Disaster Preparedness Resources for the Rio Grande Valley Region

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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Introduction

Flooding is the most common natural disaster in the US, and with climate change, the severity and frequency of storms has increased over the years (U.S Department of Homeland Security, 2021). For cities in flood plains and with frequent storms, flood preparedness is extremely important because these storms can damage property and/or be fatal if not properly prepared.

There are many factors influencing the impact of flood preparedness, and initially, for my research I decided to study what sociodemographic and economic factors impact flood preparedness within Rio Grande Valley (RGV) area located in Southern Texas. Rio Grande Valley consists of 4 counties: Cameron, Hidalgo, Willacy, and Starr. This area has high flooding risk due to its flat surface, poor water retention in soils, and rapid development (Donner and Lavariega-Montforti, 2018), and several hurricanes and frequent storms originating from the Gulf of Mexico pass through this area. In 2008 alone, Hurricane Dolly caused over two billion dollars in property damage (US Department of Commerce et al). In addition to that, the population primarily consists of young, low-income Hispanic or Latino people with lower education levels compared to the US seen in Table 1 below.

Table 1

Demographics of the Rio Grande Valley versus the US as a whole

	Hidalgo County	Cameron County	Starr County	US
Total population	831,073	420,392	62,955	318,857,056
Percentage Latino	91.20	88.70	95.80	16.30
Percentage under 18	33.60	31.60	33.00	24.00
Percentage female	51.20	51.70	51.40	50.80
Percentage high school graduate	61.80	63.70	45.00	86.00
Percentage poverty	34.80	34.80	39.20	14.80

Source: United States Census Bureau, https://www.census.gov/ (last accessed on 6 February 2018).

While researching this topic, I've concluded that while age and income have been primarily significant factors in flood preparedness across all studies, this issue is far more complex. Minority and low-income groups are most vulnerable during storms, and other factors that could account for lack of preparation include language barriers, mistrust of government, lack of evacuation route and more (Knye et al, 2020). However, I've learned that education is key to flood preparedness, which is why I'm filling in the gap, and for my research, I will explore what flood preparedness resources are available for citizens in the Rio Grande Valley area. There are several local NGOs that provide food and financial resources before and after a storm event and internet resources that help with preparation. However, broadband access is limited in this region and while the government is working on resolving that issue, an in person educational program should be provided.

Background and Significance

With the increase of severity in storms and floods, flood preparedness is very important. While engineers build water infrastructure to help mitigate flood impacts, those systems aren't perfect, and floods will still occur especially in areas that experience frequent storms and are flood prone regions such as RGV.

Since 1851, there have been 64 hurricanes that have hit the RGV region, averaging one hurricane every three years. Recently, Hurricane Dolly, 2008, and Hurricane Hanna, 2020, each caused around $1 billion or more in property and crop damage. Fortunately, these storms resulted in no casualties but there were direct injuries. Table 2 lists storms within the 21st century that caused billions of dollars in property damage, and all but Charley killed dozens to hundreds of people (Goldsmith, 2022).

Table 2.

Rio Grande Valley/Deep South Hurricane History and Impact

Storm	Main Impact Area	Year	SSHWS (landfall)	Damage ($billions)†	Primary Impact
Allison	Houston	2001	None	5.5	3+ feet of rainfall; record inland flooding in Houston
Charley	Southwest Florida	2004	4	15.4	Extensive Wind Damage, but only a 4 to 7 foot storm tide
Katrina	Louisiana and Mississippi	2005	3	81.3	Storm tide up to 28 feet. Catastrophic storm surge flooding; thousands of persons drowned
Ike	Upper Texas and Southwest Louisiana	2008	2	29.3	Storm tide up to 20 feet. Extensive to catastrophic storm surge flooding; several dozen persons drowned or missing
Sandy	Northeast U.S.	2012	1*	50+	Vast majority of damage from ≥10 foot storm tide along NJ/NY coast; dozens of persons drowned
Harvey	Texas	2017	4	125+	$100 billion from freshwater flooding in SE TX when system was Tropical Storm

*Storm considered Post-Tropical at Landfall
†Dollar values in year of landfall

Without effective disaster education, these storms can be fatal to human life. Disaster preparedness includes necessities such as three-day water supply, nonperishable food, a battery-operated radio, a flashlight with working batteries, a written household emergency plan, and a three-day prescription medical supply (CDC, 2022). Benefits for individual disaster preparation could lead to effective preparedness, mitigation, response, and recovery during hurricane or storm. With the common goal of minimizing negative impacts during disasters, individual preparedness shouldn't be undervalued. As mentioned above, there are many reasons for unpreparedness: unawareness of importance on disaster preparedness, lack of time to prepare, lack of information on how to prepare, lack of sufficient income (Knye et al, 2020). However, the education of both disaster planning and resources available to the region should help minimize the impacts of storms.

Methodology

What are flood preparedness resources available for citizens in the Rio Grande Valley area? To collect this evidence, I have looked at literature describing influential sociodemographic and economic factors impacting the RGV region. This method of evidence collection allows me to understand the factors that impede the disaster preparedness process and find what resources are available if any.

Within this literature, there is much content to work with as these articles provide survey data analyzing decisions and impacts that hurricanes have on this region. Lastly, I will use Actor Network Theory (ANT) to explore the relationship between various actors involved in the storm process. ANT is a theoretical framework that, "calls for a symmetrical relationship between people and objects that erases the commonsense notion of animate human actors and inanimate passive things" (Walker, 2008). Non-human actors in this topic are just as important as human actors, and specifically, individuals, families, communities, state and federal governments, storm frequency, broadband access, geography, and land properties such as flat surfaces intertwine in knowing what resources are available and what resources should be available for this region.

Literature Review

It's important for individuals to understand their part in being prepared, and for the government and non-governmental organizations (NGOs) to help support and educate everyone. According to Kyne et al study in 2018, majority of the people living in RGV believe that the government is largely responsible for protection during high-risk flooding events, and they believe that NGOs should provide clothes and sandbags. Specifically, this study revealed that these residents expect more help from government agencies after hurricane events specifically with public transportation, temporary shelters, food, drinking water, medicine, and other needs. However, during a disaster response, the individual is first responsible for themselves followed by family, community, state, and then the federal government (PHEgov, 2011). This is important for people to recognize that this is how the United States Public Health Emergency Department (US PHE) thinks, and how they expect others to think.

This is important to consider because if people have the perception of the government helping them after a storm, they might not take the proper precautions prior to each storm which can end up detrimental or even fatal. This can be seen specifically in the legal case *LUPE, et al. v. FEMA*. The case

study discusses an unjust response of aid from the Federal Emergency Management Agency (FEMA) after Hurricane Dolly in 2008. One of the poorest regions in the US, the Rio Grande Valley in Southern Texas received a high rejection rate in post-disaster funding from FEMA's Individuals and Households Program. Due to this, people from La Unión del Pueblo Entero (LUPE) formed a legal team and sued FEMA. A decade later, LUPE settled the case. However, FEMA wasn't inclined to change their policy. They continued to use their deferred maintenance policy to justify high rates of rejection in low-income communities. This was seen by other organizations such as Texas Housers and was unjustly used in Puerto Rico after Hurricane Sandy hit the area (Rivera, 2019).

The main reasons for less disaster preparedness are lack of access to disaster preparedness information and resources (Kyne et al, 2020). Kyne and his colleagues' study in 2020 defines what it means to objectively be prepared for hurricanes and separates it from subjective thinking and provides influential factors that help or hinder that process for a sample population in RGV. This study reveals that majority of respondents lacks the following disaster preparedness items, which include a written disaster evacuation plan, a list of emergency contact numbers, a designated safe place, familiarity with evacuation routes, a battery-operated radio, 3-day of water supply and savings for evacuation expenses. Building community resilience requires considering the needs of the most vulnerable. In terms of RGV this means considering those with insufficient disaster preparedness and educating and encouraging them to prepare (Kyne et al, 2020.)

Previous research states that authoritative warnings are geared towards the majority cultural usually missing low-income, elderly and minority populations. The majority of Rio Grande Valley falls within the missed category, and it can lead to this distrust of the government that this population experiences (Ruin et al, 2008). Another study points out beliefs surrounding the incredibility of official warnings amongst coastal residents causing them to turn to other sources to influence their decisions regarding dangerous conditions (Dow and Cutter, 1998). Ruin et al. evaluates flood preparedness after

Hurricane Dolly hit RGV in 2008. They found that about half of the sample believed they were at risk while the other half did not due to not trusting the information given, believing they were in a safe location, or they didn't believe that the weather report given was bad. None of the interviewees complained about preparation time prior to the storm, but preparation time varied from three days to six hours before the rainfall with many people preparing the day before.

In an area that experiences storms frequently, people should not be preparing for storms the day before. They need to know what resources they can access to better equip themselves before, during, and after a disaster so they are objectively and subjectively prepared. To discover how to tackle that issue, I've researched what potential barriers impact people's availabilities to prepare, what resources are available for people to take advantage of now and will suggest what's missing.

Results/Discussion

Federal government and NGO assistance

The federal government states that the individual is responsible for themselves in the event of disasters though people in the RGV look to the government for assistance according to Kyne et al in 2018. This knowledge supports a previous study in which 73% of the total respondents believed the government was the primary source for assistance after a disaster (Terpstra and Gutteling, 2008). Individuals look to NGOs for assistance as well. The federal government and NGOs are important actors within this system because they're who people expect to help them after a disastrous event although the government tells them to prepare beforehand themselves.

Non- Human Flooding Actors

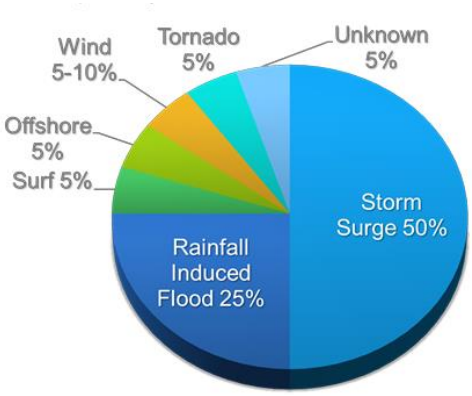
While all these interactions between human actors are happening in flood preparedness, looking at the natural surroundings of the area is important as well. With the RGV being in Southern

Texas right next to the Gulf of Mexico, it is susceptible to numerous storms due to its unique U-shaped coastline according to Ryan Truchelut, chief meteorologist at Weather Tiger. He states, “When a hurricane gets into the Gulf of Mexico, it's hard for it not to hit somebody," (6abc Philadelphia, 2022). This combined with the RGV’s high flooding risk due to its flat surface and poor water retention in soils makes flood preparedness even more important for this area. All these actors within geography and land properties, add to why it’s important to prepare for floods. Because of the location near the Gulf, the frequency of storms increases, and because of the flat surface, poor water retention of the soil, flooding is more prone to happen in this area.

According to the National Weather Service, Mobile/Pensacola, storm surges, a wall of water flooding inland, followed by rainfall induced floods are the most dangerous aspects of hurricanes (Figure 1). Storm surge flooding is the greatest threat to life as it creates a substantial threat for drowning, and the water levels can heighten within minutes (Goldsmith, 2022).

Figure 1.

Categories of most dangerous aspects of hurricanes



With climate change, the severity of these storms is increasing along with the dangers, and looking at what barriers impact preparedness is important to understanding resources available for vulnerable populations.

Factors that impact preparedness

Across several studies I've explored, age, disaster experience and income are significant factors impacting preparedness. This is important to recognize when this region has above average populations of people under 18 and high poverty rates compared to the US. With the population being younger, they're not going to have as much disaster experience which poorly influences their actions surrounding storms. With limited funds, it's harder to make efforts to prepare from being able to stock up on necessary supplies to making house repairs, and unfortunately, that's a limiting factor to preparedness (Donner and Lavariega-Montforti, 2018).

Part of the preparation is having an evacuation plan, and many of these same barriers negatively impact that as well. When it comes to evacuation routes, the state and local governments can help hinder these effects by creating spaces to teach people about how to navigate evacuating when those alerts come out such as identifying safe places. Also, local officials should cater these education opportunities to the vulnerable populations. They can also help with transportation funds in the event of storms where an evacuation order is in place. This would be extremely useful to those with a presence of medical special needs (MSN) within their household (Meyer et al, 2015).

A study in 2019 done by the National Digital Inclusion Alliance (NDIA) discovered that four out of five of the least-connected cities are in Texas, three of which are found in RGV. Pharr, Brownsville, and Harlingen are ranked the worst, 2nd worst and 5th worst connected cities with about 60%, 23%, and 34% of the population not having access to any type of broadband, respectively (NDIA, 2019). These households don't have access to cellular data or Wi-Fi to be able to communicate with friends and family nor can they access internet resources about storm preparation resources or weather events. In addition, 69%, 67%, 51% of the households in Pharr, Brownsville, and Harlingen respectively, don't have access to cable, fiber optic or DSL wireline, so not only do residents not have access to a network but

also satellite. This means the best method of communication is by mouth in these areas, and that's not the most effective method of communication in terms of storms.

After the pandemic in 2020, having high speed broadband became a priority as education and health care shifted to a virtual environment. Prior to 2022, the state of Texas did not have a statewide broadband network, and in 2022 the state governor established broadband an emergency priority which led to the creation of the Statewide Broadband Office with goals of funding those cities without and with limited broadband access (Hinojosa, 2022). Broadband access is an important actor in this process because it allows people to communicate and see information needed to determine how to prepare and take action during a storm, and the state government recognizes that so it's trying to expand it across the state of Texas.

Internet Resources

For those with access to the internet, the CDC website under natural disasters and severe weather is the first place to start when preparing for tropical storms or hurricanes. They have articles both in English and Spanish explaining the steps of preparedness such as making a plan, gathering an emergency kit, the difference between hurricane warning and watch, etc. It also has an infographic explaining what to do before and after hurricanes. In addition, Gulf Coast Hurricane Preparedness 2022 is a great resource as well. Though this guide is tailored towards Florida and Alabama residents, it has amazing information that can be used for the general public in terms of how to prepare for a storm and what to be cautious about. Having these resources available will help aid people in being proactive about preparedness. More locally, there's also a 2022 Official Rio Grande Valley/Deep South Texas Hurricane Guide that provides more in-depth information about hurricane preparedness.

Hidalgo County has a website with emergency preparedness tips. On this site, they have evacuation routes, local radio stations and a phone number to call for road conditions listed. They have

videos explaining these in both English and Spanish. The website describes how to register for transportation assistance for those who live in a hurricane evacuation zone with special health care prior to hurricane season. It's important for those to register so the county knows an estimate of how many people may need assistance prior to a storm. For flood risk assessment, the website lists another site that will provide a flood risk assessment of an address and give an estimated annual cost for flood insurance and a list of local flood insurance agents. There are video explanations provided in English and Spanish. It talks about making an emergency plan and preparing an emergency kit with videos in English and Spanish.

Local NGO Resources

Locally, there's a few organizations that help with food and financial resources which is why there are important actors in this process. La Unión del Pueblo Entero (LUPE) believes that members of the low-income community have the obligation to organize themselves. They respond to the needs of the community throughout the RGV (LUPE, 2023). RGV Mutual Aid financially supports those still impacted by Hurricane Hanna in 2020. Without the help of the government, these people come together to share resources and services (Texas Civil Rights Project, 2020). The Food Bank of RGV is the largest regional, non-religious charity in Southern Texas. Their mission is to provide food assistance, nutrition education, and access to community service while improving lives. They have an emergency food pantry that may be used only once a year, but they can also provide people with a referral to a food pantry with more frequent assistance closer to their neighborhood with a network of close to 300 places (Food Bank of the RGV, 2023). Lastly, the Catholic Charities of the RGV (CCRGV) has services to aid low income and other vulnerable populations in the community. One service they have is the disaster relief program which helps alleviate a family's burden after a disaster with financial assistance, reconstruction of damaged homes, or providing temporary shelter.

Missing Resources

While these NGOs provide resources that local residents can use before or after storms, they lack the guidance of sharing preparation knowledge. Internet access may be limited by low-income communities, meaning they miss out on the information available to help aid them during this process. There's a need for spaces to share important tips for disaster responses.

Education is key for disaster preparedness, and this research scratches the bare surface. While there are a few organizations listed to help financially and other resources, an education program dedicated to disaster preparedness would be most effective. Benefits to a public education program include effectively educating elders and increasing disaster preparedness for participants (Kyne et al, 2020). It's important to educate elders because they're more susceptible to injury and need more assistance during storms (McNeil, 2016). These programs should target vulnerable groups and should occur before a disaster. In addition, this program should highlight how-to knowledge and skills on making an evacuation plan and a list of emergency contact numbers, designating a safe place, understanding evacuation routes, purchasing/obtaining a battery-operated radio, collecting a 3-day water supply, and savings for evacuation expenses. This program could be federally or state funded programs and could be run by local community centers.

Conclusion

ANT helps capture the interlocking relationships there are between human and non-human actors pertaining to the question, what are flood preparedness resources available for citizens in the Rio Grande Valley area? While there are a few NGOs and many online resources that help with flood preparedness, there's no education program actively reaching out or established to teach people how to be prepared for storms. Due to issues with broadband access, the internet may not be the best way to communicate flood preparedness methods, and governments and NGOs can interact with individuals

more prior to storms occurring to help ease the burden of the recovery stage such as enacting the transportation assistance program that Hidalgo. Further research should explore what a successful educational program looks like for vulnerable individuals, and how it might differ between areas.

References

Admin, F. (n.d.). *Home*. Food Bank of Rio Grande Valley. Retrieved February 17, 2023, from https://foodbankrgv.com/

Disaster-relief-program. (n.d.). Retrieved February 17, 2023, from https://www.catholiccharitiesrgv.org/disaster-relief-program.shtml

Donner, W. R., & Lavariega-Montforti, J. (2018). Ethnicity, income, and disaster preparedness in Deep South Texas, United States. *Disasters*, *42*(4), 719–733. https://doi.org/10.1111/disa.12277

Dow, K. and Cutter, S. 1998. Crying wolf: Repeat responses to hurricane evacuation orders, Coastal Management (26) 237-252.

Emergency Preparedness | Hidalgo County, TX - Official Website. (n.d.). Retrieved April 16, 2023, from https://www.hidalgocounty.us/325/Preparation-Tips-and-Videos

Goldsmith, B. (2022). *The Official Rio Grande Valley/Deep South Texas Hurricane Guide 2022*. National Weather Service.

Hinojosa, J. (2022, August 12). *Hinojosa: Study showed 3 of least-connected US cities were in RGV*. Rio Grande Guardian. https://riograndeguardian.com/hinojosa-study-showed-3-of-least-connected-us-cities-were-in-rgv/

Home. (n.d.). LUPE. Retrieved February 17, 2023, from https://lupenet.org/en/

Jacobo, J. (2022, September 27). *This is why the Gulf Coast—Especially Florida—Is so vulnerable to hurricanes, storm surge*. 6abc Philadelphia. https://6abc.com/hurricane-ian-florida-path-gulf-coast/12272447/

Kyne, D., Cisneros, L., Delacruz, J., Lopez, B., Madrid, C., Moran, R., Provencio, A., Ramos, F., & Silva, M. F. (2020). Empirical evaluation of disaster preparedness for hurricanes in the Rio Grande Valley. *Progress in Disaster Science*, *5*, 100061. https://doi.org/10.1016/j.pdisas.2019.100061

Kyne, D., & Donner, W. (2018). Kyne–Donner Model of Authority's Recommendation and Hurricane Evacuation Decisions: A Study of Hypothetical Hurricane Event in the Rio Grande Valley, Texas. *Population Research and Policy Review*, *37*(6), 897–922. https://doi.org/10.1007/s11113-018-9492-2

Kyne, D., Lomeli, A., Donner, W., & Zuloaga, E. (2018). Who Will Stay, Who Will Leave: Decision-Making of Residents Living in Potential Hurricane Impact Areas During a Hypothetical Hurricane Event in the Rio Grande Valley. *Journal of Homeland Security and Emergency Management*, *15*. https://doi.org/10.1515/jhsem-2017-0010

Meyer, L., Vatcheva, K., Castellanos, S., & Reininger, B. (2015). Barriers to Disaster Preparedness among Medical Special Needs Populations. *Frontiers in Public Health*, *3*. https://www.frontiersin.org/articles/10.3389/fpubh.2015.00205

Preparing for a Hurricane or Other Tropical Storm | Hurricanes. (2022, November 30). https://www.cdc.gov/disasters/hurricanes/before.html

RGV Mutual Aid. (n.d.). *Texas Civil Rights Project*. Retrieved February 17, 2023, from https://txcivilrights.org/rgvmutualaid/

Rivera, D. (2019). *Fighting FEMA: Urban Informality and Disaster Response in Rio Grande Valley Colonias*. LINCOLN INSTITUTE OF LAND POLICY.

Ruin, I., League, C., Hayden, M., Goldsmith, B., & Estupiñán, J. (n.d.). Differential social vulnerability and response to Hurricane Dolly across the US-Mexico border. *01/01/2018*.

Terpstra, T., & Gutteling, J. (2008). Households' Perceived Responsibilities in Flood Risk Management in The Netherlands. *International Journal of Water Resources Development*, *24*, 555–565. https://doi.org/10.1080/07900620801923385

US Department of Commerce, N. (n.d.). *Storm Report on Hurricane Dolly in the Rio Grande Valley and Deep South Texas: Update #2*. NOAA's National Weather Service. Retrieved October 26, 2022, from https://www.weather.gov/bro/2008event_dollyreport

US Department of Homeland Security. (2021). *Floods | Ready.gov*. https://www.ready.gov/floods

Walker, W. H. (2008). INTERPRETIVE MODELS, DEVELOPMENT OF. In D. M. Pearsall (Ed.), *Encyclopedia of Archaeology* (pp. 1553–1560). Academic Press. https://doi.org/10.1016/B978-012373962-9.00165-5

Worst Connected Cities 2019. (n.d.). National Digital Inclusion Alliance. Retrieved April 15, 2023, from https://www.digitalinclusion.org/worst-connected-cities-2019/