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Research Paper Writing Sample



Abstract

This report is looking to explore sea level rise and the affect it will have on social vulnerability of Galveston County in Texas. Hurricane Ike struck Galveston County in September of 2008 and caused major damage to Galveston and surrounding cities. The Gulf of Mexico borders Galveston County, making it high-risk of hurricanes and tropical storms. Planning for community resilience is becoming increasingly important as natural disasters and hazards are predicted to become worse over time. Climate change is what seems to be creating more hazardous disasters, and also a rise in sea level. Rising sea levels are becoming an important factor when planning and designing projects of hazard mitigation. Observations of rising sea levels and how they will affect social vulnerability of Galveston County will be made through spatial analysis using Geographic Information Systems (GIS). Socially vulnerable populations have difficulty expecting and coping with disasters. These populations are expected to increase as sea level rise increases. This implies storm surge zones and floodplains will get larger, consuming more land and people who live on that land. In order for a community to be resilient, taking rising sea levels into account when planning is important if a goal is to prevent socially vulnerable populations.

Introduction

Galveston County, Texas is a coastal county that is susceptible to natural hazards and disasters. It is along the northern Gulf of Mexico coast, and with the gulf directly to the east, hurricanes are one of its biggest threats. The deadliest natural disaster – a hurricane – in U.S. history, the 1900 Storm, occurred in Galveston. Four years later a seawall was constructed and did well against smaller hurricanes and storms until category four Hurricane Ike.

On September 13th of 2008, Galveston county was hit by a category four hurricane named Ike which resulted in \$19.3 billion dollars of damages and 84 deaths. Hurricane Ike hit and ended up “being the third costliest natural disaster in the United States behind Hurricane Katrina and Hurricane Andrew” (Houston/Galveston, TX), costing Galveston

alone \$19.3 billion in damages. Galveston is highly likely to be hit by another hurricane of this caliber, and even worse. About every fifteen years, any five-mile segment of Texas’s coastline is hit by a major hurricane (Newman 2014).

The hurricane frequency that was experienced by the gulf coast of Texas is shown in *Figure 1*. In order to efficiently deal with these hazards, Galveston’s city website has information about hurricanes as well as a list of how to prepare for a hurricane, and what to do during one. This information is beneficial to communities – however, what about communities that either (1) do not have access to this information or (2) do not have the resources available to complete these preparation tasks?

The book *Planning for Community Resilience* describes this as “how social factors

influence the ability of communities and their populations (individuals and households) to anticipate, respond, resist, and recover from disasters” (Masterson 2014). When a natural disaster takes place, in this case, a hurricane, these socially vulnerable populations have a different experience than others. They usually do not have the resources to prepare for the hurricane by gathering supplies or evacuating, and also do not have the means to repair as quickly as others after the storm.

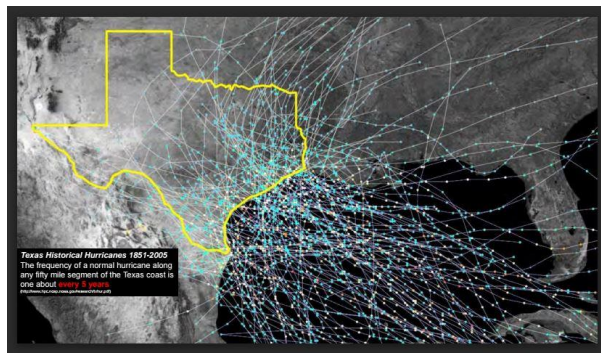


Figure 1: Hurricane paths along the Texas Gulf Coast.

These vulnerable populations incorporate “social factors . . . such as age, income, ethnicity, gender, employment statistics, and many others” (Thatcher 2013). Looking at how current and future conditions is essential in order to sustainably plan hazard mitigation while taking these communities into consideration.

Lastly, with climate change there is to be a projected of an 11% of land to be lost per every foot of sea level rise in western Galveston (Newman 2014). With this rise, it creates a potential for new vulnerable populations to arise. By including sustainable and resilient planning and design in the built environment of the island, there is potential to reduce the vulnerability of these populations. The prediction is that rising sea levels will affect the social vulnerability of people who live in Galveston County. Spatial analysis and calculations are going to be used to display the effect rises in sea level will have on populations of social vulnerability in Galveston county.

Will a sea-level rise of two, four, and six feet increase the social vulnerability of the population in Galveston County?

Study Area and Methods

Galveston County is located on the northern Gulf Coast of Texas and southeast of Houston, Texas, shown in *Figure 2*. The county has been affected by natural disasters such as hurricanes.



Figure 2: Galveston County, Texas

Spatial analysis was conducted through the use of Geographic Information Systems (GIS). Secondary data was obtained and used in ArcMap to spatially analyze the demographics of Galveston County. Demographic statistics were obtained from both the 2010 United States Census and the 2008-2012 American Community Survey. Primarily, the five social factors that were going to be used to create a social vulnerability map were:

1. *Income*: per-capita income level
2. *Ethnicity*: percent of non-white population
3. *Education*: percent of the population over 25 years of age with less than
4. *Poverty*: percent of families in poverty
5. *Age*: percent of population over 65 years of age

Each of these social factors were mapped out by block group in Galveston County, shown in parts of *Figure 3*.

Per-Capita Income Level for Galveston County

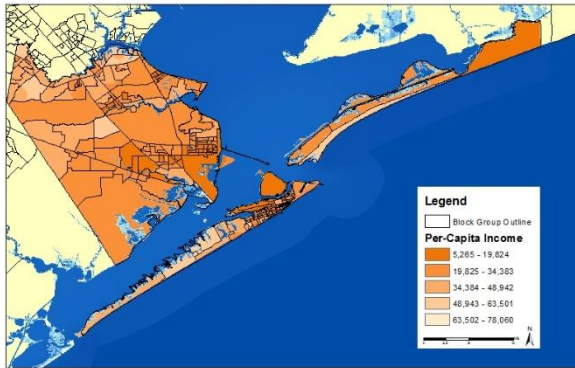


Figure 3.1: Per-capita income as a social factor.

Percentage of Families in Poverty in Galveston County

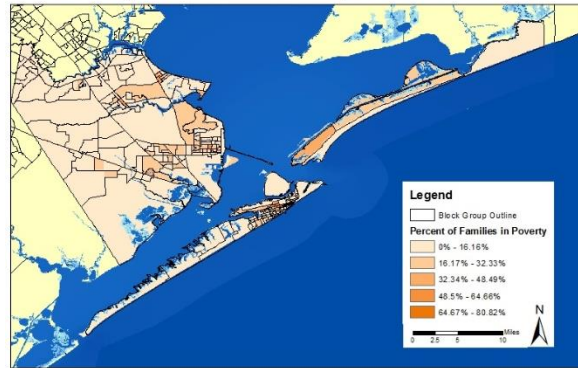


Figure 3.4: Poverty as a social factor.

Percent of Non-White Population in Galveston County

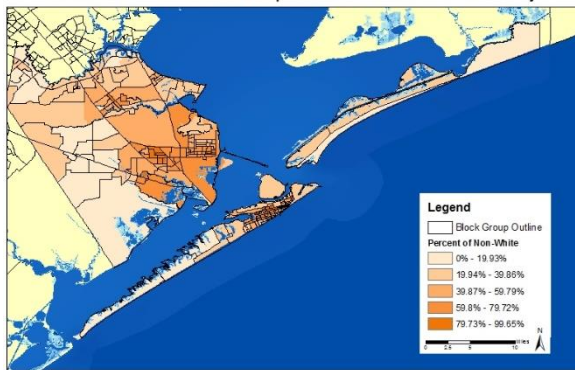


Figure 3.2: Ethnicity as a social factor.

Percentage of Population 65 Years and Up in Galveston County

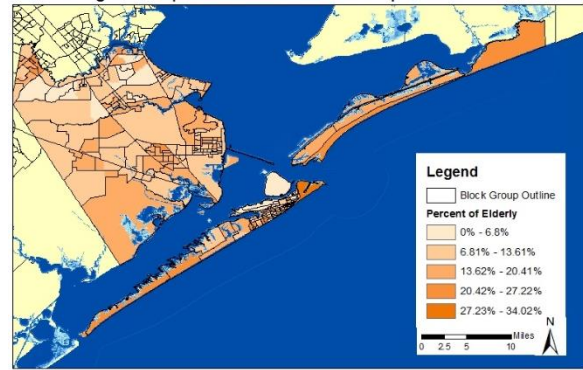


Figure 3.5: Age as a social factor.

Percentage of Population 25+ with Less than HS Education

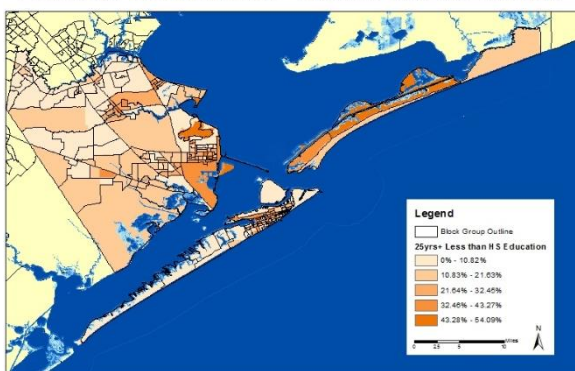


Figure 3.3: Education as a social factor.

A Social Vulnerability map was created by using a *weighted overlay* tool in GIS. With this tool, each variable is given a weighted score which affects the output map. In this case, each of the five maps were weighted the same at twenty percent each.

Results

The output map for social vulnerability is shown in *Figure 4*. In the output map, about 36% of the population is considered highly vulnerable according to the social factors and weights were assigned to each of them. Applying sea-level rise (SLR) to this map will show the effect it has on the original map.

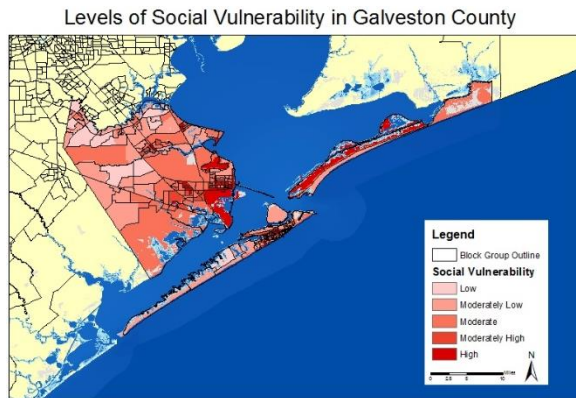


Figure 4: Social Vulnerability output map.

After the map for social vulnerability was created, sea level rise data that was obtained from the National Oceanic and Atmospheric Administration (NOAA) was used to calculate the increase in populations that were ranked as having high social vulnerability. The data obtained from NOAA display a sea-level rise (SLR) at (a) 2 feet, (b) 4 feet, and (c) 6 feet.

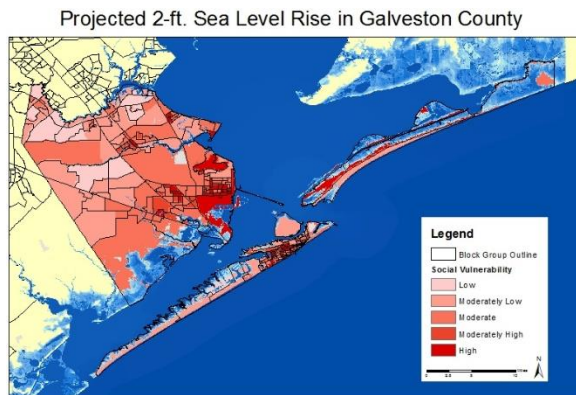


Figure 5.a: Social vulnerability map with a 2-foot SLR.

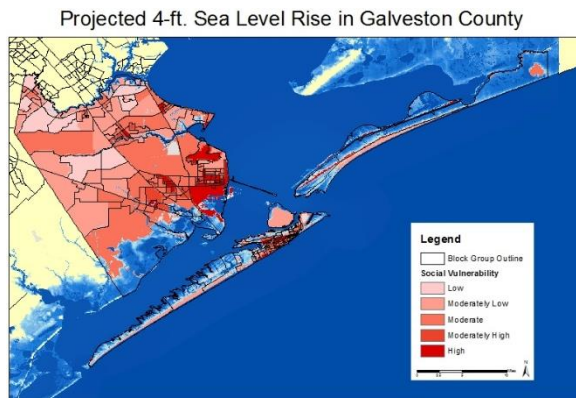


Figure 5.b: Social vulnerability map with a 4-foot SLR.

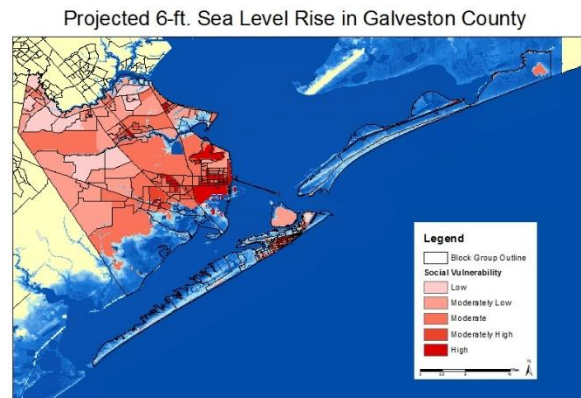


Figure 5.c: Social vulnerability map with a 6-foot SLR.

It was found that the population considered highly vulnerable increases about 16% from 36% to 52% when the sea level rises 2 feet.

With a 4-foot SLR, highly vulnerable population increases slightly to 57%. This is a 21% increase from the original output map and a 5% increase from a 2-foot SLR.

After a 6-foot rise in sea level, the highly vulnerable population increases to a dramatic 62%. This is almost two-thirds of the population, and a 26% increase from the original output map.

It is noted that there is an area on the island of Galveston where the sea level rise does not significantly affect the area. This is where a seawall was implemented after the 1900 Storm, and goes to show that advances in infrastructure could be used to prevent the effects of sea level rise. This should be used to recommend the approval and adoption of new policies that promote the implementation of phased infrastructure projects. To help prevent the worst-case scenario effects of rising sea levels over time, infrastructure is essential.

Conclusion

There is a relationship between rising sea levels and socially vulnerable populations. There is an increase of highly socially vulnerable populations with each increase of

sea level. Coastal counties of Texas are hit by a major hurricane about every 15 years which means that Galveston is at high-risk of not only hurricanes and natural hazards but with rising sea levels as well. Climate change causes an increase of warmth in the earth's atmosphere, which expands existing waters and melts ice caps to increase the amount of water in oceans. A higher sea level will essentially cause a greater storm surges, which was the most destructive tool used by Hurricane Ike. The amount of populations considered to have social vulnerability will also become larger as they will have the potential to eventually be included in surge zones. After Hurricane Ike the Community Development Block Grant Disaster Recovery provided funding for a development called Progress Galveston. It

began in January 2011 and "was divided into three major sections: the comprehensive plan update, six specialized plans, and revisions to the zoning code as new land development regulations" (Masterson 179). However, in the plan there is not a section specifically relating to rising sea levels. To plan effectively against creating a growth in social vulnerability this rise must be taken into account. New policies and infrastructure designs, such as the Ike Dike project, should be considered by the city of Galveston and even the county in their prevention techniques. Creating a livable and resilient city will not be at its full potential if it does not include combatting sea level rise.

Sources

Bergdoll, Barry. *Rising Currents*. New York: Museum of Modern Art, 2011. Print.

Ferreira, Ceslo M., Irish, Jennifer L., Olivera, Fransisco. "Quantifying the potential impact of land cover changes due to sea-level rise on storm surge on lower Texas coast bays." *Coastal Engineering* 94 (2014): 102-111. Web. 23 June 2016.

"Houston/Galveston, TX." *National Weather Service Weather Forecast Office*. HGX Webmaster, 7 Dec. 2014. Web. 12 Jun. 2015.

Masterson, Jamie Hicks, et al. *Planning for Community Resilience*. Washington, DC: Island Press, 2014. Print.

Newman, Galen and Bardenhagen, Eric. *The IKE DIKE: Design Strategies for Integrating Surge Protection Infrastructure and Resilient Communities*. Institute for Sustainable Coastal Communities, 2014. PDF File.

Thatcher, Cindy A., Brock, John C., Pendleton, Elizabeth A. "Economic Vulnerability to Sea-Level Rise along the Northern U.S. Gulf Coast." *Journal of Coastal Research* 63 (2013): 234-243. Web. 23 June 2016.