether. Possible Spanish hashtags include #SegurosEnTexas, #ChecaTuRiesgo, #RevisaTuRiesgo, #TxContraInundaciones.
- Geo-target specific areas within Texas with digital ads and posts.

Example Concise Messages in Addition to "Check Your Flood Risk"

- "Know the Zone, Know the Risk"/ "Conoce la zona, conoce el riesgo" – Emphasizing the importance of understanding local flood zones (i.e., areas prone to flooding).
- "Preparation is Protection" / "La preparación es protección" – Highlighting how being prepared can minimize risk.
- "Stay Informed, Stay Safe" / "Mantente informado, mantente seguro" – Encouraging regular updates on local weather and flood warnings.

Partnerships to Disseminate Messages

- Partner with local Texas weather channels, Homeowners Associations (HOAs), rental management companies, utility companies, and Texas cities/counties (e.g., via County Judges, Mayors) for information dissemination.

Newcomer to Texas Postcard and Flyer Toolkits

Included in the online documents is a set of templates, examples of the postcards and flyers, and instructions for how to customize these documents. **Appendix G** includes screenshots of two postcards related to this theme, and **Appendix H** includes screenshots of two flyers.

17.2   Young-Adult Male Drivers "Keep Your Car High and Dry" Toolkit

This toolkit for "Keep Your Car High and Dry" / "Mantén tu carro elevado y seco" targets young men to help them prevent flood-related damage to their vehicles. The message focuses on a clear, memorable, and actionable message. See Figure 17.2 for the graphics in English and Spanish.

Figure 17.2 Toolkit Graphic for the Message "Keep Your Car High and Dry"

a.   b.

Figure Information: Figure (a.) and Figure (b.) showcases the English and Spanish graphic versions for "Keep Your Car High and Dry," respectively.

Objectives of Using This Message

- Educate young male drivers on the risks of parking or driving in flood-prone areas.
- Encourage preventive measures to protect vehicles from flood damage.
- Instill a sense of responsibility for personal property and community safety during flood events.

Target Audience

- Young male drivers living in flood-prone regions.
- Owners of vehicles may be particularly concerned about damage because cars often represent the most expensive personal possession for young adults.
- Young men living or working in areas with frequent flood warnings.

Social Media Strategies to Disseminate Messages

- Use hashtags like #HighAndDry (#ElevadosYSecos) or #CocheSeguro (#SafeCar) for social media integration and tracking discussion.
- #Ubica/Identifica/ChecaLaZonaElevada (#SpotTheHighGround) can be used for contests encouraging young men to share photos of their smart parking during flood alerts.
- Utilize platforms popular among Spanish speakers, such as WhatsApp, WeChat, TikTok, Instagram, and X (formally known as Twitter).
- Engage with Spanish-speaking influencers and community groups to amplify the message.
- Schedule regular posts coinciding with local weather forecasts predicting heavy rains.
- Encourage user-generated content where community members share their own flood preparation stories.

- "Elevate Your Ride, Avoid the Tide" / "Eleva tu auto/nave/mueble/carro, evita el agua" – Highlighting the importance of parking in high-ground areas.
- "Floods Forecast? Park Smart!" / "¿Pronóstico de inundación? Estaciónate con cuidado" – Encouraging preemptive action when flood warnings are issued.
- "Don't Drown Your Town – Keep Your Car High and Dry" / "No te ahoges – Mantén tu auto/nave/mueble/troca/coche elevado/elevada y seco/seca"– Combining vehicle safety with community well-being.
- "Mantén tu carro/coche elevado y seco – Evita el riesgo de inundación" ("Keep Your Car High and Dry – Avoid the Risk of Flooding").
- "Antes de la lluvia, encuentra terreno alto" ("Before the Rain, Find Higher Ground").
- "Un coche/auto/mueble seguro es tu mejor aliado en tiempos de inundación" ("A Safe Car is Your Best Ally in Times of Flooding").

By integrating these components, the young-adult male drivers toolkit is designed to educate and engage young men by equipping them with the knowledge and tools to embrace the slogan "Mantén tu carro elevado y seco" ("Keep Your Car High and Dry"). This campaign not only aims to mitigate the impact of floods on personal property but also contributes to the broader community's safety and preparedness. It does this because keeping cars out of the water, also can save lives in situations where the water is dangerous.

Young-Adult Male Drivers Postcard and Flyer Toolkits

Included in the online documents is a set of templates, examples of the postcards and flyers, and instructions for how to customize these documents. **Appendix I** includes screenshots of three postcards related to this theme, and **Appendix J** includes screenshots of two flyers.

17.3   Older Adults "Take 5 Prep 5" Toolkit

Creating a toolkit using the slogan "Take 5 Prep 5" is about crafting clear, concise, and actionable content that empowers independent seniors (including those living with disabilities) to prepare for and respond to flood events in Texas. The slogan encourages them to spend 5 minutes to prepare 5 essential items in case of a flood. See Figure 17.3 for the graphics in English and Spanish.

Figure 17.3 Toolkit Graphic for the Message "Take 5 Prep 5"

a.

b.

Figure Information: Figure (a.) and Figure (b.) showcase the English and Spanish graphic versions for "Take 5 Prep 5," respectively.

Objectives of Using This Message

- Equip independent seniors (and those living with disabilities) with the knowledge and tools to prepare for floods.
- Simplify flood preparedness into manageable steps that can be done in a short time frame.
- Encourage seniors to maintain a small, personalized emergency kit that can be easily taken in case of evacuation.

Target Audience

- Independent seniors living with disabilities in Texas, particularly in flood-prone regions.
- Senior community leaders and influencers who can disseminate information.
- Family members and caregivers of independent seniors living with disabilities.

Example Messages in Addition to "Take 5 Prep 5"

- "Prep 5 Minutes Now, Save Your Life Later" / "Prepárate hoy por 5 minutos, Salva tu vida después" – Stressing the importance of short, regular preparations.
- "Your Safety Is in Your Hands – Take 5 and Thrive" / "Tu seguridad está en tus manos – Toma 5 y protégete" – Empowering seniors with a message of self-reliance.
- "Small Steps for Big Safety" / "Pequeños pasos, gran seguridad" – Highlighting that little actions can lead to substantial safety benefits.

Distribution Channels to Disseminate Messages

- Senior centers, community/recreation center bulletin boards, library community boards, Meals on Wheels, and places of worship.
- Direct mailing to reach seniors who may not frequent community spaces.
- Inclusion in local newspapers and magazines that have a high readership among seniors.

Partnerships to Disseminate Messages

- Collaborate with local pharmacies to include the postcards with prescriptions and health supplies.
- Partner with grocery stores to distribute the toolkit materials and possibly offer discounts on emergency kit items.

Accessibility

- Use clear, jargon-free language accessible to all seniors regardless of their educational background.
- Ensure all print materials are available in large print and alternative formats like audio or braille as needed.

By focusing on straightforward, manageable actions encapsulated in the "Take 5 Prep 5" / "Toma 5, prepara 5" slogan, this toolkit aims to instill a sense of confidence and readiness among independent seniors. The success of this toolkit hinges on its ability to resonate with the senior community, prompting them to take meaningful steps towards flood preparedness.

Older Adults Postcard and Flyer Toolkits

Included in the online documents is a set of templates, examples of the postcards and flyers, and instructions for how to customize these documents. **Appendix K** includes screenshots of two postcards related to this theme, and **Appendix L** includes screenshots of four flyers.

18   Implementation Strategy

18.1   Recommended Timeline for Disseminating/Posting Toolkit Materials

We recommend disseminating/posting toolkit materials year-round, but especially between March and September. This timeline extends the social media activity related to flood awareness prevention in previous years in the state of Texas. It also recognizes that even though Texas often focuses on Flood Awareness Week during May, National Preparedness Month is September. Developing and disseminating flood prevention and education content will provide opportunities to incorporate the toolkit's features, along with additional materials, to support the toolkit's aims. Using the recommended approach has several benefits:

1) **Seasonal Relevance:** Focusing the dissemination between March and September aligns with the period leading up to and including the early part of the flood season as well as hurricane season in Texas. This makes the information highly relevant and timely for the audience, increasing the likelihood that they will pay attention to and engage with the content.

2) **Leveraging Historical Data:** Aligning the dissemination timeline with previous years of heightened social media activity related to flood awareness takes advantage of established patterns of audience engagement. People are likely already seeking information during this period based on historical trends, so introducing the toolkit at this time meets an existing demand. By tapping into these established periods of interest and concern, the toolkit can achieve greater visibility and impact.

3) **Opportunity for Integrated Campaigns:** By planning the development and dissemination of the toolkit to coincide with the peak season for flood awareness, there is an opportunity to create integrated, multi-faceted campaigns. This allows for a comprehensive approach where the toolkit can be complemented with additional materials, activities, and engagement strategies. Such an approach not only reinforces the message but also keeps the audience engaged over a sustained period, thereby deepening their understanding and potentially influencing their preparedness behaviors.

18.1.1   Monthly Breakdown of Timeline

Creating a practical timeline for disseminating flood prevention awareness and information resources for Texas residents requires a strategic approach, focusing on the key periods when such information is most relevant and impactful.

This implementation plan is a guide for the TWDB personnel involved in engaging the Communications and Community Assistance Programs along with other officials and stakeholders.

This plan assumes that www.texasFLOOD.org has a landing page that guides the public to appropriate resources to check their flood risk and to know what should be involved in developing flood emergency preparedness kits.

Here is a suggested timeline for the year:

1. **January - February**
Preparation and Planning: This step involves updating resources, planning campaigns, and partnering with local organizations to prepare for the dissemination of general audience messaging and campaign awareness announcements.

- Awareness Campaigns: This process involves sharing print and social media content with the general audience and prioritized end-user groups. It involves promoting the preparation of flood prevention materials using the tailored graphics and messaging.

- This is an ideal time to launch the General Audience message **"Texans Fight Floods, Together,"** as well as the newcomer message, **"Check Your Flood Risk,"** and the older-adult focused message **"Take 5 Prep 5."** This approach involves using the developed TWDB Flood Awareness Toolkit materials and launching a series of informational posts discussing the risks and preparation tips to encourage residents to prepare early. The message should end with a call to action. For print media, consider using a combination of the pre-prepared toolkit postcards and flyers, and asking for local media appearances to discuss the urgency of flood preparation with the general audience.

- Community Involvement and Education about Flood Risk and Prevention: This process involves partnering with local community partners to host a series of talks and presentations. These events will reinforce flood prevention and preparation information and strategies, using the general audience message **"Texans Fight Floods, Together,"** as well as the end-user focused messages **"Check Your Flood Risk,"** and **"Take 5 Prep 5."** At this time, remind your community partners that all the graphics and toolkit materials are easily customizable, so they can tailor these items for their communities. Featuring local experts on the subject matter of flooding can also be important. Encourage your community partners to incorporate the general audience messaging in all communications to reinforce the message of unity and collective effort to raise awareness regarding flooding in Texas, and ways residents can get involved.

2. **March - April**
For disseminating the flood prevention message with the slogans "**Texans Fight Floods, Together," "Check Your Flood Risk," "Keep Your Car High and Dry,"** and **"Take 5 Prep 5"** during March and April, it is important to adjust the strategy to reflect the changing seasons and potential increase in flood risk due to flash floods and spring weather patterns.

- Community Engagement: Promote awareness about increased rainfall and potential flooding during seasonal changes. Emphasize preparation urgency by featuring local experts and public figures who share personal preparation strategies and communicate locally relevant information. Conclude with messages **"Check Your Flood Risk," "Keep Your Car High and Dry,"** and **"Take 5 Prep 5."**

- Social Media: Enhance flood prevention outreach on social media through the developed toolkit hashtags, as well as hosting live Q/A sessions targeting the prioritized end-user groups (newcomers, young-adult men drivers, older adults, and Spanish-speakers) promoting the messages "**Texans Fight Floods, Together / Texanos unidos contra las inundaciones," "Check Your Flood Risk / Revisa tu riesgo de inundación," "Keep**

Your Car High and Dry / Mantén tu carro Elevado y seco," and **"Take 5 Prep 5 / Toma 5 prepara 5."**

- Print Media: Have your community partners visit independent assisted living facilities to educate older adults about flood prevention. Distribute the toolkit "Sandbag Story," postcards, and flyers, and have local experts discuss preparation strategies that include the toolkit content around the messages of **"Check Your Flood Risk"** and **"Take 5 Prep 5."**

- Emergency Preparedness Workshop: Partner with local authorities to organize community-wide emergency preparedness workshops. Our research suggests that many emergency management coordinators (EMCs) already conduct some of the events, so partnering with them is important. Some of the prepared toolkit materials to be used include "The Sandbag Story," as well as the postcards and flyers. It is likely that the EMCs are already using the Federal Emergency Management Agency's (FEMA) materials and providing hands-on preparedness education, so adding the Texas-specific messaging around **"Texans Fight Floods, Together," "Check Your Flood Risk," "Take 5 Prep 5,"** and **"Keep Your Car High and Dry,"** should be welcomed by many local communities. The Spanish content can be used in communities when needed.

- Partner with the National Weather Service (NWS), local news stations, and local officials: In Flash Flood Alley, in particular, it could be beneficial to encourage your local communities to use the toolkit materials with the message, **"Keep Your Car High and Dry,"** in conjunction with the existing **Turn Around Don't Drown (TADD)** messages. Gathering feedback from them around the response to this young-adult male targeted message will be helpful for future dissemination efforts.

3. **May - June**
For disseminating a flood awareness message during May and June, it is important to consider the changing weather patterns and activities typical of late spring and early summer. These months often continue flash flood season and the preparation for hurricane season along the Gulf Coast. Here are ways you can adopt **"Texans Fight Floods, Together," "Check Your Flood Risk," "Keep Your Car High and Dry,"** and **"Take 5 Prep 5."**

- Hurricane Season Preparedness: Increase awareness and website traffic to highlight the risks and significance of hurricane season from late May to June. Feature local experts discussing the predictions for each hurricane season's severity, and flood prevention and education. Promote this information through local media, print, and social media, using the toolkit items and slogan **"Texans Fight Floods Together"** to engage audiences and prioritized end-user groups.

- Community Engagement: As weather warms and outdoor activities increase, encourage your community partners to set up informational booths at local parks, festivals, and events. Distribute the toolkit materials on the importance of being aware and prepared for floods. Feature local experts, authorities, and public figures sharing personal preparation strategies, concluding with the messages **"Check Your Flood Risk," "Keep Your Car High and Dry,"** and **"Take 5 Prep 5."**

- Social and Print Media Blitz: Intensify the use of social and print media as people plan summer activities. Enhance flood prevention outreach on social media through the developed toolkit hashtags and have local experts and civilians share their stories along with the messages **"Check Your Flood Risk"** and **"Keep Your Car High and Dry."**

- Emergency Preparedness Workshops: Partner with local authorities to organize community-wide emergency preparedness workshops. Some of the prepared toolkit materials to be used include "The Sandbag Story," as well as the postcards and flyers. Be sure to have them add the Texas-specific messaging around **"Texans Fight Floods, Together," "Check Your Flood Risk," "Keep Your Car High and Dry,"** and **"Take 5 Prep 5,"** and remind your partners these messages and toolkit materials are easily customized using Microsoft PowerPoint.

4. **July - August**
For July and August, a crucial period characterized by peak summer weather and often heightened hurricane activity and flash flooding, focusing on flood awareness is essential. Here are ways you can adopt **"Texans Fight Floods, Together," "Check Your Flood Risk," "Keep Your Car High and Dry,"** and **"Take 5 Prep 5."**

- Community Events: In partnership with local authorities, organize community-wide flood awareness activities. If communities are engaged in sandbag filling, provide them copies of "The Sandbag Story" to share with the community members. Keep using the toolkit materials around the messages **"Check Your Flood Risk," "Keep Your Car High and Dry,"** and **"Take 5 Prep 5"** in both English and Spanish.

- Social Media Live Q/A: Expand social media outreach with content focused on flood prevention. This includes material from the toolkit as well has hosting live interactive Q/A sessions tailored to specific end-user groups (newcomers, young-adult men drivers, and Spanish speakers) with hashtags from the toolkit around the messages **"Keep Your Car High and Dry," "Check Your Flood Risk,"** and **"Texans Fight Floods, Together."**

- Print Media Promotion Increase: Intensify the use of print media as people begin planning summer activities. Leverage graphics and content from the toolkit to share information. Feature local experts and civilians discussing flood preparation and prevention at the onset of hurricane season, along with testimonies from survivors of previous hurricanes using the messages **"Keep Your Car High and Dry," "Check Your Flood Risk,"** and **"Take 5 Prep 5."**

5. **September - October**
For September and October, adapting the slogan should take into account the ending of hurricane season and the transition into fall. Given late August through early September is still hurricane season and historically the worst time for the Texas coast, continue to emphasize hurricane and flood preparedness using the messages **"Check Your Flood Risk," "Keep Your Car High and Dry,"** and **"Take 5 Prep 5."**

- National Preparedness Month (September): Leverage National Preparedness Month in September to amplify your campaign. Focus on comprehensive flood preparedness,

including home-related flood risk checks and knowledge of evacuation routes. Emphasize the creation of emergency kits as part of the campaign using the messages **"Check Your Flood Risk"** and
"Take 5 Prep 5."

- Updating Resources and Information: Regularly update your website (texasFLOOD.org) and other resources with the latest information on flood prevention and preparedness. Take into account any recent changes in flood mapping or emergency protocols to ensure the information is current and useful.

- Social Media: Shift your focus to include fall-related content, emphasizing preparedness in the context of seasonal weather changes. Use Hurricane Harvey-anniversary posts (and any other hurricane and/or devastating weather event anniversaries that have hit specific regions along the Texas coast) to coordinate with the toolkit hashtags and messaging. This approach can engage audiences as they adapt to the changing season using the hashtags related to **"Check Your Flood Risk"** and **"Keep Your Car High and Dry."**

6. **November - December**

For November and December, tailoring your **"Texans Fight Floods, Together"** and **"Check Your Flood Risk"** flood prevention campaign should consider the onset of cooler weather, holiday season activities, and the end of hurricane season. Here's an approach suitable for these months:

- Winter Weather Preparedness: Refocus efforts on preparing for winter weather conditions that may lead to flooding, such as heavy rains or early snowmelt (in some places in Texas). Emphasize the importance of readiness for these specific scenarios using the message **"Check Your Flood Risk."**

- Holiday Safety Messaging: Incorporate flood safety messages into holiday season communications. Encourage your community partners to customize the toolkit materials to meet their specific needs.

- Community Engagement: Leverage community events such as Thanksgiving parades, Holiday Celebrations, and New Year's celebrations to spread information. Set up booths or interactive displays at these events to engage the public in an informative yet festive manner using the messages **"Texans Fight Floods, Together," "Check Your Flood Risk," "Keep Your Car High and Dry,"** and **"Take 5 Prep 5."**

- Social Media Campaigns: Develop social media campaigns that resonate with the holiday spirit, focusing on community and family safety. The toolkit materials can be customized with holiday-themed content to effectively communicate messages about flood preparedness and safety using the toolkit hashtags around **"Texans Fight Floods, Together"** and **"Check Your Flood Risk."**

7. **Throughout the Year**
- Continuous Online Resources: Maintain a dedicated website with resources, updates, and interactive tools.

- Partnerships with Local Media: Regular segments or announcements on local news, radio, and online platforms.
- Mobile Alerts and Apps: Use mobile technology for regular updates and alerts.

Remember, it is crucial to tailor the content and timing of these initiatives to the specific needs and characteristics of different communities within Texas. Each community may have an anniversary of a weather event that is especially significant to them (e.g., a winter storm, tornado, hurricane, or flood that happened during a particular year). Collaboration with local authorities, meteorological departments, and community leaders is essential for the success of these initiatives.

18.2 Identification of Relevant Stakeholders, Public Organizations, and Conferences

The following spreadsheet identifies the recommended stakeholders, public organizations, and conferences where these materials can be shared. Below is a brief explanation:

1. **Local Government Agencies:** City and county offices, especially those involved in emergency management, public safety, and environmental protection, are crucial. They can help distribute the toolkit through their channels and integrate it into local disaster preparedness plans. In the past, the agencies that participated tended to use materials from the Federal Emergency Management Agency (FEMA) that were not tailored to Texas.
2. **Community Leaders and Organizations:** Engage with leaders in neighborhoods, particularly those in flood-prone areas. They can help spread the word through community meetings and local events.
3. **Schools and Educational Institutions:** Schools can incorporate the toolkit into their safety and environmental education programs, reaching students and their families.
4. **National Flood Conference:** Organized by FEMA and the National Flood Insurance Program (NFIP), this conference is a key platform for discussing flood issues.
5. **Association of State Floodplain Managers (ASFPM) Conference:** An annual event that brings together professionals involved in floodplain management, flood hazard mitigation, the NFIP, and flood preparedness.
6. **Environmental and Disaster Management Conferences:** Events focusing on climate change, environmental management, and disaster preparedness often have sessions on flood management and are ideal for networking and dissemination.

18.3 Strategies to Share Toolkit Materials With Other Stakeholders

Sharing toolkit materials with other stakeholders effectively and encouraging them to adopt these resources for their own campaign efforts requires a strategic approach. Here are some key strategies:

1. **Tailored Presentations and Demonstrations:** Host presentations or webinars tailored to the interests and needs of different stakeholder groups. Demonstrating how the toolkit can be beneficial for their objectives and audience can encourage adoption.
2. **Customizable Materials:** Offer customizable versions of the toolkit materials. This allows stakeholders to adapt the content to their specific context, branding, and messaging, making it more relevant and appealing for their use.

3. **Partnership and Collaboration Opportunities:** Establish partnerships with key stakeholders. Collaborating on a campaign can provide mutual benefits and shared resources, making the toolkit more attractive for adoption.
4. **Training and Support:** Provide training sessions or support materials on how to effectively use the toolkit. This can be facilitated by a communication specialist with expertise in flood messaging. This can include best practices for social media campaigns, integrating toolkit materials into existing programs, and measuring impact.
5. **Success Stories and Case Studies:** Share success stories and case studies of the toolkit's effective use. Demonstrating tangible results and benefits can motivate others to adopt the toolkit. These items can be shared at https://www.texasFLOOD.org to build out a more public-facing website.
6. **Networking at Conferences and Meetings:** Use conferences, meetings, and workshops to network with potential stakeholders. Face-to-face interactions can be a powerful way to build relationships and encourage adoption.
7. **Feedback and Continuous Improvement:** Encourage stakeholders to provide feedback on the toolkit and use this feedback for continuous improvement. This not only improves the toolkit but also shows stakeholders that their input is valued and taken seriously.
8. **Direct Outreach and Follow-Up:** Engage in direct outreach to key stakeholders and follow up regularly. Personalized communication can help maintain interest and encourage adoption.
9. **Offer Incentives:** If feasible, offer incentives for adopting the toolkit, such as recognition in promotional materials, access to exclusive resources, or participation in a network of like-minded organizations.

By implementing these strategies, you can effectively share your toolkit materials with other stakeholders and encourage them to adopt these resources for their own flood awareness and prevention campaigns.

18.4   Future Recommendations & Potential Toolkit Expanision

To effectively implement the featured campaigns, TWDB will need media communications specialists with expertise in social media analytics, website design and search engine optimization, and social marketing. These specialists will focus on disseminating flood prevention and education campaigns to engage both end-user groups and the general population. The media communications specialists should also be able to train groups like the TWDB Community Assistance Program and Flood Outreach Specialists and local community leaders to effectively disseminate these materials. Both of these groups often have strong relationships with communities that could use these types of messages. By incorporating a media communications specialist, TWDB will ensure that the contents of this report are implemented, evaluated, and iterated upon effectively. Additionally, this will allow TWDB to measure the campaign's effectiveness for future expansion and continuing to develop new content for social media, print, and outdoor advertising.

While we have designed these toolkit materials for non-graphic design specialists to use, it is important to continue building on these basic toolkits to create more resources for communities to use.

Engagement Tactics to Be Developed in the Future

- QR codes on advertisements linking to a website with more detailed flood-prevention tips.
- QR codes on advertisements linking to a website showing high-ground parking maps.
- Infographics that visually explain how to protect cars from floods.
- Infographics that visually show how to put together a flood preparedness kit.
- Interactive polls and stories to engage the community in flood preparedness conversations (i.e., games, crosswords).
- Host Spanish Q&A sessions with trusted community leaders, local weather forecasters, and experts in flood management and vehicle safety.

Images and Videos to Start Collecting

- Images/Videos of cars safely parked in elevated areas contrasted with flooded streets to drive the message home.
- Images/Videos of older adults preparing at least the most important items for them in case of evacuation.
- Images/Videos of people receiving symbolic rewards for checking their flood risk.
- Images/Videos of communities addressing their flood issues.

Consider Developing an Outdoor Advertising Campaign in the Future

To extend the reach of the "Keep Your Car High and Dry" campaign in Texas, outdoor advertising should be considered. This is not something to be orchestrated on a local level because of the cost of designing the campaign as well as the advertising costs. Outdoor advertising boasts a significant advantage in its ability to reach audiences on the move, particularly those who are actively engaged in driving or commuting, making it an ideal medium for conveying messages about protecting vehicles from flood damage. Men, often influenced by visual cues and direct messaging, are more likely to absorb and act upon the striking and memorable slogans and imagery presented in large-scale formats along highways, in parking areas, and near water-prone zones.

Tips for an Outdoor Advertising Campaign:

- Create bold and visually striking billboards with clear imagery of what happens when people drive through flood water.
- Consider transit advertisements on buses and trains that young men might use for commuting in urban areas.
- Consider street furniture advertisements, such as on bus shelters and benches, in areas near parking spots.
- Locate advertisements near known flood-prone areas, parking lots, and commuter routes.
- Use digital billboards for dynamic messaging that can change based on weather warnings. This might be an opportunity to partner with the Texas Department of Transportation (TxDOT).

19   Background Research

Evaluating communication and awareness efforts is an essential, but often overlooked part of any awareness and/or educational campaign, including flood awareness (Balog-Way et al., 2020). Therefore, Part 4 of this report provides guidance on how to use specific metrics and develop an ongoing evaluation program.

As reviewed in Part 1 of this report, countries other than the U.S. have attempted country-wide flood awareness and action projects with limited success. Osberghaus and Hinrichs (2021) conducted the most rigorous evaluation of flood coping behavior, and they concluded: "Large-scale awareness campaigns in the real world, controlled for general time trends and unobserved heterogeneity, are of limited effectiveness in terms of increasing flood coping behavior." (p. 954). This study was conducted in Germany, used rigorous sampling and longitudinal approaches, and they still found their non-targeted approach to flood awareness was ineffective. Studies in other countries have found similar results (O'Sullivan et al., 2012; Soane et al., 2010).

Taking a different approach, using general messages in a hyperlocal environment, can be successful, but this approach is also very labor intensive. For example, using a more localized approach focused on a single small town of 1,900 residents, Bodoque et al. (2019) found that flash flood preparedness (not related to insurance) increased after their risk communication efforts. They invested in four different types of communication and awareness strategies to see improvement: briefings, quizzes, storytelling—including videos and photographs about past floods, and an intergenerational workshop. Australian researchers have also reported positive effects in several of their localized studies, and many of them focus on a message similar to "Turn Around Don't Drown": "If It's Flooded, Forget It!" (Davies & Rigby, 2016).

Therefore, it is important for TWDB to continue their focus on identifying the specific needs of flood awareness end-user groups and using targeted approaches that are salient to their needs, providing meaningful actions, and communicating in user-appropriate ways so they understand their risk and the actions they can take. There are likely ways for TWDB to develop messages and action-oriented approaches to address the needs of specific end-user groups while also leveraging the power of localized approaches. This forms the basis of our first recommendation.

19.1   Recommendation to Use a Distributed Approach to Reach Local Texans

While the most effective flood awareness projects have been conducted in a single location, and this may work for an academic research study or a highly localized effort, our recommendation is for TWDB to use a distributed approach. See Part 5 of this report for specific examples of local stakeholders in Texas who may be able to implement TWDB's approaches for their local communities if provided with customizable messages and communication products like brochures and social media messages. See Part 3 of this report for those toolkits.

19.2   Analysis of TexasFLOOD.org as of October 31, 2022

Many companies, non-profit organizations, governmental organizations, and individuals believe that if they create content and put it online, people will find their website and engage with it. Actually, people's search for and engagement with informational websites is typically a complex and slow process. We provide a few key explanations next.

Current data on *TexasFLOOD.org*:
- There have been approximately 9,000 site visits during 2022 with an average of approximately 700 visits per month in a downward trend. The webmaster reports that visits increase around major flood events in the state, but the site specifically says its purpose is NOT to provide real-time information during an event. For comparison, the TWDB Agency website had 37,008 visitors in the month of October 2022, a fairly typical month for website traffic.
- Visitors are not spending much time on *TexasFLOOD.org* – approximately 38 seconds per visit, compared to 2 min 8 sec when they visit the TWDB Agency website.
- While we examined these website statistics at the end of October 2022, it is important to do another baseline assessment, using what we have provided here, prior to implementing the suggested changes in this report.

Conclusions:
- Not many people know *TexasFLOOD.org* exists and the content will need to be better tailored to engage Texans. The site will also need to narrow some of its audiences or create tabs where users can quickly click and find the information more relevant to them. The website is currently not targeted for any specific audiences.

19.3   Recommendations for *TexasFLOOD.org*

Consider investing to make *TexasFLOOD.org* the go-to place for Texans seeking flood information. Focus on search engine optimization (SEO) to have webpages indexed by search engines. This means that when Texans search for flood information, this website will appear in the search results. This investment will entail finding the funds to hire marketing experts experienced in interactive website design and search engine optimization, and also providing regularly updated and relevant content for Texans and the local community partners who will use this site. Employ principles of website design that increase visitor engagement and satisfaction such as a salient navigation bar, distinct logos and icons, and avoidance of visual overload (Garett et al., 2020). Specifically, the toolkit contents and graphics developed in Parts 2 and 3 of this report can be located on this website. This would encourage communities to access the materials and make the website more valuable. Tracking the downloads of all these materials will be important metrics.

Websites are often designed by digital strategists who create the website with measurability designed into it. Then, metrics like the following can be easily tracked:
- Specific social media, websites, or search engines that led people to the website,
- Impacts of paid advertising on social media and websites that led to content clicks,
- Metrics specific to the website, such as downloads of toolkit materials, and clicks on floodplain map links or additional information from FEMA,
- Sharing of content that can demonstrate amplification of *TexasFLOOD.org* content,

- Comparison of unique visitors and repeated visitors, and
- Demographics of visitors such as their location.

Consider adding social media channels to the dissemination mix and have those automatically post to this website for consistency and to drive traffic to the site. Setting up social media accounts complementary to *TexasFLOOD.org* and engaging social listening practices—defined as actively monitoring relevant social media activity—will allow for greater understanding around message uptake. While there are firms that can handle social media listening activities for TWDB, lower cost options include Hootsuite and Google Alerts, but realize these options will change over time. Monitoring social media will only capture demographics actively using the platforms being monitored, but this approach will allow TWDB to measure the reach of its digital efforts. By monitoring key phrases and hashtags, TWDB can iterate around the best messages over time.

Some good questions to ask while collecting flood awareness and action metrics include:
- What messages generate the most active conversations online?
- When do people engage with these messages the most? Current *TexasFLOOD.org* data suggests it is right before or after a flood event, but this needs to be tracked as a metric.
- What did people appear to learn and take away from those messages?
- What actions did people say they would implement as a result of seeing those messages?
- How much interaction and dialogue were generated from each message?
- Which target audiences are engaging most with the messages and content?
- Are there target audiences, beyond the four identified as prioritized end-user groups as part of this project, that are engaging with the content? If so, this is a clear indicator they might need to be prioritized in the future.
- If using different forms of media (e.g., video, brochures, information sheets), which ones are getting the most views, shares, and downloads from the websites and social media?
- If using different messengers (e.g., county officials, local weather meteorologists, libraries, celebrity influencers), whose messages are being viewed, shared, and downloaded the most? If the messages are in print form, which ones are being requested, downloaded, and printed the most?

Furthermore, once the website content is deemed useful and relevant for the target audiences, a publicity/awareness campaign should be conducted to bring it to the attention of these audiences. This is where mass media, such as radio and television—including public service announcements and printed signs like those for buses and billboards—can be used to attract people to *TexasFLOOD.org*. This is also a key opportunity for TWDB to share the URL with local Certified Floodplain Administrators and county emergency response personnel. Leveraging relationships within the state agencies could provide low-cost and highly effective ways to reach end-users.

Three months after implementation of the aforementioned website makeover and awareness campaign, the usage metrics should be tracked monthly. The awareness campaign will need to be ongoing to sustain awareness and interest.

One way to sustain interest and generate new content is to use the Timeline created in Part 3 of this report to drive awareness of *TexasFLOOD.org*. Another opportunity around flood awareness

is to promote Flood Awareness Week—a National Weather Service and Ready.gov awareness program that is promoted throughout the U.S. Currently, as part of the research in this project, we found that the state most actively involved in this program is Florida, where almost every community does programming and planning during this week. Many Texas communities also participate, but there does not seem to be a centralized source that helps these communities. TWDB could promote these efforts to local flood officials, emergency response coordinators, and also work with TDEM and the Texas A&M AgriLife Extension Service to share meaningful content that would get the word out about *TexasFLOOD.org*. Here is a link to the 2022 materials NWS provided. For more ideas, see the Timeline in Part 3 of this report.

TexasFLOOD.org could provide helpful links to other websites, such as the newly created Flood Resiliency Guide for Small Business Owners housed at the Technology & Policy Institute at The University of Texas at Austin (https://texastipi.org/project/smallbusinessresources/). The Homeowner's Handbook to Prepare for Coastal Natural Hazards—compiled by the Texas Sea Grant College Program and the Texas General Land Office (GLO)—as well as the Community Official Flood Resource Guide for Local Flood Officials are both on *TexasFLOOD.org*, but they might be re-organized for different audiences to help people quickly find the resources they need.

In addition to having *TexasFLOOD.org* be a resource for local officials, organizations, and emergency management professionals, all four prioritized end-user groups identified in this project could also use *TexasFLOOD.org* and the associated social media if it is designed and marketed for a more public audience.

20 Current Data Generated From Texas-Wide Surveys

Understanding how surveys of Texans can be used to track flood information awareness and behavior change is another important component to understand needed metrics. The only flood awareness survey we could find in the U.S. was funded by the Neptune Flood Insurance Agency in partnership with the University of Southern Florida, and they have published their results for 2021 (https://neptuneflood.com/wp-content/uploads/2021/03/Neptune-USF-Survey-2021-Published-Results.pdf). This survey predominantly focused on flood insurance and it used Amazon.com's crowdsourcing platform, *Mechanical Turk,* to get their sample. While using crowdsourcing platforms is fairly common today, it does not produce a random sample or even a quota sample, so it is difficult to generalize beyond that study. One important finding from the survey is that people tend to underestimate the flood risk in their area. This is consistent with the findings from Stephens et al. (2023) and their survey of Texans' flood understanding and risk perception.

U.S. communities developing a hazard mitigation or floodplain management plan often conduct surveys (they are required for certain types of local funding) to understand their community members' experiences and priorities with hazards. For example, there is one example conducted by Brazoria County in Texas. These surveys are not typically about flood-specific awareness and are more focused on all hazards, but they do provide insight into the communities' perceived needs. TWDB has also conducted surveys in the past, especially with floodplain administrators, and those constitute a meaningful corpus of past data that can be built upon.

20.1 Texas-Wide Survey (Stephens et al., 2023)

The University of Texas Moody College of Communication team has conducted two surveys focused on flood awareness in Texas. Part 1 of this report provided a detailed overview of the survey conducted in 2020 that was published in 2023 (Stephens et al., 2023). Some items used on their survey could be helpful to track metrics over time.

For your reference, these are some relevant items used in Stephens et al.'s (2023) survey:

Table 20.1 Stephens et al.'s (2023) Survey Items

Construct and Item Wording *(Note. All scales are 5-point Likert like ranging from strongly disagree to strongly agree unless otherwise noted.)*	Reliability	Mean	SD
Perceived information seeking control 1. I know how to search for information about the potential risks for floods. 2. When it comes to information about the potential risks posed by floods, I know how to separate fact from fiction. 3. I can readily access information about the potential risks posed by floods. 4. When it comes to finding information about the potential risk posed by floods, I know what to do.	.85	3.95	.82
Seeking-related subjective norms	.95	2.98	1.07

1. Most of my close friends who are important to me think that I should seek information about the risks posed by floods.
2. Most of my family whose opinions I value seek information about the risks posed by floods.
3. Most of my family expects me to seek information about the risks posed by floods.
4. Most of my close friends expect me to seek information about the risks posed by floods.
5. Most people in my community (excluding my family and close friends) who are important to me expect me to seek information about the risks posed by floods.
6. Most people in my community (excluding my family and close friends) who are important to me think I should seek information about the risks posed by floods.
7. The majority of the people in my community (excluding my family and close friends) expect me to seek information about the risks posed by floods.
8. Most people in my community (excluding my family and close friends) whose opinions I value seek information about the risks posed by floods.

Attitude towards seeking information (not at all to extremely)   .91   4.14   .82
Stem: Using the scale below, please indicate whether you feel that seeking information about the potential risks posed by floods is:
1. Valuable
2. Good
3. Beneficial
4. Helpful
5. Productive

Perceived knowledge   62.78   26.17
1. On a scale from 0-100, please rate **your knowledge** of the potential risks posed by floods where 0 means you know nothing about the potential risks posed by floods and 100 means you know everything you could possibly know about the potential risks posed by floods.

Desired knowledge (called perceived knowledge insufficiency in other PRISM studies)   63.79   26.86
1. On a scale from 0-100, please estimate **how much knowledge you need to deal adequately** with the potential risks posed by floods where 0 is no required knowledge and 100 is the most knowledge you could possibly have about the potential risks posed by floods.

Perceived risk probability   .72   2.52   .86
1. How often does flooding occur in the community where you live? (never to always)
2. How likely is it that flooding will occur this year in the community where you live? (extremely unlikely to extremely likely)
3. I am confident that flooding will not occur this year in the community where I live. (not at all confident to extremely confident). Reverse Coded Item omitted (raised α from .65 to .72)

	α	M	SD
Perceived risk severity	.73	3.62	1.05

Stem: If I did experience flooding, it...
1. Is likely that it would negatively impact me.
2. Would have a severe effect on me personally.

	α	M	SD
Risk affect (not at all to extremely)	.95	2.98	1.21

Stem: When you think about flooding, to what extent do you feel:
1. Concerned
2. Fearful
3. Anxious
4. Worried
5. Personally concerned

	α	M	SD
Seeking intent	.96	3.53	1.06

1. I will look for information related to potential risks posed by floods in the near future.
2. I intend to look for information about potential risks posed by floods in the near future.
3. I intend to find more information about potential risks posed by floods in the near future.
4. I will try to seek information about potential risks posed by floods in the near future.
5. I plan to seek information about potential risks posed by floods in the near future.

Note. All the reliability scores were calculated using Cronbach's α in SPSS (v.27).

The demographic composition of the Stephens et al. (2023) survey sample mirrored Texas except they deliberately oversampled people living in zip codes with a higher risk for floods. The resulting sample ($n = 1,079$) was 53% ($n = 572$) female, 46% ($n = 499$) male, .06% ($n = 6$) nonbinary, and .02% ($n = 2$) prefer not to say. Participants consisted of 41% ($n = 442$) Hispanic, 37% ($n = 399$) Non-Hispanic White, 12% ($n = 132$) African American, 7% ($n = 74$) Asian, 3% ($N = 31$) American Indian, .05% ($n = 5$) Native Hawaiian, and 8% ($n = 84$) Other. Sixty-nine percent ($n = 745$) of the sample lived in zip codes at a higher risk for floods, and 60% ($n = 643$) of the sample had experienced flooding in the past.

The main findings were that people view their knowledge of floods as fairly high and do not perceive much of a gap concerning what they need to know; this suggests they are not aware of their risk. Furthermore, people who live in flood-prone zip codes are no more likely to seek flood information than people living in areas that are less flood prone. Please see Stephens et al. (2023) for the full study details.

20.2   Texas-Wide Survey in 2024

The survey conducted for this project finished data collection very early in January 2024 and focused on better understanding the four prioritized end-user groups identified in Part 2 of this report. Many of the same risk-perception variables found in Stephens et al. (2023) were considered, including perceived knowledge, desired knowledge, perceived risk probability, perceived risk severity, and risk affect (or concern about flood risk). There were also more nuanced comparisons included between different parts of the state (coastal areas vs Flash Flood Alley vs other areas).

This survey also used a quota-based sample (not a random sample) and deliberately sampled people in each of the three geographic flood-risk areas of the state (coastal vs Flash Flood vs other) as well as oversampled people who fell within the prioritized end-user groups. The sample size was 1,086, and of that sample, 59 Spanish-speakers chose to take the survey in Spanish and were analyzed separately. The option to take the survey in Spanish was not present in the 2020 survey. The 59 Spanish-speakers were not included in the general demographics reported here because of the small sample size. The resulting sample taking the survey in English was 52.8% ($n = 542$) female, 46.7% ($n = 480$) male, and .05% ($n = 5$) nonbinary/third gender. The sample had an average age of 47 (standard deviation = 18.2), which broke down to 31.5% ($n = 324$) in the 18-35 age range, 44.4% ($n = 456$) in the 36-64 range, and 24.1% ($n = 247$) 65 and older. The Hispanic/Latinx/Spanish origin sample was 46.8% ($n = 479$) of the total, while 34.6% ($n = 348$) were Non-Hispanic White, 10.8% ($n = 111$) were Black, and 7.8% ($n = 81$) were other race/ethnicities.

While Stephens et al. (2023) concluded there was a lack of flood information and education in Texas, they could not rule out the possibility that the reason people do not seek flood information differently depending on their geographic risk is that they were overloaded and/or simply tired of hearing about their flood risk. Therefore, in the 2024 study, the team measured a construct called message fatigue (So et al., 2017) to test these assumptions. The findings showed no differences between people living in more flood-prone areas than less flood-prone areas. This further supports the claims that flood education and information is not widespread in Texas.

The current survey data provides the following findings that constitute baseline data for future work and evaluation efforts:

- People who completed the survey in Spanish reported *lower* perceived current knowledge, had not heard of FEMA and STEAR at the same levels as participants taking the survey in English, and had lower knowledge of important flood safety information including road signage.
- People living in Flash Flood Alley have *lower* risk perception than people living in areas less prone to flooding.
- Newcomers report *lower knowledge* of floods, but they also perceive a higher probability of risk from floods than people with a tenure of longer than one year in Texas. This suggests they may be receptive to learning more about their risk.
- Young adults (not only males) ***do not believe they need as much information*** to be ready to handle floods as people in the older age categories. There were few differences between young men and young women, so while the messages designed in Parts 2 and 3 of this report target young men, in the future it is important to better understand how similar messages might be effective with both men and women.
- While the survey captured a nice sample of older adults, it did not capture many people who considered themselves a person with a disability. The major findings suggest efforts to reach older adults with targeted messages, especially around evacuation needs, before they need help evacuating, would be prudent.

21 Recommended Evaluation Metrics for Flood Awareness

In their summary of risk communication published research, Balog-Way et al. (2020) claim that evaluating risk messages is vitally important because we simply do not know the impact of untested messages. While the messages designed in Parts 2 and 3 of this report were focus-group tested, after the toolkits have been further developed and communities deploy them (beyond the current project), it is important to identify how the messages are being received and if they are having the positive effects predicted. Therefore, these are our recommendations for metrics.

There are five categories of flood-related actions that can be measured by using different metrics: Risk Awareness, Engagement, Efficacy, Intent, and Action. These actions are arranged in a specific order to indicate where they fall on the path toward achieving the desired actions. Achieving desired behavioral actions, such as purchasing flood insurance, not driving through flood waters, or preparing an evacuation go-bag, require people to first become aware of their risk, engage and learn more, feel confident they can take actions, and intend to take actions, all before they engage in the behavior change. Figure 21.1 provides an overview of the different types of metrics useful to assess where people are along this behavioral continuum.

Figure 21.1 Framework for Flood Awareness Evaluation Metrics

Awareness Component	Metrics	Evaluator	Frequency
Risk Perception	• Prior Experience with Flood Events • Perceptions of Flood Probability, Severity and Affect • Knowledge of Flood Causes and Conditions • Flood Message Awareness/Exposure and Fatigue	Academic Partner & Local Partners (Survey)	Biannually
Engagement	• Website traffic/site visits/page views • Number of followers • Social media impressions, likes, shares • Number of people who attend community flood awareness events • Number of people who contact local agencies requesting flood information	Social Media Analytics Firm & Local Partners	Monthly After events
Efficacy	• Confidence in Effectiveness of Precautionary Measures (Response Efficacy) • Confidence in Ability to Take Precautionary Measures (Self Efficacy) • Trust in Community and Government Resources	Academic Partner (survey)	Biannually and After significant Flood Events
Intent	• Reported Intent to Prepare for Floods • Reported Intent to Seek Flood Information • Intent to not drive through flood waters • Perceived Community Norms for Flood Preparation	Academic Partner Community Partner TWDB (survey)	Biannually
Action	• Reported Flood Mitigation Strategies Taken • Post-Flood Analysis of Casualties, Property Damage • Field Observations of Flood Planning and Precautionary Measures	TWDB (observation/survey)	After significant flood events

Figure Information: This figure shows the types of behaviors related to flood awareness, specific metrics to track these behaviors, proposed partners to track these metrics, and the desired frequency of tracking the behaviors.

21.1   Evaluation Metric #1: Risk Perception for Prioritized End-User Group Messages

Risk perception contains three concepts: perceived risk probability (how susceptible to floods someone feels), perceived risk severity (if a flood happened how bad would it be), and risk affect (the emotions around feelings of risk perception). Both Stephens et al. (2023) and the 2024 survey conducted for this project used measures found in Table 21.1 from Wilson et al.'s (2019) recent research on risk communication.

Risk-perception metrics should also include prior experience with flood events because experience often changes perceptions of risk, and this was included in Stephens et al. (2023) and 2024 survey. It is also important to measure people's knowledge of flood risk, what causes that risk, flood message awareness (or exposure), and flood message fatigue. The 2024 survey included all these measures, and they provide a solid way to continue assessing understanding around risk perception.

Table 21.1 presents the items measuring flood message awareness/exposure and people's perceived effectiveness of those messages. The University of Texas at Austin (UT Austin) team developed these items for the 2024 survey and for future metrics.

Table 21.1 Flood Message Awareness Survey Items

Question	Answer Choices
How many, if any, messages about flooding in your area have you seen or heard?	None, A few, Some, A fair bit, A lot, Too many
Which of the following places have you seen or heard flood messages? Select all that apply.	Road signs, Billboards, TV ads, Local news, Local emergency apps, Community newsletters, Social media, Nextdoor or any other neighborhood app, Other (Please describe)
Thinking of the flood-related messages you have seen and heard in Texas, how often have you seen messages recommending the following actions? Don't drive through water on the road	Never, Occasionally, Some, Often, Always
Thinking of the flood-related messages you have seen and heard in Texas, how often have you seen messages recommending the following actions? Don't play in waterways that are flooded	Never, Occasionally, Some, Often, Always
Thinking of the flood-related messages you have seen and heard in Texas, how often have you seen messages recommending the following actions? Get flood insurance	Never, Occasionally, Some, Often, Always
Thinking of the flood-related messages you have seen and heard in Texas, how often have you seen messages recommending the following actions? Be sure you are prepared for floods	Never, Occasionally, Some, Often, Always

Thinking of the flood-related messages you have seen and heard in Texas, how often have you seen messages recommending the following actions? Specific ways to prepare for floods	Never, Occasionally, Some, Often, Always
Thinking of flood-related messages, how **effective do you find** messages recommending the following actions? Don't drive through water on the road	Not at all effective, Somewhat not effective, Neither effective nor not effective, Somewhat effective, Extremely effective
Thinking of flood-related messages, how **effective do you find** messages recommending the following actions? Don't play in waterways that are flooded	Not at all effective, Somewhat not effective, Neither effective nor not effective, Somewhat effective, Extremely effective
Thinking of flood-related messages, how **effective do you find** messages recommending the following actions? Get flood insurance	Not at all effective, Somewhat not effective, Neither effective nor not effective, Somewhat effective, Extremely effective
Thinking of flood-related messages, how **effective do you find** messages recommending the following actions? Be sure you are prepared for floods	Not at all effective, Somewhat not effective, Neither effective nor not effective, Somewhat effective, Extremely effective
Thinking of flood-related messages, how **effective do you find** messages recommending the following actions? Specific ways to prepare for floods	Not at all effective, Somewhat not effective, Neither effective nor not effective, Somewhat effective, Extremely effective

Tables 21.2-21.4 include survey items that the UT team created for flood information, knowledge of specific flood-related terms, and awareness of flood resources.

Table 21.2 Flood Information Survey Items

Question	Answer Choices
Have you ever needed to look for flood information?	No, Yes
Which of the following places did you find that information? Select all that apply.	I never found what I was looking for, Social media, Internet, Television, Radio, City website, Community website, Government website, Friends, Family, Neighbors, Other (please describe)
Why did you seek flood information? Select all that apply.	To understand my flood risk, To decide if I should protect my home/property, To know what I should prepare in case of a flood, To know how to evacuate, Other (please describe)

Table 21.3 Knowledge About Specific Terms Survey Items

Question	Answer Choices
Flooding can happen around rivers.	Strongly disagree, Disagree, Somewhat disagree, Neither agree nor disagree, Somewhat agree, Agree, Strongly agree
Flooding can happen around coastal areas.	Strongly disagree, Disagree, Somewhat disagree, Neither agree nor disagree, Somewhat agree, Agree, Strongly agree

Flooding can happen in neighborhoods if people do not pick up leaves from their yards.	Strongly disagree, Disagree, Somewhat disagree, Neither agree nor disagree, Somewhat agree, Agree, Strongly agree
I understand what the word "floodplain" means.	Strongly disagree, Disagree, Somewhat disagree, Neither agree nor disagree, Somewhat agree, Agree, Strongly agree
Flooding only happens on a designated floodplain (or flood hazard area).	Strongly disagree, Disagree, Somewhat disagree, Neither agree nor disagree, Somewhat agree, Agree, Strongly agree
Only people who live in a designated floodplain should get flood insurance.	Strongly disagree, Disagree, Somewhat disagree, Neither agree nor disagree, Somewhat agree, Agree, Strongly agree
I understand what "urban flooding" means	Strongly disagree, Disagree, Somewhat disagree, Neither agree nor disagree, Somewhat agree, Agree, Strongly agree
I understand what "flash flooding" means	Strongly disagree, Disagree, Somewhat disagree, Neither agree nor disagree, Somewhat agree, Agree, Strongly agree
I understand what "storm surge" means	Strongly disagree, Disagree, Somewhat disagree, Neither agree nor disagree, Somewhat agree, Agree, Strongly agree
I understand what "compound flooding" means	Strongly disagree, Disagree, Somewhat disagree, Neither agree nor disagree, Somewhat agree, Agree, Strongly agree

Table 21.4 Flood Message and Resource Awareness Survey Items

Question	Answer Choices
Have you heard of FEMA?	No, Yes
Have you heard of the State of Texas Emergency Assistance Registry (STEAR)?	No, Yes
Have you heard of TexasFlood.org?	No, Yes
What other flood messages or resources have you heard of?	

Table 21.5 presents the survey items measuring message fatigue. These items were adapted from So et al. (2017).

Table 21.5 Message Fatigue Survey Items

Question	Answer Choices
I have lost track of the amount of times I have heard that flooding is a serious problem.	Strongly disagree, Disagree, Somewhat disagree, Neither agree nor disagree, Somewhat agree, Agree, Strongly agree
At this point, I've heard about problems related to flooding more than I ever needed to.	Strongly disagree, Disagree, Somewhat disagree, Neither agree nor disagree, Somewhat agree, Agree, Strongly agree
There are simply too many messages about flooding nowadays.	Strongly disagree, Disagree, Somewhat disagree, Neither agree nor disagree, Somewhat agree, Agree, Strongly agree

After hearing them for years, messages about flooding seem repetitive.	Strongly disagree, Disagree, Somewhat disagree, Neither agree nor disagree, Somewhat agree, Agree, Strongly agree
Messages about flooding are all beginning to sound the same to me.	Strongly disagree, Disagree, Somewhat disagree, Neither agree nor disagree, Somewhat agree, Agree, Strongly agree
I can predict what a message about flooding is going to say.	Strongly disagree, Disagree, Somewhat disagree, Neither agree nor disagree, Somewhat agree, Agree, Strongly agree

21.2   Evaluation Metric #2: Engagement with Messages for Prioritized End-User Groups

The best ways to capture quantitative measures of engagement with messages is to capture metrics from *TexasFLOOD.org* and social media. Additionally, it is important to monitor new ways organizations are using machine learning to analyze online information, paying to identify behavioral patterns, and using online advertisements to conduct audience segmentation based on responses to those advertisements. Additionally, generative artificial intelligence (AI) should be investigated because in the future it will likely be possible to develop personalized messages using AI (Deloitte, n.d.). The UT Austin team that developed the 2024 survey is also working on ways to use AI for messages.

Other ways to evaluate engagement are to work with local community organizations, agencies, and groups engaged in using the Toolkit materials and those involved in hosting flood awareness events. These groups likely already track how many people attend their events, but creating an incentive for them to share that information with you could provide important engagement data. These groups may also be willing to distribute brief surveys around the other metrics mentioned here, and this will likely provide helpful feedback as TWDB expands their flood awareness activities. TWDB should create standardized tools for local organizations to use when collecting data so the same information is tracked and comparable across the state. These standardized instruments could be located on *TexasFLOOD.org* for them to download. Finally, creating an easy way for flood-related officials to report how many community members reach out to them for flood information would be an ideal metric to track over time. Presenting at continuing education events that flood and emergency officials attend is an important way to let them know TWDB would like their help in tracking these metrics.

21.3   Evaluation Metric #3: Efficacy

Efficacy is a metric that tracks people's confidence around a given set of behaviors. We recommend separating these measures into response efficacy (confidence that taking a recommended action will actually be helpful) and self-efficacy (confidence in one's own ability to take the recommended actions). The UT-created items from the 2024 survey that reflect metrics for response efficacy are found in Table 21.6.

Table 21.6 Response Efficacy Survey Items

Question	Answer Choices
How much would it **help you prepare for floods** if you took these actions? Packed an emergency kit	Not at all, Slightly, Somewhat, Much, A great deal
How much would it **help you prepare for floods** if you took these actions? Planned an evacuation route	Not at all, Slightly, Somewhat, Much, A great

	deal
How much would it **help you prepare for floods** if you took these actions? Made an emergency plan	Not at all, Slightly, Somewhat, Much, A great deal
How much would it **help you prepare for floods** if you took these actions? Made arrangements with family, friends, or neighbors to help one another	Not at all, Slightly, Somewhat, Much, A great deal
How much would it **help you prepare for floods** if you took these actions? Got sandbags or barriers for your home	Not at all, Slightly, Somewhat, Much, A great deal
How much would it **help you prepare for floods** if you took these actions? Got insurance against flood damage	Not at all, Slightly, Somewhat, Much, A great deal
How much would it **help you prepare for floods** if you took these actions? Signed up to receive flood alerts	Not at all, Slightly, Somewhat, Much, A great deal
How much would it **help you prepare for floods** if you took these actions? Understood and followed the orders/instructions from authorities	Not at all, Slightly, Somewhat, Much, A great deal

The self-efficacy items are found in Table 21.7. Some of these items were adapted from Morss et al. (2016b).

Table 21.7 Self-Efficacy Survey Items

Question	Answer Choices
How **capable are you** of taking the following flood-related actions? Packing an emergency kit	Not at all capable, Slightly, Somewhat, Much, Completely capable, I've already done this
How **capable are you** of taking the following flood-related actions? Planning an evacuation route	Not at all capable, Slightly, Somewhat, Much, Completely capable, I've already done this
How **capable are you** of taking the following flood-related actions? Making an emergency plan	Not at all capable, Slightly, Somewhat, Much, Completely capable, I've already done this
How **capable are you** of taking the following flood-related actions? Making arrangements with family, friends, or neighbors to help one another	Not at all capable, Slightly, Somewhat, Much, Completely capable, I've already done this
How **capable are you** of taking the following flood-related actions? Getting sandbags or barriers for your home	Not at all capable, Slightly, Somewhat, Much, Completely capable, I've already done this
How **capable are you** of taking the following flood-related actions? Getting insurance against flood damage	Not at all capable, Slightly, Somewhat, Much, Completely capable, I've already done this
How **capable are you** of taking the following flood-related actions? Signing up to receive flood alerts	Not at all capable, Slightly, Somewhat, Much, Completely capable, I've already done this

How **capable are you** of taking the following flood-related actions? Understanding and following the orders/instructions from authorities	Not at all capable, Slightly, Somewhat, Much, Completely capable, I've already done this

We also recommend measures around trust in local government, trust in local community organizations, and other customized measures that help identify where trust is present and where it is lacking. Trust in available resources often influences people's perceptions of efficacy.

21.4 Evaluation Metrics #4 and #5: Intent to Take Action and Taking Action

Intent is a self-reported measure of what people intend to do with the messages and information they have received. Research consistently uses this as an outcome measure because it is often difficult to track the actual actions people take. However, this is not an ideal measure because it is self-reported, and people may not engage in the actual actions. We still recommend tracking four specific intent measures: Intent to be prepared for floods (this will differ depending on whether people are in areas that are asked to evacuate or not), intent to seek flood information, and intent to not drive through flood waters. Here is an example of how Stephens et al. (2023) measured intent to seek flood information:
- I will look for information related to potential risks posed by floods in the near future.
- I intend to look for information about potential risks posed by floods in the near future.
- I intend to find more information about potential risks posed by floods in the near future.
- I will try to seek information about potential risks posed by floods in the near future.
- I plan to seek information about potential risks posed by floods in the near future.

A final measure related to intent is perceived community norms for flood preparation. This variable has been shown to influence people's intent to prepare, and here is an example of how Stephens et al. (2023) measured this concept:
- Most of my close friends who are important to me think that I should seek information about the risks posed by floods.
- Most of my family whose opinions I value seek information about the risks posed by floods.
- Most of my family expects me to seek information about the risks posed by floods.
- Most of my close friends expect me to seek information about the risks posed by floods.
- Most people in my community (excluding my family and close friends) who are important to me expect me to seek information about the risks posed by floods.
- Most people in my community (excluding my family and close friends) who are important to me think I should seek information about the risks posed by floods.
- The majority of the people in my community (excluding my family and close friends) expect me to seek information about the risks posed by floods.
- Most people in my community (excluding my family and close friends) whose opinions I value seek information about the risks posed by floods.

Actual behavior, while much harder to measure, is important. In surveys, people can be asked what flood mitigation measures they have taken, and these could include: choosing a home in an area less at risk for floods, getting flood insurance, planning evacuation routes, preparing a go-bag, turning a car around instead of driving through the water, and getting sandbags ready to deploy. FEMA may have the data around how many policies are written in certain zip codes.

TWDB and/or its local partners could conduct a post-flood analysis of casualties or property damage. If there is a way to work with FEMA and or TDEM, this could be a good metric to track. Identifying increases in flood insurance policies could also be a helpful metric. Finally, conducing field observations around how communities are preparing and taking precautionary measures could provide some insight into the exact types of actions people take.

Data currently exists (although not in a consistent form, as mentioned in Part 1 of this report) around deaths due to driving through flood waters. Flood-related fatalities could be tracked over time to see if there is a decrease after the messages around "Keep Your Car High and Dry" are disseminated.

21.5   Ideas to Collect These Metrics: Longitudinal Household Survey

For the items to be captured using a self-report survey, conducting a longitudinal household survey to assess the impact of messages developed in the one-year project would be ideal. Engaging with an academic research team that can conduct longitudinal household surveys through a multi-year project is one way to capture this data. The same data should be gathered from the same exact sample over at least two time periods for this approach to be meaningful. Our experience is that the researchers should oversample in year 1 because there will likely be at least a 50% drop-off rate in the year two sample. These panel participants are compensated and typically at a higher rate during time two and beyond. This provides an added incentive to continue participating over time.

The household data should contain residential addresses so they can be matched with actual flood risk using a flood risk map. In a recent study conducted collaboratively with UT Austin and the Institute for a Disaster Resilient Texas (IDRT) at Texas A&M University, the team used a convenience sample to test residents' perceptions of the Damage Plain flood hazard model (Mobley et al., 2021) as well as different graphical legends. They captured residential addresses and compared individual responses to actual risk for damage by flood waters (Stephens et al., 2024). That study (along with Stephens et al., 2023 and the 2024 survey) demonstrated the importance of getting residential address data because many people are unaware of their flood risk.

Note that using a random or household-panel longitudinal sample will not be directly comparable to the Stephens et al. (2023) and current 2024 surveys. They did not have the funds or time to conduct a longitudinal survey. Nevertheless, those baseline findings provide considerable guidance for what is recommended moving forward.

21.6   Ideas to Collect These Metrics: Online A/B Testing of Flood Messages

Online experiments can be used to refine and understand both the messages and graphics designed as part of this project. These experiments work by inviting members of the specific end-user groups identified in the current project to participate in what looks like an online survey. When the participants enter the online system, they are randomly assigned to see one of the messages or graphics and are asked for their opinion. Because they only see one of the messages or graphics, they are not influenced by the other options. This allows the researcher to make causal claims about which message/graphic produces the highest level of a desired effect. We recommend this approach be used to better understand risk perception, efficacy, and intent. There are variations of this method that can be used effectively.

21.7   Ideas to Collect These Metrics: Interviews or Additional Surveys

Rigorous interviewing and conducting focus groups remain excellent ways to understand the nuances of how specific flood end-user groups interpret messages and graphics. Building on the work done in this project, it is important to continue engaging directly with the prioritized end-user groups and gathering qualitative data—including stories and specific examples—of how they are using the toolkits as well as how they are incorporating the messages into their lives. This approach could provide an ideal opportunity for TWDB to collect video-based examples of how people are using these materials. This content can be great for *TexasFLOOD.org* as well as social media.

Part 5: Maximizing Flood Outreach

22 Identification & Inclusion of Non-Traditional Stakeholders

22.1 Identification of Traditional Stakeholders

Before identifying the non-traditional stakeholders, it is important to provide a list of the major stakeholders in Texas who are currently involved in flood communication (see Table 22.1). We believe many of them might be able to become more involved as TWDB takes a leadership role in this type of information.

Table 22.1 List of Texas Stakeholders Currently Involved in Flood Communication

Type of Organization	Why Identified	Current Outreach and Opportunities
City Emergency Management Offices including Fire/Police	They work on flood preparedness and response in addition to other types of disasters and emergencies.	Vary by city. Some participate in Flood Awareness Week, some pass out sandbags, some host preparedness workshops.
County Emergency Management Offices	They work on flood preparedness and response in addition to other types of disasters and emergencies.	Varies by county. From our experience, they are often interested in content and will host some preparedness workshops.
Federal Emergency Management Agency (FEMA)	Already involved and working with TWDB.	There might be more opportunities to partner with them around flood awareness.
General Land Office (GLO)	Work with mitigation and post-disaster recovery, including HUD (U.S. Department of Housing and Urban Development) funds	TWDB already collaborates with GLO, but there could be more opportunities.
Local media outlets	Weather forecasters on local television stations (especially Telemundo) are some of the most trusted communicators around flooding.	See if they might be receptive to sharing the different messages around flooding with their viewing public.
National Weather Service (NWS)	NWS has a page on their website that contains Texas-specific information. They have a Texas-specific education module on floods (that requires an account to access it). You can also get updates in Spanish.	Their website needs to be updated and streamlined. There might be ways to engage them directly, but most likely the local weather forecasters will be a better partner.
Regional Flood Planning Groups and Councils of Government (COGs)	They bring together local stakeholders to develop flood plans at the regional watershed level.	Limited outreach, but they do involve local industry and community stakeholders. Many COGs work with aging populations.

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River Authorities/Districts	Manage flood control reservoirs and infrastructure.	Varies. San Antonio River Authority does some nice outreach and has a sharp website.
Texas Department of Emergency Management (TDEM), especially County Liaison Officers (CLOs)	They focus on mitigation and response for disasters. The oversee the State of Texas Emergency Assistance Registry (STEAR) program.	Already collaborating with TDEM, but the CLOs are in every county and could be point people for flood-related education. Working with STEAR can also be helpful.
Texas Department of Transportation (TxDOT)	Communicates road closures and flooding impacts on infrastructure. DriveTexas.org has information on flooded roads when rain events are happening.	They have a public involvement team, and communicating with the public is required under certain regulatory frameworks. They might be interested in helping with flood outreach if it is coupled with their public meetings.
Texas Floodplain Management Association (TFMA)	Goals are to provide development and content for Certified Floodplain Managers (CFMs).	Flood Awareness Week TexAnna TADDpole outreach for school children
Texas Water Development Board (TWDB)	Goals are to grow efforts in flood communication.	Community Officials Flood Resource Guide TexasFLOOD.org
U.S. Army Corps of Engineers (USACE)	Conduct some educational programs around drowning prevention.	While TWDB collaborates with USACE on technical flood modeling and related products, there could be opportunities around education.
U.S. Geological Survey (USGS)	While the USGS's outreach is primarily around water education, they have a visualization lab working on science communication to better explain water to broader publics. Some visualizations depict rainfall during hurricanes.	While TWDB has collaborated with USGS on InFRM, there could be opportunities around flooding that have not been explored.

Many of the existing state agencies could be ideal partners for promoting flood risk awareness. Many of them have a communications or outreach team, so providing them with Texas-specific flood information could help them accomplish some of their objectives. We recommend that TWDB not create and maintain communication channels itself, but instead provide information to organizations who are already reaching their local constituents and are likely to be better known and trusted sources of information.

22.2   Identification of Non-Traditional Stakeholders

There are many reasons that non-traditional stakeholders who are not currently disseminating much if any flood risk awareness information might be interested in sharing TWDB content. First, many have an explicit mission to provide education, assistance, and/or resources to the general public, and promoting risk awareness aligns with these missions. Second, several are called upon to support citizens during and after flood events, so expanding their supporting role to proactive information distribution is natural and relatively seamless. Third, many of them look for ways to stay front-of-mind for their clients/customers. They provide their clients with informational newsletters as a way to add value without having to constantly discuss their particular services. This is a common strategy used by many organizations that rely on customers (or donors) for their business models. This is also common with non-profit organizations. See Table 22.2 for a list of non-traditional government organizations, and Table 22.3 for a list of non-traditional industry/for-profit organizations and trade associations.

Table 22.2 Non-Traditional Government Organizations and Opportunities

Type of Organization	Why Identified	Potential for Outreach
Agencies on Aging (often housed within a COG)	Offer services for aging populations.	Could be ideal to reach the needs of older adults and those with mobility disabilities.
AgriLife Community Health and Resource Management (CHARM)	They provide local stakeholder workshops that help with planning, including flood mitigation.	The group is growing and expanding into an online platform. They have potential to be a good partner for outreach.
City housing/community development departments and/or housing authorities	Offer renter assistance.	Could help reach renters, and many newcomers to Texas rent first. They also reach people with lower incomes.
Department of Motor Vehicles (DMV)	People come to this office to get their car registered and their driver's license.	Many people who are new to Texas and are new drivers need to physically visit a DMV office. This is an opportunity to reach many target groups with flood-related information.
Elected officials: County Judge, County & City Commissioners, Mayors, and non-elected City Managers	These are the City and County government officials and they often look for non-partisan topics to share with constituents. Their social media feeds are sometimes the most followed in a community.	Our team has seen first-hand that these officials can be great partners in disseminating flood and disaster preparedness information. They want to keep their constituents safe.
Texas A&M University (TAMU) Institute for a Disaster Resilient Texas (IDRT)	Mission is to deliver research on flooding and support state agencies with data analytics and tools.	IDRT is doing many different projects in Texas and might be willing to share flood risk materials. They would also probably put a link on their website.
K-12 Education	Water education is required at certain grade levels, but flood-specific information is	Developing flood materials for teachers to use, that also help them meet state requirements, could

	not required. Some organizations have developed flood modules for middle school. Meets the state's standards for what students should know and be able to do (Texas Essential Knowledge and Skills, or TEKS).	reach almost all children and young people in Texas, and that information can extend to their families.
Local public health agencies (through the Texas Department of State Health Services)	Their goal is to improve the health of Texans. They offer over 150 programs, but none are about flooding. They also train Community Health Workers called Promotoras work with people who have lower incomes and speak Spanish.	They already play a role in things like drowning prevention, so if flooding risks were communicated broadly as health risks, they might disseminate the information. For example, the CDC has materials urging people to stay out of floodwaters.
Texas A&M AgriLife Extension, especially the Disaster Assessment and Recovery (DAR) agents	They provide training and programs related to agriculture and natural resources, including flood and disaster information.	They already have Extension and DAR agents throughout Texas. Prairie View A&M has Community & Economic Development Agents who are doing outreach, including flood information.
Texas Department of Information Resources (DIR)	This group manages https://www.texas.gov/	This website is an ideal partner because they provide resources for people moving to Texas, links to local DMVs, and they allow public websites to link to them.
Texas Home School Coalition (THSC)	They provide curriculum guidance and resources for home schooled students.	This group might have more flexibility to include flood education than public schools. This is a growing population of young people in Texas and their families.
Texas Library Association (TLA)	Libraries can be a key community resource during flooding and disasters.	TLA hosts an annual conference for members and provide professional development. Individual libraries are willing to post flyers and share information with their community if you go through the proper approach process.
Texas Department of Insurance (TDI)	Regulates insurance in Texas and provides education and materials related to reducing risk.	TDI refers people to FEMA's insurance website. They have limited information on disaster preparedness and might share this content to their agents.
Texas Parks and Wildlife	The state agency managing parks and providing	While their focus is often on water conservation, some locations offer

	education for conservation in Texas.	education on flash flooding. They might be interested in flood materials as part of their education programs.
Utilities (Government-Owned)	Water utilities often distribute sandbags and play a role in floods when water services are disrupted.	They have contact information for almost every customer in their service area. They often provide helpful disaster-related and water conservation information to their service area.

Table 22.3 Non-Traditional Industry/For-Profit Organizations/Trade Associations

Type of Organization	Why Identified	Potential for Outreach
Bankers/loan officers	Bankers require flood insurance if people get a loan for a home located in a flood hazard area.	Bankers might be willing to distribute flood risk information to all their clients because they want to limit their own risk in making the loan.
Insurance companies	The direct contact for people to purchase a variety of types of insurance, including those that could be related to flooding.	Individual agents and agencies are often looking for ways to add value to their clients and prospects. They might find prepared content helpful and be willing to share it.
Journalism organizations	Often share information about flooding in articles. They tend to have a science/environmental journalist contact if they are a large organization.	Articles can reach people with needed information. For example, the Texas Tribune recently ran an article.
Real estate companies	Currently required to disclose flood status when selling properties.	Training of individual agents varies. They are careful about what they say and would likely not want to disseminate flood awareness information. Because agents need continuing education credits, one opportunity might be to provide content to the trainers who follow regulations.
Texas Association of Realtors	The largest professional membership association in Texas for real estate professionals. Approximately 85% of licensees are a member.	They publish Texas REALTOR, a magazine with a current circulation of over 135,000 copies. The association also provides training for many realtors in Texas, and that training includes brief information on flood disclosure.
Texas Automobile Dealers Association (TADA)	They represent the automobile dealers in Texas.	TADA could share the flood messages directed to young adult males, because "Keep Your Car High and Dry" resonates with the goal of selling automobiles.
Texas Bankers Association	This is the state-based trade organization for banks. Currently, 412 of the 491 banks	They offer training and education (none seems flood-specific) and may be willing to share Texas-specific flood information

	in Texas are members of this organization.	with their members and individuals who attend training.
Texas Mortgage Bankers Association (TMBA)	State-based trade organization for mortgage lenders in Texas.	TMBA says they provide their members with educational opportunities, and this could be a potential partner for flood education.
Texas Press Association (TPA)	The largest trade association for newspapers in Texas.	TPA has a list of members and could be willing to share information with them. Contacting smaller local newspapers, including community impact newspapers, could also be an approach.
Texas Water Conservation Association (TWCA)	Members include all the Texas river authorities and many water districts. They have been active in state flood policy issues.	This group might be willing to partner on flood education efforts.
Utilities (for-profit)	Water utilities often distribute sandbags and play a role in floods when water services are disrupted.	They have contact information for almost every customer in their service area and they look for ways to add value.

We recommend focusing on the state-wide organizations for insurance, real estate, and banking because they can reach a lot of members using the meta-channel communication approach.

We recommend providing "The Sandbag Story" (originally developed with funds supported by the IC^2 Institute) to utilities and allowing them to customize the materials for their local audiences. We found there are limited resources available that provide sandbag instructions, and sandbags are one of the lowest cost forms of mitigation.

We have provided a list of non-traditional non-profit organizations in Table 22.4.

Table 22.4 Non-Traditional Non-Profit Organizations and Opportunities

Type of Organization	Why Identified	Potential for Outreach
American Association of Retired Persons Texas (AARP Texas)	They reach many older adults in Texas.	AARP Texas provides a wide-range of education and information materials, so sharing preparedness information would likely be welcomed.
American Red Cross (they have regions)	They often help during response and recovery and run shelters.	They have local Texas chapters and regions that might be interested in sharing flood information.
Chambers of Commerce	They promote economic interests in communities and have many small business owner members. They serve a geographic area.	They can have extensive reach into communities. They offer workshops around business continuity and are distributing

		our flood materials in the Lower Rio Grande Valley.
Churches and religious organizations	Keeping their members safe is a key goal of religious organizations and they serve their local constituency. They often serve as an unofficial shelter and they help with flood recovery.	If they have flood materials their members find helpful, they will likely share them.
Grocery stores that provide relief for disaster response	Local Texas-based chains, like H.E.B., provide considerable help with disaster response and recovery.	Partnering with grocery stores might be an ideal way to reach groups in need after floods.
Housing-related non-profits	Offer renter and homeowner assistance.	Sharing information with their clients. They often educate as well as provide services to residents. For example, there is Foundation Communities in Austin.
Meals on Wheels Texas	Association of home-delivered and group meal programs focused on older adults and people with disabilities having food and the social support they need. They operate with the help of many volunteers.	Working with local programs to target people in flood-prone areas. Because this program has location-specific services, they are aware of people in need.
Museums in Texas	There are many museums that have a Texas-specific section. While their content is curated, they often share local information.	Museum of South Texas History has an exhibit collecting stories about flooding. The Houston Flood Museum is designed to keep memories of floods alive.
Neighborhood associations	There are many of these groups, so it might be helpful to suggest that TWDB's local partners engage with them.	In areas where flooding is a concern, these associations often have newsletters and share information with community members.
Refugee and immigrant associations (many cities have these non-profit organizations)	They offer a host of resources for immigrant populations and often provide services in multiple languages.	These organizations may be willing to share flood-preparedness information. For example, one such organization is RAICES (Refugee and Immigrant Center for Education and Legal Services).
Salvation Army	Provides disaster response.	This organization, and others like it, are in direct contact with people in need after a disaster. They might find it a part of their

		mission to better inform their clients of flood awareness.
Texas Water Foundation (includes the Texas Runs on Water campaign)	Mission includes educating the public to understand importance of water and training leaders in this area. Current focus is water conservation.	Future potential could be to expand into flood outreach.

23   Recommendations to Maximize the Accessibility of Flood-Related Outreach

23.1   Key Partners to Maximize Flood Outreach Among Vulnerable Populations

To effectively maximize the accessibility and reach of flood communication efforts, we recommend building relationships with community organizations that provide resources and services to vulnerable populations in Texas. We included people new to Texas (including immigrants) as well as people who speak Spanish as two of the prioritized end-user groups. Refer to Part 3 of this report for an overview of strategies to effectively share toolkit materials with these community organizations. Parts 2 and 3 of this report include all messages in Spanish designed for the targeted end-users.

23.2   Languages Other Than English

Increasingly there are tools available, for free or low cost, to help translate messages into multiple languages. Google Translate, and AI-driven tools like ChatGPT and Bing Microsoft Translator, work reasonably well, but users must take into account that all these automated systems miss many culture-specific idioms and context-specific meanings. For example, our team not only included feedback on all the messages we designed from three separate Spanish speakers (who grew up in different areas of the U.S. and Mexico), but also conducted focus groups with Spanish speakers to assess the specific meaning of our designed messages. Meanings and even specific words change depending on the area of Texas.

For the future, designing messages in multiple languages will require more resources than simply translating into a different language. Partnering with organizations that serve immigrants who speak languages other than English could be a good strategy, but those are primarily located in major metropolitan areas. For example, in Houston, there is a national Vietnamese-American organization, Boat People SOS, that serves people who speak Vietnamese. Note that most of these organizations focus on providing legal services, so it will take research to identify the best one for reaching people speaking languages other than English in a specific geographic area. Messages will need to be verified by multiple people who speak that language. It would also be prudent to include people who speak that language and understand the cultural nuances to participate in interviews or focus groups.

23.3   Reaching People With Lower Income

Several agencies and non-profit organizations well-positioned to reach people with lower incomes have been included earlier in this section. Specifically, city housing departments serve people with lower incomes and they often assist them with rental housing or housing purchases. These local city departments would be ideal partners to share and distribute TWDB's flood information among their constituencies. Texas Health and Human Services Commission, which processes eligibility for Medicaid and other programs could also be a helpful partner. Meals on Wheels, another organization that serves people with lower incomes, especially older adults, is discussed next.

23.4   Meals on Wheels

Meals on Wheels Texas coordinates many local programs that serve older adults and people with disabilities. Many of their services are provided to home-bound people, but they also offer programs where groups of people meet for social activities. Their reach is extensive. For example, Meals on Wheels Central Texas serves nearly 5,000 homebound older adults and people living with disabilities via the aid of over 8,000 volunteers. They provide services to those who require help with personal care (e.g., bathing, preparing meals), surgery recovery (e.g., picking up prescription drugs, accompanying individuals to/from doctor appointments), or home safety repair.

Among the pros of Meals on Wheels, we found that:

- According to a local news report, Meals on Wheels prepared for Hurricane Harvey by giving their clients five extra days of meals to last through the storm. Volunteers contacted their clients daily to ensure their well-being during Hurricane Harvey.
- According to Somerville-Cambridge Elder Services, Meals on Wheels serves not only as a meal delivery service, but also as a safety check for clients. They notify emergency contacts and can communicate with emergency services if necessary. Meals on Wheels also arranges community social events where clients can eat together.

23.5   State of Texas Emergency Assistance Registry (STEAR)

The Texas Division of Emergency Management (TDEM) offers the State of Texas Emergency Assistance Registry (STEAR) where anyone with a disability or who requires transportation assistance in an emergency can enter their information and emergency responders will have access to that information. Preliminary conversations reveal that not many people may be aware of the STEAR resource but it might be helpful to raise awareness about the registry for the protection it could provide during a flood event.

The STEAR registry is a free service that offers information to emergency responders and planners about community members in need of help during disasters. People who need assistance can register online or through a call to 211. However, registration does not guarantee specific services during emergencies, and services vary across communities (verified during an interview with STEAR on May 8th, 2023; see also Care Connection). Registration expires annually and must be renewed by the user. According to STEAR, 80% of their registrants speak English while 16% speak Spanish (see Figure 23.1), and 57% of their registrants require assistance related to a mobility disability (see Figure 23.2).

Figure 23.1 Language Demographics of STEAR Registrants
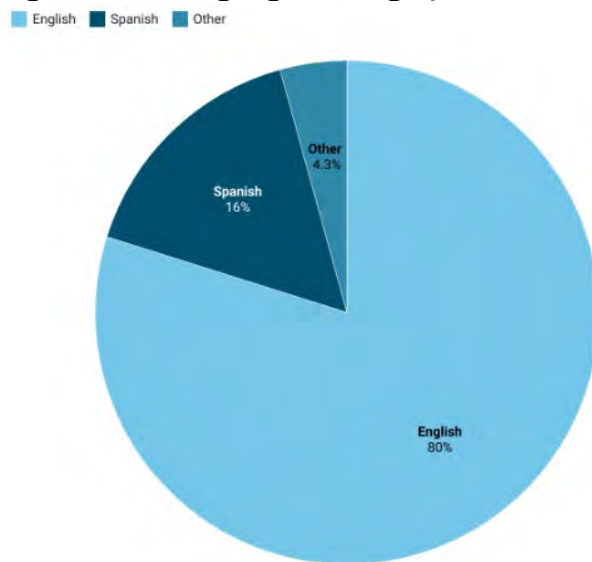
Figure Information: Spanish is the second-largest language among STEAR registrants. *Source: Data taken from an excel spreadsheet that was shared with our team during an interview with STEAR on May 8th, 2023.*

Figure 23.2 Proportion of STEAR Registrants Needing Moving Assistance
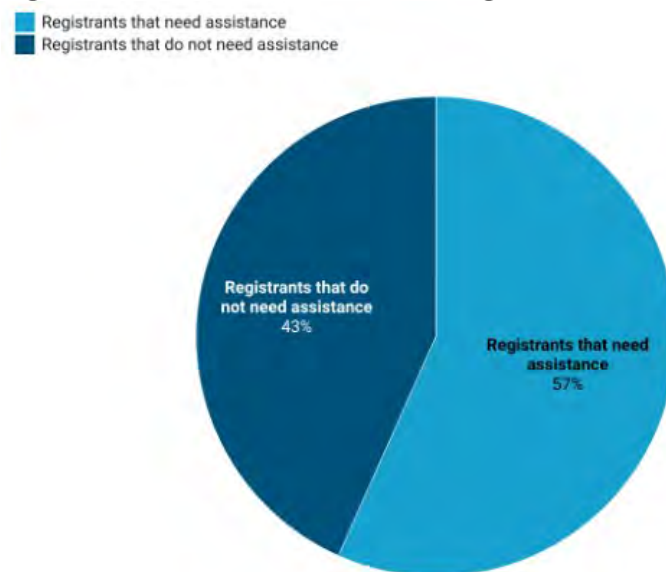
Figure Information: The majority of STEAR registrants require assistance because of a mobility disability. *Source: Data taken from an excel spreadsheet that was shared with our team during an interview with STEAR on May 8th, 2023.*

Only 33.5% of Texas counties are members of STEAR, resulting in approximately 35-40% state-wide geographic coverage (19th Texas Silver-Haired Legislative Report). Figure 23.3 shows the distribution of STEAR registrants by Texas county.

Figure 23.3 Number of Texas Residents Registered on STEAR by County

Total Registrations: 21,919
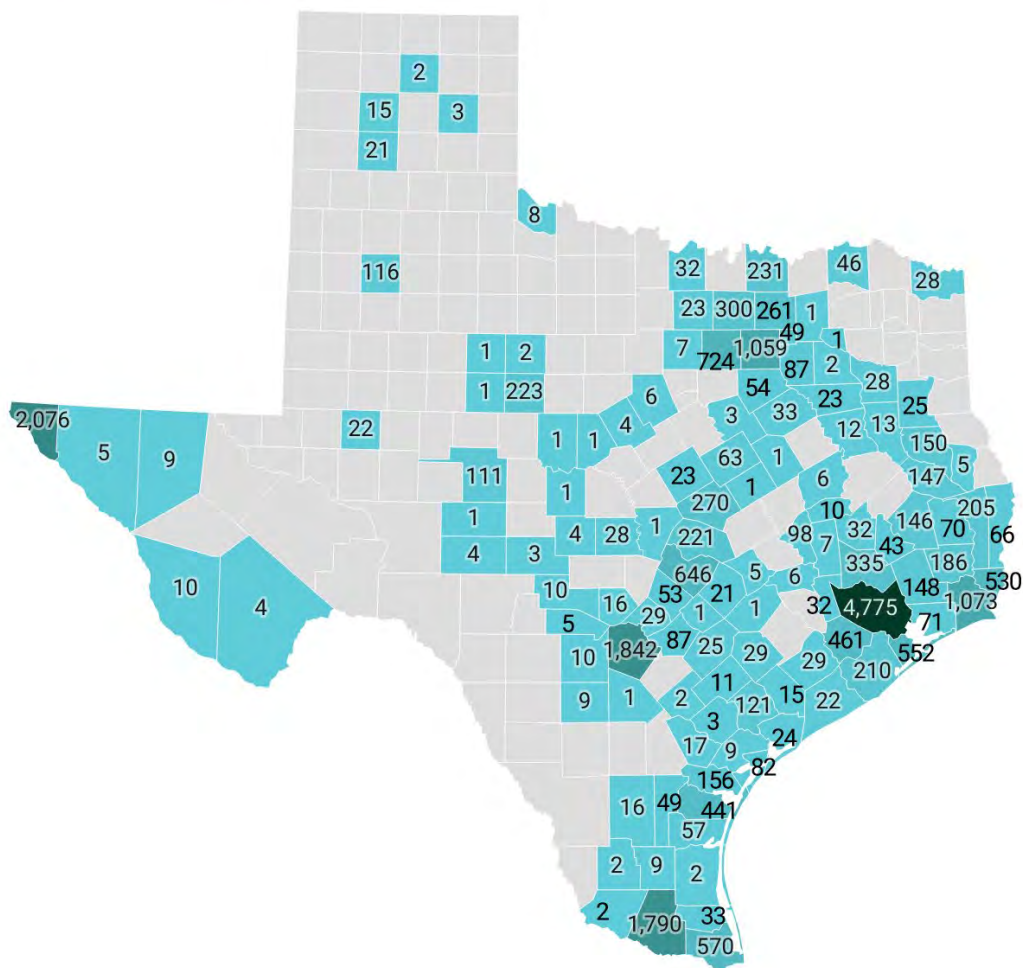
Figure Information: The counties with the greatest number of STEAR registrants include (in order from highest to lowest): Harris County, El Paso County, Bexar County, Hidalgo County, Jefferson County, and Tarrant County. *Source: Data taken from an excel spreadsheet that was shared with our team during an interview with STEAR on May 8th, 2023.*

Figure 23.4 shows the counties in Texas with the highest number of STEAR registrants who use some form of assistive equipment for mobility. Notably, ***7 out of the top 15 counties are in Flash Flood Alley***, including Bexar County, Dallas County, Tarrant County, and Travis County. Furthermore, each local jurisdiction manages the STEAR program differently, with some choosing to instead have a local registry, causing non-standardization across different jurisdictions (see also the 19th Texas Silver-Haired Legislative Report). To make STEAR more useful for Texans with disabilities, TWDB might work with TDEM to promote greater visibility for the service.

Figure 23.4 Texas Counties' STEAR Registrants Using Assistive Equipment for Mobility

Legend:
- ■ Medical Equipment Wheelchair
- ■ Medical Equipment Walker
- ■ Medical Equipment Cane
- ■ Motorized Wheelchair Scooter

County	Total
Harris	4,609
El Paso	1,944
Hidalgo	1,637
Bexar	1,355
Dallas	862
Tarrant	692
Travis	660
Jefferson	783
Cameron	538
Orange	518
Galveston	491
Fort Bend	433
Bell	271
Collin	245
Williamson	215

Figure Information: Nearly half of the top 15 counties are in Flash Flood Alley (Bexar County, Dallas County, Tarrant County, Travis County, Bell County, Collin County, and Williamson County). *Source: Data taken from an excel spreadsheet that was shared with our team during an interview with STEAR on May 8th, 2023.*

24 Highly Trusted Organizations to Serve as Flood Communication Ambassadors

24.1 Identification of Three Highly Trusted Organizations

While there are many organizations listed here that are potential partners, here we identify three that are highly trusted and could reach the prioritized end-user groups.

To reach males 18-35 with messages around "Keep Your Car High and Dry," we suggest partnering with universities and community colleges across Texas. They have extensive reach into this prioritized end-user group, and there are opportunities to train students to be flood communication ambassadors. Universities and community colleges offer an untapped potential to engage young adults as citizen scientists and flood communication ambassadors. It is true that students with specific majors in c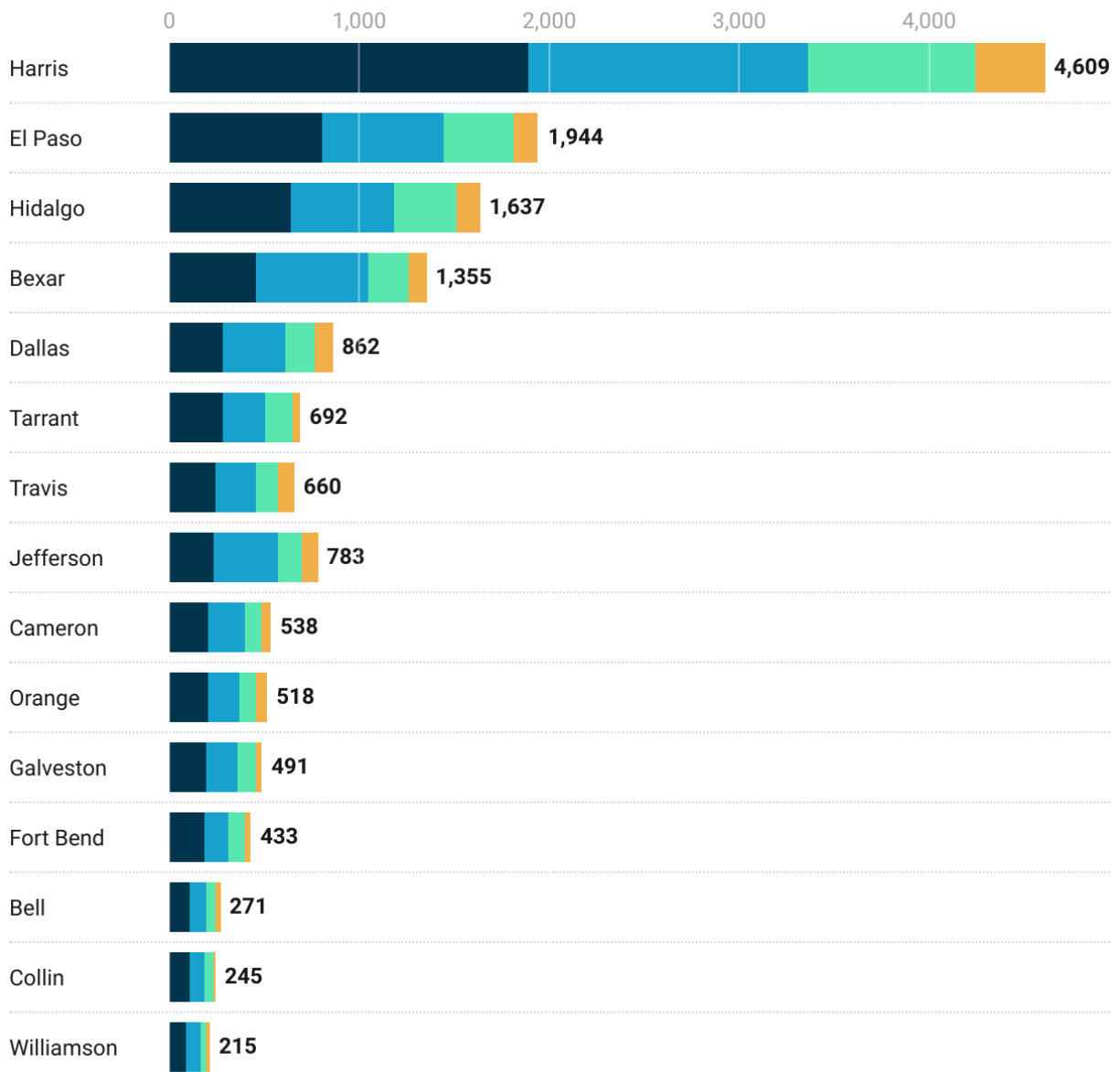ollege might learn about opportunities to be citizen scientists, but this is typically as part of a course or a specific instructor's project. These efforts could be expanded, and for equity reasons, the focus should be on providing young adults with paid internships. The Home to Texas Program is offered by the IC^2 Institute at The University of Texas at Austin. The program provides workforce development and summer internships for undergraduates. It is designed to get students engaged in their home communities. For the TWDB program, the goal would be to hire these young adults into Flood Ambassador Internships where they distribute flood education materials to peers on their campuses. They may also engage in creating new flood awareness materials, such as quick-format videos, social media posts specific for their campuses, and hosting flood awareness programs on campus.

To reach people new to Texas, we suggest partnering with local water and power utilities. Regardless of the type of home, when people are new to an area, they need to have their water and power turned on. At the same time this happens, the utilities could share flood-related information with them. This is happening already in some counties, and in Fayette County, Texas the local utilities reach out to their Certified Floodplain Administrator to verify that new service is not being activated on a designated flood hazard area. This approach can identify people who would otherwise slip through the system and be unaware they are at risk. It is difficult to say if these utilities are trusted in every community, but they have extensive reach and people who are new to an area will need to contact them.

To reach older adults, especially those with mobility disabilities, we suggest partnering with Meals on Wheels Texas. Of all the organizations we examined that might reach this prioritized end-user group, Meals on Wheels offers the most trusted and location-specific path. With a TWDB partnership, they could include preparedness information, information about STEAR, and other flood-related tips on flyers that are delivered along with the meals going to the households they serve. Another benefit to partnering with this organization is their extensive volunteer network that could provide a clear path toward the development of Flood Communication Ambassadors. These volunteers could be trained in flood preparedness and they could offer local programs for Meals on Wheels clients.

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