

Puerto Rico's Hazard Risk Assessment

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Introduction

Rationale

A complete risk assessment has four basic components, including: hazard identification; profiling of hazard events; inventory of assets; and an estimate of potential human and economic losses based on exposure and vulnerability of people, buildings, and infrastructure.¹ This report utilizes the Department of Homeland Security extended risk definition.² Here, risk is the potential for an adverse outcome assessed as a function of threats, vulnerabilities, and consequences associated with an incident, event, or occurrence. This report is partitioned into four (4) discrete sections strictly following DHS guidance: Threat Assessment, Vulnerability Assessment, Severity of Consequences Assessment, and the combination of these three resulting in Risk Assessment. A focus first on hazard identification and frequency analysis for all of Puerto Rico with an emphasis on utilizing the most appropriate data, methods, and analytic tools to meet rapid turn-around Community Development Block Grant – Mitigation (CDBG-MIT) timelines provides the basis from which sound planning and mitigation decisions can be made. This report is intended for CDBG-MIT risk assessment informational and planning purposes only. A rigorous geospatial approach and a deep understanding of hazards geography are utilized in the following analytics and associated results. Connecting empirically based hazard assessments with vulnerability, infrastructure at risk, and severity of consequences information provides a more holistic view of risks across Puerto Rico.

Methodology

Many hazard analytics processes in this assessment and spatial-analytic processes are adapted from previous risk assessment procedures in several state^{3,4} and regional⁵ local mitigation planning documents⁶. Several processes have been specifically altered to reflect Puerto Rico's location closer to the equator (hurricane hazard) and mountainous terrain (landslide hazard). Data specific to Puerto Rico for each hazard analyzed herein (Table 1) has been carefully reviewed to ensure data quality in several respects. These include spatial – does the data adequately reflect all of Puerto Rico?; temporal – does the data provide an appropriate timeframe for understanding current and future risks?; and numerical – is the data free from incomplete or inconsistent records?

¹ <https://www.fema.gov/hazard-identification-and-risk-assessment>

² https://www.dhs.gov/xlibrary/assets/dhs_risk_lexicon.pdf

³ <https://www.scemd.org/media/1391/sc-hazard-mitigation-plan-2018-update.pdf>

⁴ https://www.floridadisaster.org/globalassets/dem/mitigation/mitigate-fl--shmp/shmp-2018-full_final_approved.6.11.2018.pdf

⁵ <https://centralmidlands.org/freedocs/HMPforadoption-WithRevisions.pdf>

⁶ Puerto Rico Hazard Mitigation Plan - <https://recovery.pr/en/document-library>

Table 1: Hazards analyzed in this report, in order of priority of analysis⁷

| Hazard | Data type | Period | Temporal/Spatial resolution | Methods | Dataset and/or Source* |
|-------------------------|------------------|---------------|------------------------------------|---|---|
| Flood (100 year) | Polygon | - | Time independent | Modeled inundation of 100-year flood | Federal Emergency Management Agency |
| Hurricane | Point | 1989-2018 | 6-hourly | Average times per year an area can expect to experience hurricane-force winds 34 kt | National Oceanic and Atmospheric Administration |
| Landslide | Grid | N/A | Various grid cell sizes | Average landslide susceptibility index in any given area | United States Geological Survey |
| Earthquake | Polygon | N/A | Time independent | Peak ground acceleration with a 2% probability of exceedance in 50 years | United States Geological Survey |
| Severe Storm | Polygon | 2002-2019 | Yearly | Average number of times per year an area can expect to be under a severe thunderstorm warning | Iowa State University's Environmental Mesonet |
| Storm Surge | Grid | N/A | Time independent/30 m | Modeled inundation of storm surge from a Category-1 hurricane | National Oceanic and Atmospheric Administration |
| Drought | Polygon | 2000-2019 | Weekly | Average number of weeks in drought per year | United States Drought Monitor |
| Wind | Point | 1989-2018 | Daily | Average number of days per year with winds above 30 knots | National Oceanic and Atmospheric Administration |
| Fog | Point | 1989-2018 | Daily | Average number of fog days per year using weather station interpolation | National Oceanic and Atmospheric Administration |

⁷ Priority of analysis determined by Puerto Rico Hazard Mitigation Plan - <https://recovery.pr/en/document-library>

| | | | | | |
|-------------------------|------------|----------------|------------------|---|--|
| Hail | Point/Line | 1955-2018 | Yearly | Average number of reported hail events per year | National Oceanic and Atmospheric Administration |
| High Temperature | Point | 1989-2018 | Daily | Average number of days where the daily maximum is above 100 °F | National Oceanic and Atmospheric Administration |
| Lightning | Point | 2009-2018 | Daily | Average number of cloud-to-ground lightning flashes per year | World Wide Lightning Detection Network |
| Tornado | Polygon | 2002-2019 | Yearly | Average number of times per year an area can expect to be under a tornado warning | Iowa State University's Environmental Mesonet |
| Wildfires | Polygon | 2003- 2011 | Yearly | Average number of wildfires | USDA Caribbean Climate Hub |
| Human Hazards | Polygon | 1970 - Present | Daily | Average annual number of terrorist events of chemical transportation spill | Global Terrorism Database and Pipeline and Hazardous Materials Safety Administration |
| Liquefaction | Polygon | N/A | Time independent | Liquefaction susceptibility index | Universidad Metropolitana (2002(|
| Sea Level Rise | Polygon | N/A | Time independent | Sea Level Rise – Feet (1, 4, 10) above Mean Higher High Water (MHHW) level. | National Oceanic and Atmospheric Administration |
| Tsunami | Polygon | N/A | Time independent | | Puerto Rico Seismic Network Tsunami Program |

A ½-square-mile hexagonal grid is used in this assessment because it provides the best coverage for small spatial areas, such as Cantano Municipio, while providing an ability to visualize spatial differences across the island as a whole (Figure 1). Summarizing underlying spatial data to the ½-square-mile grid cell provides a specific set of information that will be different than using a different sized grid cell. Different grid sizes will yield different results.

Hexagonal grids represent a simplified method to display complex geospatial information⁸ in an approachable way⁹. Using regular spatial bins (hexagons) serves three primary goals: First, it simplifies data sets and aids in visual communication of complex data. If done correctly, visual binning can enable readers to make reasonable count or density estimates that would otherwise be impossible because of the complexity of underlying data. Second, spatial binning shows a smooth surface of aggregated values across larger areas. Finally, a standardized regular gridded framework, such as the hexagonal grids used here enables analysis and evaluation within and between datasets that would normally be difficult (or impossible) to visually, statistically, or spatially compare.

⁸ <https://www.tableau.com/about/blog/2017/11/data-map-discovery-78603>

⁹

https://www.researchgate.net/publication/303290602_Shapes_on_a_plane_evaluating_the_impact_of_projection_distortion_on_spatial_binning

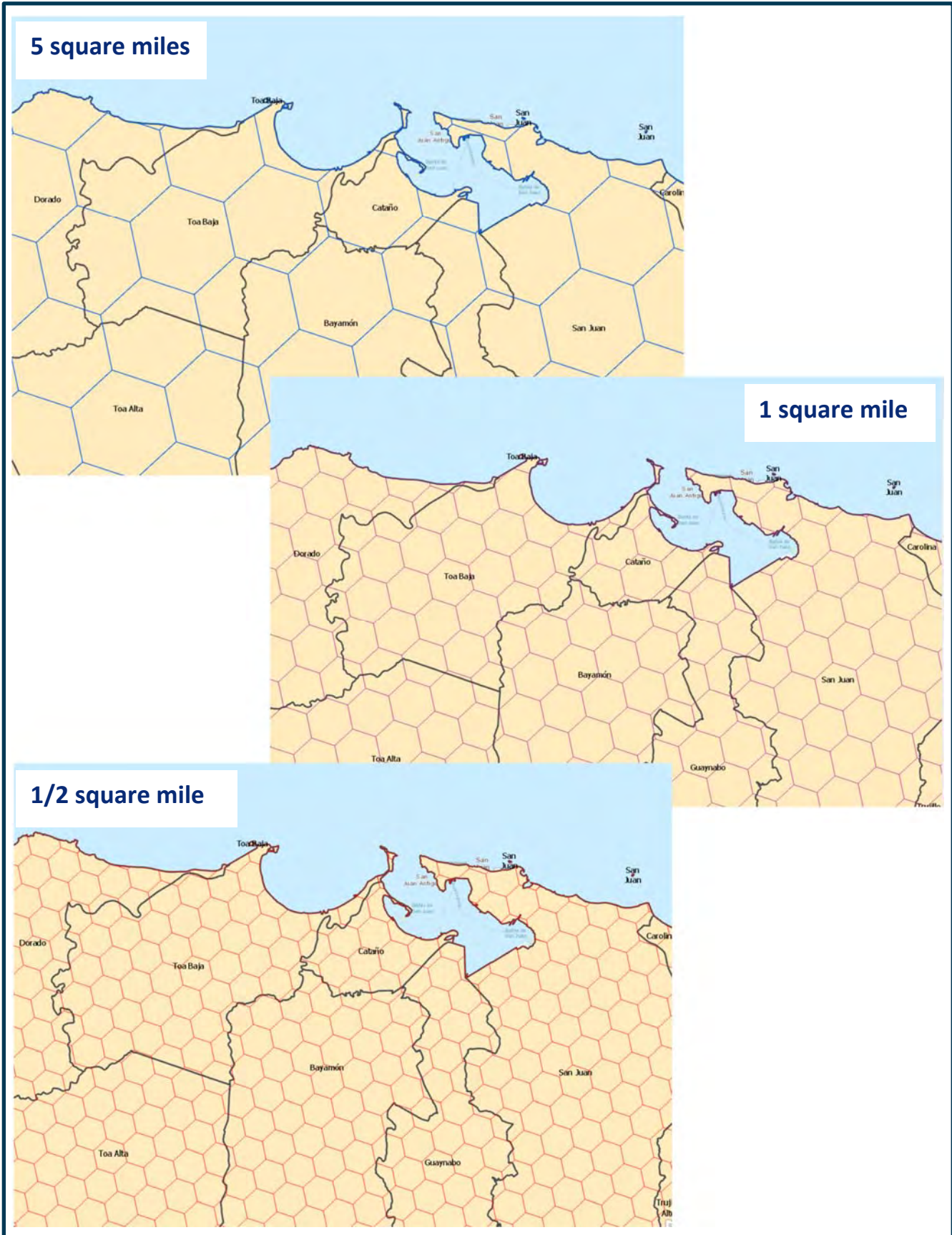


Figure 1: Comparison of Hexagonal Grids for Puerto Rico

Report Format

The analysis and associated outputs of this report are not intended to replace more detailed, multi-year risk assessment process such as updating FEMA required risk assessments and mitigation plans. A geospatial analytics focus on hazard geographies forms the basis of the current assessment. As such, each hazard section provides the following standardized information:

1. Overview of Hazard. Where applicable, background material on hazards is adapted from Puerto Rico's current Hazard Mitigation Plan (HMP)¹⁰. A brief background is provided if a hazard has not been cataloged in Puerto Rico's HMP.
2. Data and Methods. General descriptions of data and methods are provided for reference.
3. Hazard Frequency Analysis Results. An overview of hazard frequency across Puerto Rico including
 - a. Maps of hazard zones. Hazard categories for each hazard type are provided showing frequency of occurrence or other hazard zone/category information for each municipio.
 - b. Tables of land area impacted. Three distinct tables are provided each showing results from slightly different perspectives.
 - i. Land area in each municipio/hazard zone/category combination.
 - ii. Percentage of municipio land area in each municipio/hazard zone/category combination
 - iii. Percentage of total island land area in each municipio/hazard zone/category combination
 - iv. Standardized hazard score for each municipio. Utilizing the hexagonal grid enables a relative comparison of hazard zones for each municipio. A score for each hazard category (1 - Low to 5 - High) was created by first calculating the percentage of total island land area in each "zone" in comparison to total island land area.
 - v.
 - vi.
 - vii.
 - viii. Table 2 provides an example (based on severe storm hazard) showing that Adjuntas Municipio has .88% of the total island-wide land area in the 'Low' severe storm category, another 1.01% in 'Medium Low', .05% in 'Medium' in no land in 'Medium High' or 'High' categories.

¹⁰ Puerto Rico Hazard Mitigation Plan - <https://recovery.pr/en/document-library>

Table 2: Example of Hazard Scoring Step 1, Calculating Percentage Area for Each Category

| Municipio | Severe Storm Percentage of Total (Island) Land Area | | | | |
|--------------|---|------------|--------|-------------|-------|
| | Low | Medium Low | Medium | Medium High | High |
| Adjuntas | 0.88% | 1.01% | 0.05% | 0.00% | 0.00% |
| Aguada | 0.00% | 0.00% | 0.83% | 0.07% | 0.00% |
| Aguadilla | 0.00% | 0.00% | 1.05% | 0.00% | 0.00% |
| Aguas Buenas | 0.00% | 0.25% | 0.62% | 0.00% | 0.00% |
| Aibonito | 0.73% | 0.17% | 0.01% | 0.00% | 0.00% |
| Anasco | 0.00% | 0.03% | 0.43% | 0.42% | 0.26% |
| Arecibo | 0.25% | 1.74% | 1.68% | 0.00% | 0.00% |
| Arroyo | 0.00% | 0.07% | 0.37% | 0.00% | 0.00% |
| Barceloneta | 0.00% | 0.50% | 0.04% | 0.00% | 0.00% |

Each of these municipio/hazard category combinations is then “normalized” to a 0-1 scale using a min/max scaling technique. In this approach, the data is scaled to a fixed range of 0 to 1. Min-Max scaling is accomplished using the following equation:

$$X_{sc} = \frac{X - \text{Min } X}{\text{Max } X - \text{Min } X}$$

Resulting values represent a minimum (0) to a maximum (1) score for each hazard zone category and each municipio (Table 5). There are several ways to represent how hazardous a particular area is. One is called straight line in which we simply assign a number to the level of hazard without considering any other factors, or weighting, that number. Another is called interval (1-5) multiplicative weighting. The problem with these two systems is that, in places where there is a lot of geographic area with “Medium High” hazard risk, it will get a higher number than someplace with a smaller geographic area but a higher hazard risk. This could confuse results and the actions that follow. Instead, we decided to use logarithmic weighting which codifies an increased threat in higher hazard areas over lower hazard areas. Values are converted to a log-multiplied score where ‘Low’ score is multiplied by 1, ‘Medium Low’ score is multiplied by 10, ‘Medium’ score multiplied by 100, ‘Medium High’ score multiplied by 1,000, and ‘High’ score by 10,000. Then, the scores are rescaled to 0-1 using the min/max scaling procedures used above.

Table 3: Example Of Hazard Scoring Step 2, Calculating Min/Max Values for Each Category/Municipio

| Municipio | Min/Mx of Severe Storm Percentage of Total (Island) Land Area | | | | | Log multiplier score | Severe Storms Score |
|--------------|---|------------|--------|-------------|------|----------------------|---------------------|
| | Low | Medium Low | Medium | Medium High | High | | |
| Adjuntas | 0.39 | 0.58 | 0.02 | 0.00 | 0.00 | 22.62 | 0.0002 |
| Aguada | 0.00 | 0.00 | 0.26 | 0.09 | 0.00 | 1172.07 | 0.0111 |
| Aguadilla | 0.00 | 0.00 | 0.33 | 0.01 | 0.00 | 390.16 | 0.0037 |
| Aguas Buenas | 0.00 | 0.14 | 0.20 | 0.00 | 0.00 | 197.32 | 0.0019 |
| Aibonito | 0.32 | 0.10 | 0.00 | 0.00 | 0.00 | 4.13 | 0.0000 |
| Anasco | 0.00 | 0.02 | 0.14 | 0.57 | 0.18 | 23987.60 | 0.2268 |
| Arecibo | 0.11 | 1.00 | 0.53 | 0.00 | 0.00 | 542.33 | 0.0051 |
| Arroyo | 0.00 | 0.04 | 0.12 | 0.00 | 0.00 | 117.30 | 0.0011 |
| Barceloneta | 0.00 | 0.29 | 0.01 | 0.00 | 0.00 | 14.92 | 0.0001 |

Hazard Threat Analysis and Findings

100-year Flooding

Hazard Overview

Flooding is the most frequent and costly natural hazard in the United States. Floods are generally the result of excessive precipitation, and can be classified under two categories: flash floods, the product of heavy localized precipitation in short time period over a given location; and general floods, caused by precipitation over a longer time period and over a given river basin. The severity of a flooding event is determined by a combination of stream and river basin topography and physiography, precipitation and weather patterns, recent soil moisture conditions and the degree of vegetative clearing. Flash flooding events usually occur within minutes or hours of heavy amounts of rainfall, from a dam or levee failure, or from a sudden release of water held by an ice jam. Most flash flooding is caused by slow-moving thunderstorms in a local area or by heavy rains associated with hurricanes and tropical storms. Although flash flooding occurs often along mountain streams, it is also common in urbanized areas where much of the ground is covered by impervious surfaces. General floods are usually longer-term events and may last for several days. The primary types of general flooding include riverine flooding, coastal flooding and urban flooding. Riverine flooding is a function of excessive precipitation levels and water runoff volumes within the watershed of a stream or river. Coastal flooding is typically a result of storm surge, wind-driven waves, and heavy rainfall produced by hurricanes, tropical storms, and other large coastal storms. Urban flooding occurs where man-made development has obstructed the natural flow of water and/or decreased the ability of natural groundcover to absorb and retain surface water runoff.

Data and Methods

The Federal Emergency Management Agency (FEMA) provides a national flood hazard dataset for the US through an online Map Service Center (MSC). Accordingly, we downloaded for the entire US the Special Flood Hazard Area (SFHA) dataset, which represents flood hazards with a 0.01 probability of occurrence in any given year, commonly referred to as a 100-year flood or the 1% annual chance of flooding. Though additional flood zones exist for many locations in the US, depicting the 0.002 chance (500-year) of flooding or areas that may experience high velocity floodwater flows, we utilize only the 100-year SFHA data in our composite hazard analysis. In the case of Puerto Rico, Preliminary 100-year Flood Zones, provided by the Puerto Rico Planning Board, were spatially intersected with Puerto Rico's 0.5-mile hexagonal grid to produce a spatial representation of flood hazard across the island.

Hazard Frequency Analysis Results

Flood hazard potential is present in every municipio, but is significantly more pronounced along the north central, northeastern, eastern, south central, south east, and western municipios (Figure 2). This map categorizes each ½ mile hex grid based on the amount of land area it has inside the FEMA Preliminary 100-Year Flood Zone using equal interval classification. Unlike simply using the flood zone perimeter, this map allows for areal comparison across the island. The northwestern municipios appear to have relatively less flood hazard potential than most of the other enumeration units across the island. Additionally, inland municipios such as Caguas, Gurabo, and Juncos have more areas at flood risk than most other inland neighbors. Analytic results populated into municipio level tables provide a higher level of information than available from an island wide map. Table 4 shows the total land area in square miles in each flood category, Table 5 shows the percent of each municipios land area in each category, and Table 6 shows the percent of total Puerto Rico land area in each category by municipio. Finally, Table 7 provides a rank order breakdown of land area in 100-year flood hazard areas by municipio.

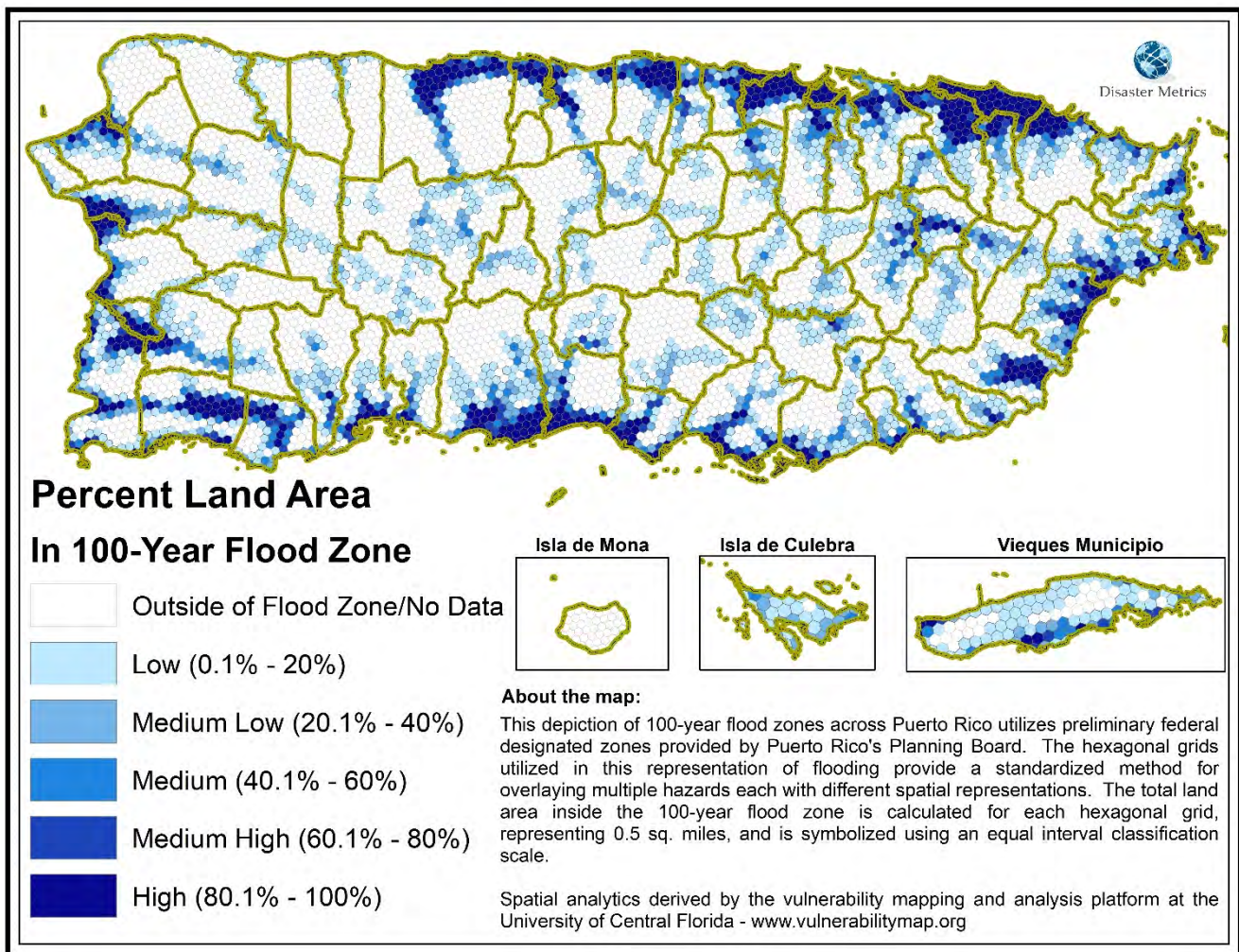


Figure 2: 100-Year Flood Zone Hazard Areas

Table 4: 100-Year Flooding by Municipio and Areal Extent

| Municipio | Hex Grid Area in 100-Year Flood Zones (Sq. miles) | | | | | |
|--------------|---|------------------|--------------------------|----------------------|---------------------------|-------------|
| | None (0%) | Low (0.1% - 20%) | Medium Low (20.1% - 40%) | Medium (40.1% - 60%) | Medium High (60.1% - 80%) | High (>80%) |
| Adjuntas | 43.52 | 21.88 | 1.70 | | | |
| Aguada | 12.38 | 7.23 | 2.34 | 3.39 | 1.35 | 4.23 |
| Aguadilla | 28.52 | 4.42 | 1.29 | 0.63 | 0.79 | 0.96 |
| Aguas Buenas | 20.42 | 9.50 | 0.17 | | | |
| Aibonito | 14.34 | 16.00 | 1.00 | | | |
| Anasco | 16.70 | 8.70 | 4.29 | 2.00 | 1.42 | 6.46 |
| Arecibo | 85.47 | 8.07 | 5.94 | 5.68 | 6.39 | 15.43 |
| Arroyo | 6.24 | 3.79 | 1.50 | 1.42 | 0.48 | 1.61 |
| Barceloneta | 8.43 | 1.51 | 0.07 | 0.96 | 2.84 | 4.95 |
| Barranquitas | 22.73 | 11.56 | | | | |
| Bayamon | 21.33 | 12.92 | 3.56 | 2.99 | 0.61 | 3.10 |
| Cabo Rojo | 25.99 | 17.71 | 7.35 | 5.55 | 3.97 | 12.54 |
| Caguas | 25.71 | 21.99 | 4.22 | 3.58 | 2.58 | 0.99 |
| Camuy | 40.88 | 4.41 | 0.48 | 0.22 | 0.29 | 0.08 |
| Canovanas | 16.97 | 6.13 | 2.88 | 1.82 | 1.00 | 4.21 |
| Cantano | 11.97 | 12.24 | 0.46 | 2.18 | 3.45 | 17.01 |
| Carolina | | | | | | 5.08 |
| Cayey | 35.59 | 11.75 | 3.00 | 0.67 | 0.50 | 0.45 |
| Ceiba | 7.38 | 9.47 | 3.09 | 3.24 | 1.65 | 5.54 |
| Ciales | 48.62 | 15.13 | 2.00 | 0.96 | | |
| Cidra | 20.26 | 12.49 | 3.32 | 0.33 | | 0.05 |
| Coamo | 59.95 | 15.01 | 3.00 | 0.07 | | |
| Comerio | 18.96 | 8.57 | 0.50 | 0.50 | | |
| Corozal | 27.75 | 14.83 | | | | |
| Culebra | 0.50 | 7.18 | 4.80 | 0.75 | 0.05 | 0.03 |
| Dorado | 6.48 | 3.31 | 2.00 | 2.52 | 2.60 | 6.52 |
| Fajardo | 11.65 | 8.05 | 2.71 | 4.01 | 2.45 | 1.65 |
| Florida | 15.22 | | | | | |
| Guanica | 13.53 | 7.59 | 4.12 | 5.34 | 3.43 | 5.01 |
| Guayama | 32.56 | 18.29 | 5.00 | 2.84 | 1.00 | 6.18 |
| Guayanilla | 21.14 | 10.94 | 2.37 | 2.00 | 2.09 | 4.46 |
| Guaynabo | 12.29 | 9.95 | 3.39 | 0.51 | 0.39 | 1.24 |
| Gurabo | 12.71 | 7.00 | 2.65 | 1.94 | 2.01 | 2.01 |
| Hatillo | 36.13 | 4.05 | 0.90 | 0.22 | 0.39 | 0.15 |
| Hormigueros | 2.21 | 1.67 | 1.13 | 0.91 | 0.69 | 4.74 |
| Humacao | 6.91 | 16.27 | 5.95 | 4.50 | 2.84 | 8.64 |
| Isabela | 44.37 | 7.78 | 2.30 | 0.72 | | 0.25 |
| Jayuya | 34.69 | 7.34 | 2.50 | | | |

| Municipio | Hex Grid Area in 100-Year Flood Zones (Sq. miles) | | | | | |
|---------------|---|------------------|--------------------------|----------------------|---------------------------|-------------|
| | None (0%) | Low (0.1% - 20%) | Medium Low (20.1% - 40%) | Medium (40.1% - 60%) | Medium High (60.1% - 80%) | High (>80%) |
| Juana Diaz | 30.79 | 11.28 | 2.98 | 4.21 | 2.00 | 9.47 |
| Juncos | 12.28 | 8.01 | 4.33 | 0.99 | 1.00 | |
| Lajas | 23.80 | 13.31 | 3.08 | 3.91 | 3.90 | 13.36 |
| Lares | 45.86 | 15.16 | 0.62 | | | |
| Las Marias | 33.11 | 11.84 | 1.56 | | | |
| Las Piedras | 23.68 | 8.82 | 0.90 | | 0.50 | |
| Loiza | | 0.44 | 0.19 | 0.23 | 1.10 | 18.57 |
| Luquillo | 8.10 | 10.17 | 3.73 | 1.52 | 1.17 | 1.18 |
| Manati | 26.90 | 5.09 | 5.13 | 1.18 | 2.10 | 6.43 |
| Maricao | 31.55 | 5.08 | | | | |
| Maunabo | 8.67 | 8.55 | 1.98 | | 1.00 | 0.88 |
| Mayaguez | 55.80 | 8.86 | 2.06 | 2.01 | 1.89 | 7.35 |
| Moca | 39.45 | 6.44 | 3.20 | 0.92 | 0.36 | |
| Morovis | 25.56 | 11.28 | 2.04 | 0.04 | | |
| Naguabo | 19.00 | 15.03 | 6.30 | 2.27 | 3.89 | 5.39 |
| Naranjito | 19.68 | 6.37 | 1.69 | | | |
| Orocovis | 48.10 | 14.89 | 0.78 | | | |
| Patillas | 28.36 | 12.22 | 2.15 | 1.47 | 2.22 | 0.80 |
| Penuelas | 28.61 | 9.72 | 2.00 | 0.98 | 1.46 | 1.98 |
| Ponce | 57.01 | 27.01 | 5.98 | 6.47 | 4.00 | 16.51 |
| Quebradillas | 15.55 | 6.14 | 0.53 | 0.63 | 0.28 | |
| Rio Grande | 8.71 | 3.22 | 1.89 | 0.03 | 0.33 | 0.21 |
| Rincon | 29.89 | 14.39 | 3.21 | 1.98 | 1.82 | 9.52 |
| Sabana Grande | 27.41 | 6.62 | 1.26 | 0.55 | | |
| Salinas | 35.67 | 14.44 | 4.50 | 4.17 | 2.50 | 8.78 |
| San German | 29.99 | 11.86 | 4.09 | 4.54 | 1.16 | 2.87 |
| San Juan | 19.81 | 13.58 | 3.00 | 4.03 | 3.79 | 5.32 |
| San Lorenzo | 33.18 | 16.63 | 3.40 | | | |
| San Sebastian | 50.98 | 13.76 | 4.82 | 1.44 | 0.22 | |
| Santa Isabel | 11.29 | 8.29 | 2.50 | 1.61 | 3.04 | 7.85 |
| Toa Alta | 11.16 | 9.04 | 4.15 | 2.22 | 0.50 | 0.50 |
| Toa Baja | 4.47 | 2.03 | 1.55 | 1.16 | 0.62 | 13.97 |
| Trujillo Alto | 10.02 | 7.65 | 1.79 | 1.00 | 0.92 | |
| Utua | 75.38 | 32.16 | 6.02 | 1.50 | | |
| Vega Alta | 11.50 | 7.87 | 3.09 | 2.28 | 2.05 | 0.95 |
| Vega Baja | 20.63 | 8.58 | 0.99 | 4.57 | 2.97 | 8.90 |
| Vieques | 14.00 | 25.61 | 4.54 | 3.91 | 2.63 | 2.50 |
| Villalba | 22.82 | 10.97 | 1.63 | 0.61 | 1.00 | |
| Yabucoa | 30.99 | 9.91 | 1.43 | 2.00 | 3.99 | 7.09 |
| Yauco | 45.88 | 15.64 | 3.68 | 2.00 | 1.11 | 0.52 |

| Municipio | Hex Grid Area in 100-Year Flood Zones (Sq. miles) | | | | | |
|--------------------|---|------------------|--------------------------|----------------------|---------------------------|-------------|
| | None (0%) | Low (0.1% - 20%) | Medium Low (20.1% - 40%) | Medium (40.1% - 60%) | Medium High (60.1% - 80%) | High (>80%) |
| Grand Total | 1946.16 | 812.67 | 200.74 | 128.84 | 100.77 | 274.44 |

Table 5: Percent of (Municipio) Hexagonal Area by 100-Year Flooding per Municipio

| Municipio | 100-Year Flood Zone Percent Area by Total (Municipio) Land Area | | | | | |
|--------------|---|------------------|--------------------------|----------------------|---------------------------|-------------|
| | None (0%) | Low (0.1% - 20%) | Medium Low (20.1% - 40%) | Medium (40.1% - 60%) | Medium High (60.1% - 80%) | High (>80%) |
| Adjuntas | 64.86% | 32.61% | 2.53% | 0.00% | 0.00% | 0.00% |
| Aguada | 40.04% | 23.37% | 7.56% | 10.97% | 4.37% | 13.69% |
| Aguadilla | 77.90% | 12.06% | 3.53% | 1.72% | 2.17% | 2.61% |
| Aguas Buenas | 67.86% | 31.56% | 0.57% | 0.00% | 0.00% | 0.00% |
| Aibonito | 45.75% | 51.05% | 3.20% | 0.00% | 0.00% | 0.00% |
| Anasco | 42.21% | 22.00% | 10.84% | 5.06% | 3.59% | 16.32% |
| Arecibo | 67.32% | 6.35% | 4.67% | 4.47% | 5.03% | 12.15% |
| Arroyo | 41.46% | 25.18% | 10.00% | 9.45% | 3.19% | 10.72% |
| Barceloneta | 44.94% | 8.02% | 0.36% | 5.13% | 15.17% | 26.37% |
| Barranquitas | 66.29% | 33.71% | 0.00% | 0.00% | 0.00% | 0.00% |
| Bayamon | 47.92% | 29.02% | 8.00% | 6.72% | 1.38% | 6.97% |
| Cabo Rojo | 35.54% | 24.23% | 10.06% | 7.59% | 5.44% | 17.15% |
| Caguas | 43.53% | 37.23% | 7.14% | 6.06% | 4.36% | 1.68% |
| Camuy | 88.16% | 9.52% | 1.04% | 0.48% | 0.63% | 0.17% |
| Canovanas | 51.43% | 18.56% | 8.71% | 5.52% | 3.03% | 12.74% |
| Cantano | 25.30% | 25.87% | 0.98% | 4.60% | 7.29% | 35.96% |
| Carolina | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 100.00% |
| Cayey | 68.49% | 22.62% | 5.77% | 1.29% | 0.96% | 0.87% |
| Ceiba | 24.30% | 31.17% | 10.18% | 10.66% | 5.45% | 18.25% |
| Ciales | 72.89% | 22.68% | 3.00% | 1.43% | 0.00% | 0.00% |
| Cidra | 55.59% | 34.26% | 9.12% | 0.91% | 0.00% | 0.13% |
| Coamo | 76.83% | 19.24% | 3.84% | 0.09% | 0.00% | 0.00% |
| Comerio | 66.46% | 30.03% | 1.75% | 1.75% | 0.00% | 0.00% |
| Corozal | 65.16% | 34.84% | 0.00% | 0.00% | 0.00% | 0.00% |
| Culebra | 3.76% | 53.98% | 36.06% | 5.63% | 0.37% | 0.20% |
| Dorado | 27.65% | 14.12% | 8.53% | 10.74% | 11.09% | 27.86% |
| Fajardo | 38.17% | 26.39% | 8.87% | 13.13% | 8.04% | 5.39% |
| Florida | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Guanica | 34.68% | 19.45% | 10.55% | 13.68% | 8.80% | 12.83% |
| Guayama | 49.44% | 27.76% | 7.58% | 4.31% | 1.52% | 9.38% |
| Guayanilla | 49.18% | 25.44% | 5.51% | 4.64% | 4.86% | 10.36% |
| Guaynabo | 44.28% | 35.82% | 12.20% | 1.83% | 1.39% | 4.48% |

| Municipio | 100-Year Flood Zone Percent Area by Total (Municipio) Land Area | | | | | |
|---------------|---|------------------|--------------------------|----------------------|---------------------------|-------------|
| | None (0%) | Low (0.1% - 20%) | Medium Low (20.1% - 40%) | Medium (40.1% - 60%) | Medium High (60.1% - 80%) | High (>80%) |
| Gurabo | 44.90% | 24.72% | 9.36% | 6.83% | 7.09% | 7.10% |
| Hatillo | 86.36% | 9.68% | 2.14% | 0.52% | 0.94% | 0.36% |
| Hormigueros | 19.48% | 14.68% | 9.99% | 8.01% | 6.10% | 41.74% |
| Humacao | 15.32% | 36.08% | 13.19% | 9.98% | 6.29% | 19.15% |
| Isabela | 80.08% | 14.04% | 4.14% | 1.29% | 0.00% | 0.44% |
| Jayuya | 77.90% | 16.49% | 5.61% | 0.00% | 0.00% | 0.00% |
| Juana Diaz | 50.70% | 18.57% | 4.90% | 6.94% | 3.29% | 15.59% |
| Juncos | 46.14% | 30.11% | 16.28% | 3.70% | 3.76% | 0.00% |
| Lajas | 38.78% | 21.70% | 5.02% | 6.38% | 6.35% | 21.77% |
| Lares | 74.41% | 24.59% | 1.00% | 0.00% | 0.00% | 0.00% |
| Las Marias | 71.19% | 25.46% | 3.35% | 0.00% | 0.00% | 0.00% |
| Las Piedras | 69.86% | 26.02% | 2.65% | 0.00% | 1.47% | 0.00% |
| Loiza | 0.00% | 2.16% | 0.93% | 1.12% | 5.36% | 90.42% |
| Luquillo | 31.32% | 39.33% | 14.42% | 5.87% | 4.51% | 4.54% |
| Manati | 57.44% | 10.87% | 10.96% | 2.51% | 4.48% | 13.73% |
| Maricao | 86.14% | 13.86% | 0.00% | 0.00% | 0.00% | 0.00% |
| Maunabo | 41.10% | 40.57% | 9.41% | 0.00% | 4.74% | 4.18% |
| Mayaguez | 71.57% | 11.36% | 2.65% | 2.58% | 2.42% | 9.43% |
| Moca | 78.33% | 12.78% | 6.36% | 1.82% | 0.71% | 0.00% |
| Morovis | 65.67% | 28.98% | 5.24% | 0.12% | 0.00% | 0.00% |
| Naguabo | 36.63% | 28.97% | 12.14% | 4.38% | 7.50% | 10.39% |
| Naranjito | 70.92% | 22.97% | 6.11% | 0.00% | 0.00% | 0.00% |
| Orocovis | 75.43% | 23.35% | 1.22% | 0.00% | 0.00% | 0.00% |
| Patillas | 60.06% | 25.88% | 4.54% | 3.12% | 4.70% | 1.69% |
| Penuelas | 63.91% | 21.72% | 4.47% | 2.19% | 3.27% | 4.43% |
| Ponce | 48.73% | 23.09% | 5.12% | 5.53% | 3.42% | 14.11% |
| Quebradillas | 67.20% | 26.56% | 2.31% | 2.72% | 1.22% | 0.00% |
| Rio Grande | 60.56% | 22.38% | 13.11% | 0.24% | 2.27% | 1.44% |
| Rincon | 49.15% | 23.66% | 5.28% | 3.26% | 3.00% | 15.65% |
| Sabana Grande | 76.49% | 18.47% | 3.51% | 1.53% | 0.00% | 0.00% |
| Salinas | 50.91% | 20.61% | 6.42% | 5.95% | 3.57% | 12.54% |
| San German | 55.02% | 21.75% | 7.50% | 8.33% | 2.12% | 5.27% |
| San Juan | 40.00% | 27.43% | 6.06% | 8.13% | 7.66% | 10.73% |
| San Lorenzo | 62.36% | 31.25% | 6.39% | 0.00% | 0.00% | 0.00% |
| San Sebastian | 71.58% | 19.32% | 6.77% | 2.02% | 0.31% | 0.00% |
| Santa Isabel | 32.65% | 23.97% | 7.23% | 4.64% | 8.80% | 22.71% |
| Toa Alta | 40.48% | 32.80% | 15.05% | 8.05% | 1.81% | 1.81% |
| Toa Baja | 18.79% | 8.53% | 6.51% | 4.86% | 2.61% | 58.70% |
| Trujillo Alto | 46.88% | 35.78% | 8.37% | 4.68% | 4.29% | 0.00% |
| Utua | 65.51% | 27.95% | 5.23% | 1.30% | 0.00% | 0.00% |

| Municipio | 100-Year Flood Zone Percent Area by Total (Municipio) Land Area | | | | | |
|-----------|---|------------------|--------------------------|----------------------|---------------------------|-------------|
| | None (0%) | Low (0.1% - 20%) | Medium Low (20.1% - 40%) | Medium (40.1% - 60%) | Medium High (60.1% - 80%) | High (>80%) |
| Vega Alta | 41.45% | 28.37% | 11.15% | 8.23% | 7.38% | 3.41% |
| Vega Baja | 44.23% | 18.40% | 2.13% | 9.79% | 6.37% | 19.07% |
| Vieques | 26.32% | 48.15% | 8.53% | 7.36% | 4.94% | 4.70% |
| Villalba | 61.63% | 29.62% | 4.41% | 1.64% | 2.70% | 0.00% |
| Yabucoa | 55.94% | 17.88% | 2.58% | 3.61% | 7.19% | 12.80% |
| Yauco | 66.67% | 22.72% | 5.34% | 2.91% | 1.61% | 0.75% |

Table 6: Percent of (Island) Hexagonal Area by 100-Year Flooding per Municipio

| Municipio | 100-Year Flood Zone Percent Area by Total (Island) Land Area | | | | | |
|--------------|--|------------------|--------------------------|----------------------|---------------------------|-------------|
| | None (0%) | Low (0.1% - 20%) | Medium Low (20.1% - 40%) | Medium (40.1% - 60%) | Medium High (60.1% - 80%) | High (>80%) |
| Adjuntas | 2.24% | 2.69% | 0.85% | 0.00% | 0.00% | 0.00% |
| Aguada | 0.64% | 0.89% | 1.16% | 2.63% | 1.34% | 1.54% |
| Aguadilla | 1.47% | 0.54% | 0.64% | 0.49% | 0.79% | 0.35% |
| Aguas Buenas | 1.05% | 1.17% | 0.09% | 0.00% | 0.00% | 0.00% |
| Aibonito | 0.74% | 1.97% | 0.50% | 0.00% | 0.00% | 0.00% |
| Anasco | 0.86% | 1.07% | 2.14% | 1.55% | 1.41% | 2.35% |
| Arecibo | 4.39% | 0.99% | 2.96% | 4.41% | 6.34% | 5.62% |
| Arroyo | 0.32% | 0.47% | 0.75% | 1.10% | 0.48% | 0.59% |
| Barceloneta | 0.43% | 0.19% | 0.03% | 0.75% | 2.82% | 1.80% |
| Barranquitas | 1.17% | 1.42% | 0.00% | 0.00% | 0.00% | 0.00% |
| Bayamon | 1.10% | 1.59% | 1.77% | 2.32% | 0.61% | 1.13% |
| Cabo Rojo | 1.34% | 2.18% | 3.66% | 4.30% | 3.94% | 4.57% |
| Caguas | 1.32% | 2.71% | 2.10% | 2.78% | 2.56% | 0.36% |
| Camuy | 2.10% | 0.54% | 0.24% | 0.17% | 0.29% | 0.03% |
| Canovanas | 0.87% | 0.75% | 1.43% | 1.42% | 0.99% | 1.53% |
| Cantano | 0.61% | 1.51% | 0.23% | 1.69% | 3.42% | 6.20% |
| Carolina | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 1.85% |
| Cayey | 1.83% | 1.45% | 1.49% | 0.52% | 0.50% | 0.16% |
| Ceiba | 0.38% | 1.16% | 1.54% | 2.51% | 1.64% | 2.02% |
| Ciales | 2.50% | 1.86% | 1.00% | 0.74% | 0.00% | 0.00% |
| Cidra | 1.04% | 1.54% | 1.66% | 0.26% | 0.00% | 0.02% |
| Coamo | 3.08% | 1.85% | 1.49% | 0.05% | 0.00% | 0.00% |
| Comerio | 0.97% | 1.05% | 0.25% | 0.39% | 0.00% | 0.00% |
| Corozal | 1.43% | 1.83% | 0.00% | 0.00% | 0.00% | 0.00% |
| Culebra | 0.03% | 0.88% | 2.39% | 0.58% | 0.05% | 0.01% |
| Dorado | 0.33% | 0.41% | 1.00% | 1.95% | 2.58% | 2.38% |
| Fajardo | 0.60% | 0.99% | 1.35% | 3.11% | 2.43% | 0.60% |
| Florida | 0.78% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |

| Municipio | 100-Year Flood Zone Percent Area by Total (Island) Land Area | | | | | |
|---------------|--|------------------|--------------------------|----------------------|---------------------------|-------------|
| | None (0%) | Low (0.1% - 20%) | Medium Low (20.1% - 40%) | Medium (40.1% - 60%) | Medium High (60.1% - 80%) | High (>80%) |
| Guanica | 0.70% | 0.93% | 2.05% | 4.14% | 3.41% | 1.82% |
| Guayama | 1.67% | 2.25% | 2.49% | 2.20% | 0.99% | 2.25% |
| Guayanilla | 1.09% | 1.35% | 1.18% | 1.55% | 2.07% | 1.62% |
| Guaynabo | 0.63% | 1.22% | 1.69% | 0.40% | 0.38% | 0.45% |
| Gurabo | 0.65% | 0.86% | 1.32% | 1.50% | 1.99% | 0.73% |
| Hatillo | 1.86% | 0.50% | 0.45% | 0.17% | 0.39% | 0.06% |
| Hormigueros | 0.11% | 0.20% | 0.56% | 0.71% | 0.69% | 1.73% |
| Humacao | 0.36% | 2.00% | 2.96% | 3.49% | 2.81% | 3.15% |
| Isabela | 2.28% | 0.96% | 1.14% | 0.56% | 0.00% | 0.09% |
| Jayuya | 1.78% | 0.90% | 1.25% | 0.00% | 0.00% | 0.00% |
| Juana Diaz | 1.58% | 1.39% | 1.48% | 3.27% | 1.98% | 3.45% |
| Juncos | 0.63% | 0.99% | 2.16% | 0.76% | 0.99% | 0.00% |
| Lajas | 1.22% | 1.64% | 1.54% | 3.04% | 3.87% | 4.87% |
| Lares | 2.36% | 1.87% | 0.31% | 0.00% | 0.00% | 0.00% |
| Las Marias | 1.70% | 1.46% | 0.78% | 0.00% | 0.00% | 0.00% |
| Las Piedras | 1.22% | 1.09% | 0.45% | 0.00% | 0.49% | 0.00% |
| Loiza | 0.00% | 0.05% | 0.10% | 0.18% | 1.09% | 6.77% |
| Luquillo | 0.42% | 1.25% | 1.86% | 1.18% | 1.16% | 0.43% |
| Manati | 1.38% | 0.63% | 2.56% | 0.91% | 2.08% | 2.34% |
| Maricao | 1.62% | 0.62% | 0.00% | 0.00% | 0.00% | 0.00% |
| Maunabo | 0.45% | 1.05% | 0.99% | 0.00% | 0.99% | 0.32% |
| Mayaguez | 2.87% | 1.09% | 1.03% | 1.56% | 1.87% | 2.68% |
| Moca | 2.03% | 0.79% | 1.60% | 0.71% | 0.35% | 0.00% |
| Morovis | 1.31% | 1.39% | 1.02% | 0.03% | 0.00% | 0.00% |
| Naguabo | 0.98% | 1.85% | 3.14% | 1.76% | 3.86% | 1.96% |
| Naranjito | 1.01% | 0.78% | 0.84% | 0.00% | 0.00% | 0.00% |
| Orocovis | 2.47% | 1.83% | 0.39% | 0.00% | 0.00% | 0.00% |
| Patillas | 1.46% | 1.50% | 1.07% | 1.14% | 2.20% | 0.29% |
| Penuelas | 1.47% | 1.20% | 1.00% | 0.76% | 1.45% | 0.72% |
| Ponce | 2.93% | 3.32% | 2.98% | 5.02% | 3.97% | 6.01% |
| Quebradillas | 0.80% | 0.76% | 0.27% | 0.49% | 0.28% | 0.00% |
| Rjo Grande | 0.45% | 0.40% | 0.94% | 0.03% | 0.32% | 0.08% |
| Rincon | 1.54% | 1.77% | 1.60% | 1.54% | 1.81% | 3.47% |
| Sabana Grande | 1.41% | 0.81% | 0.63% | 0.43% | 0.00% | 0.00% |
| Salinas | 1.83% | 1.78% | 2.24% | 3.23% | 2.48% | 3.20% |
| San German | 1.54% | 1.46% | 2.04% | 3.52% | 1.15% | 1.05% |
| San Juan | 1.02% | 1.67% | 1.49% | 3.13% | 3.76% | 1.94% |
| San Lorenzo | 1.70% | 2.05% | 1.69% | 0.00% | 0.00% | 0.00% |
| San Sebastian | 2.62% | 1.69% | 2.40% | 1.11% | 0.22% | 0.00% |
| Santa Isabel | 0.58% | 1.02% | 1.25% | 1.25% | 3.02% | 2.86% |

| Municipio | 100-Year Flood Zone Percent Area by Total (Island) Land Area | | | | | |
|---------------|--|------------------|--------------------------|----------------------|---------------------------|-------------|
| | None (0%) | Low (0.1% - 20%) | Medium Low (20.1% - 40%) | Medium (40.1% - 60%) | Medium High (60.1% - 80%) | High (>80%) |
| Toa Alta | 0.57% | 1.11% | 2.07% | 1.72% | 0.50% | 0.18% |
| Toa Baja | 0.23% | 0.25% | 0.77% | 0.90% | 0.62% | 5.09% |
| Trujillo Alto | 0.52% | 0.94% | 0.89% | 0.78% | 0.91% | 0.00% |
| Utua | 3.87% | 3.96% | 3.00% | 1.16% | 0.00% | 0.00% |
| Vega Alta | 0.59% | 0.97% | 1.54% | 1.77% | 2.03% | 0.35% |
| Vega Baja | 1.06% | 1.06% | 0.50% | 3.55% | 2.95% | 3.24% |
| Vieques | 0.72% | 3.15% | 2.26% | 3.04% | 2.61% | 0.91% |
| Villalba | 1.17% | 1.35% | 0.81% | 0.47% | 0.99% | 0.00% |
| Yabucoa | 1.59% | 1.22% | 0.71% | 1.55% | 3.95% | 2.58% |
| Yauco | 2.36% | 1.92% | 1.83% | 1.55% | 1.10% | 0.19% |

Table 7: 100-Year Flood Hazard Scores and Ranks by Municipio

| Municipio | 100-Year Flooding Hazard Score (Log Multiplied) | | |
|--------------|---|--------------------------|------------------------|
| | Total Score | Standardized Score (0-1) | Rank of Score (1 – 78) |
| Loiza | 10,176.1003 | 1 | 1 |
| Carolina | 9,734.7295 | 0.9566 | 2 |
| Ponce | 9,624.1830 | 0.9458 | 3 |
| Arecibo | 9,405.5651 | 0.9243 | 4 |
| Lajas | 7,869.1423 | 0.7733 | 5 |
| Toa Baja | 7,642.7714 | 0.7511 | 6 |
| Cabo Rojo | 7,471.8646 | 0.7343 | 7 |
| Juana Diaz | 5,480.9566 | 0.5386 | 8 |
| Rio Grande | 5,445.9575 | 0.5352 | 9 |
| Vega Baja | 5,328.7416 | 0.5237 | 10 |
| Salinas | 5,192.3116 | 0.5102 | 11 |
| Humacao | 5,173.5534 | 0.5084 | 12 |
| Santa Isabel | 4,732.4740 | 0.4651 | 13 |
| Yabucoa | 4,476.4757 | 0.4399 | 14 |
| Mayaguez | 4,288.0298 | 0.4214 | 15 |
| Dorado | 3,961.5483 | 0.3893 | 16 |
| Manati | 3,816.6956 | 0.3751 | 17 |
| Anasco | 3,735.8522 | 0.3671 | 18 |
| Naguabo | 3,556.3199 | 0.3495 | 19 |
| Guayama | 3,536.8567 | 0.3476 | 20 |
| San Juan | 3,522.9634 | 0.3462 | 21 |
| Guanica | 3,321.9363 | 0.3264 | 22 |
| Ceiba | 3,298.0640 | 0.3241 | 23 |
| Barceloneta | 3,124.5844 | 0.3071 | 24 |

| | | | |
|---------------|------------|--------|----|
| Guayanilla | 2,761.0856 | 0.2713 | 25 |
| Catano | 2,738.2127 | 0.2691 | 26 |
| Hormigueros | 2,674.2150 | 0.2628 | 27 |
| Aguada | 2,547.6497 | 0.2504 | 28 |
| Canovanas | 2,453.9711 | 0.2412 | 29 |
| Vieques | 1,825.2986 | 0.1794 | 30 |
| Bayamon | 1,818.2223 | 0.1787 | 31 |
| San German | 1,804.6357 | 0.1773 | 32 |
| Gurabo | 1,429.6209 | 0.1405 | 33 |
| Fajardo | 1,335.8118 | 0.1313 | 34 |
| Penuelas | 1,316.2098 | 0.1293 | 35 |
| Caguas | 998.4528 | 0.0981 | 36 |
| Arroyo | 968.1643 | 0.0951 | 37 |
| Vega Alta | 870.1229 | 0.0855 | 38 |
| Luquillo | 844.1161 | 0.083 | 39 |
| Patillas | 804.0050 | 0.079 | 40 |
| Guaynabo | 743.1405 | 0.073 | 41 |
| Aguadilla | 650.3363 | 0.0639 | 42 |
| Maunabo | 634.5043 | 0.0624 | 43 |
| Yauco | 487.4669 | 0.0479 | 44 |
| Toa Alta | 387.6786 | 0.0381 | 45 |
| Cayey | 336.1140 | 0.033 | 46 |
| Juncos | 178.0542 | 0.0175 | 47 |
| Villalba | 168.3872 | 0.0165 | 48 |
| Rincon | 165.8999 | 0.0163 | 49 |
| Trujillo Alto | 161.5943 | 0.0159 | 50 |
| Hatillo | 147.8753 | 0.0145 | 51 |
| Isabela | 146.9539 | 0.0144 | 52 |
| Camuy | 93.1579 | 0.0092 | 53 |
| Las Piedras | 79.4641 | 0.0078 | 54 |
| Moca | 74.5402 | 0.0073 | 55 |
| San Sebastian | 63.3458 | 0.0062 | 56 |
| Quebradillas | 54.6955 | 0.0054 | 57 |
| Culebra | 40.5576 | 0.004 | 58 |
| Cidra | 36.1906 | 0.0036 | 59 |
| Utuado | 32.3615 | 0.0032 | 60 |
| Ciales | 17.9512 | 0.0018 | 61 |
| Sabana Grande | 10.4067 | 0.001 | 62 |
| Comerio | 8.6713 | 0.0009 | 63 |
| Coamo | 5.6327 | 0.0006 | 64 |
| San Lorenzo | 5.1369 | 0.0005 | 65 |
| Jayuya | 3.6277 | 0.0004 | 66 |

| | | | |
|--------------|--------|--------|----|
| Morovis | 3.8166 | 0.0004 | 66 |
| Adjuntas | 2.9882 | 0.0003 | 68 |
| Aibonito | 1.8615 | 0.0002 | 69 |
| Las Marias | 2.4885 | 0.0002 | 69 |
| Naranjito | 2.5023 | 0.0002 | 69 |
| Aguas Buenas | 0.5303 | 0.0001 | 72 |
| Lares | 1.3086 | 0.0001 | 72 |
| Orocovis | 1.5220 | 0.0001 | 72 |
| Barranquitas | 0.3593 | 0.0000 | 75 |
| Corozal | 0.4612 | 0.0000 | 75 |
| Florida | 0.0000 | 0.0000 | 75 |
| Maricao | 0.1579 | 0.0000 | 75 |

Hurricane Force Winds

Hazard Overview

Hurricanes and tropical storms are the most common natural hazard in Puerto Rico, causing extensive damage and loss. Hurricanes are tropical weather systems with a higher intensity of sustained winds at 74 miles per hour. They develop over warm waters and are caused by the instability created by the collision of warm and cool air. A hurricane is a type of tropical cyclone.

Tropical cyclones are classified according to the intensity of their sustained winds, namely:

1. Tropical Depression: An organized system of clouds with a defined circulation and maximum sustained winds which are less than 39 miles per hour. It is considered a tropical cyclone in its formative stage.
2. Tropical Storm: An organized system of clouds with a defined circulation and maximum sustained winds which fluctuate between 39 and 73 miles per hour.
3. Hurricane: A maximum intensity tropical cyclone at which the maximum sustained winds reach or exceed 74 miles per hour. It has a definite center with a very low barometric pressure in it. Hurricanes are classified into categories ranging from 1 to 5, and winds can reach over 155 miles per hour.

Hurricanes are dangerous because of their potential for destruction, their ability to affect large areas, their ability to form spontaneously, and their unpredictable movement. Hurricanes are often accompanied by high tides, storm surges, and heavy rains that can cause landslides and flooding by swollen rivers.

As an incipient hurricane develops, barometric pressure at its center falls and winds increase. If the atmospheric and oceanic conditions are favorable, it can intensify into a tropical depression. When maximum sustained winds reach or exceed 39 miles per hour, the system is designated a tropical storm, given a name and closely monitored by the National Hurricane Center in Miami, Florida. When sustained winds reach or exceed 74 miles per hour, the storm is deemed a hurricane. Hurricane

intensity is further classified by the Saffir-Simpson Scale, which rates hurricane intensity on a scale of 1 to 5, with 5 being the most intense. The Saffir-Simpson hurricane wind scale (Figure 3¹¹) categorizes hurricane intensity linearly based upon maximum sustained winds, barometric pressure and storm surge potential, which are combined to estimate potential damage.

| Category | Sustained Winds | Types of Damage Due to Hurricane Winds |
|--------------|---|--|
| 1 | 74-95 mph 64-82 kt 119-153 km/h | Very dangerous winds will produce some damage: Well-constructed frame homes could have damage to roof, shingles, vinyl siding and gutters. Large branches of trees will snap and shallowly rooted trees may be toppled. Extensive damage to power lines and poles likely will result in power outages that could last a few to several days. |
| 2 | 96-110 mph 83-95 kt 154-177 km/h | Extremely dangerous winds will cause extensive damage: Well-constructed frame homes could sustain major roof and siding damage. Many shallowly rooted trees will be snapped or uprooted and block numerous roads. Near-total power loss is expected with outages that could last from several days to weeks. |
| 3 (major) | 111-129 mph 96-112 kt 178-208 km/h | Devastating damage will occur: Well-built framed homes may incur major damage or removal of roof decking and gable ends. Many trees will be snapped or uprooted, blocking numerous roads. Electricity and water will be unavailable for several days to weeks after the storm passes. |
| 4 (major) | 130-156 mph 113-136 kt 209-251 km/h | Catastrophic damage will occur: Well-built framed homes can sustain severe damage with loss of most of the roof structure and/or some exterior walls. Most trees will be snapped or uprooted and power poles downed. Fallen trees and power poles will isolate residential areas. Power outages will last weeks to possibly months. Most of the area will be uninhabitable for weeks or months. |
| 5 (major) | 157 mph or higher 137 kt or higher 252 km/h or higher | Catastrophic damage will occur: A high percentage of framed homes will be destroyed, with total roof failure and wall collapse. Fallen trees and power poles will isolate residential areas. Power outages will last for weeks to possibly months. Most of the area will be uninhabitable for weeks or months. |

Figure 3: Saffir-Simpson Hurricane Wind Scale

Categories 3 – 5 hurricanes are classified as “major hurricanes”, and while hurricanes within this range comprise only 20% of US total tropical cyclone landfalls, they account for over 70% of the damage in the U.S.. Damage during hurricanes may also result from spawned tornadoes and inland flooding associated with heavy rainfall that usually accompanies these storms.

Data and Methods

Gaining perspective on historical frequencies of sustained hurricane force wind speeds across Puerto Rico required a multi-step geospatial process. First, we downloaded Extended Best Track (EBT) data for all Atlantic tropical cyclones from the National Hurricane Center¹². The National Hurricane Center (NHC) maintains a climatology of all Atlantic tropical cyclones since 1851, called HURDAT. For each storm, HURDAT contains estimates of the latitude, longitude, 1-minute maximum sustained surface winds, minimum sea-level pressure, and an indicator of whether the system was purely tropical, subtropical or extra-tropical at 6-hour intervals. However, HURDAT lacks any information about storm structure. By supplementing HURDAT with additional storm parameters determined by NHC, we created the “extended” best track file used here. The additional parameters include the following:

1. Maximum radial extent of 34, 50 and 64 kt wind in four quadrants
2. Radius of maximum wind
3. Eye diameter (if available)
4. Pressure and radius of the outer closed isobar

¹¹ <https://www.nhc.noaa.gov/aboutsshws.php>

¹² http://rammb.cira.colostate.edu/research/tropical_cyclones/tc_extended_best_track_dataset/

This EBT data was subset for Puerto Rico, resulting in a set of more than 624 6-hour locations for 77 tropical cyclones close enough to Puerto Rico to impact the island with winds (Figure 4A) between 1988 – 2018. The radius to maximum winds (for each point) was used to create a buffer around each point showing the most likely hurricane wind field. This fan shaped buffer (Figure 4B), created specifically for this assessment accounts for the general movement of hurricanes in this part of the Caribbean. Because most hurricanes travel in an East – West or Southeast – Northwest tract, compared to the more North-South pattern seen in the SE United States, the resulting winds associated with these storms is not on the east side of the storm generally, but rather on the north east. Each of the wind fields is then summarized to recreate a specific wind zone polygon for each hurricane event (Figure 4C) so that each storm is only counted once in the analytic process. Finally, a sum of the number of hurricanes impacted Puerto Rico between 1988 – 2018 is generated for each hex grid and summarized by municipio (Figure 4D).

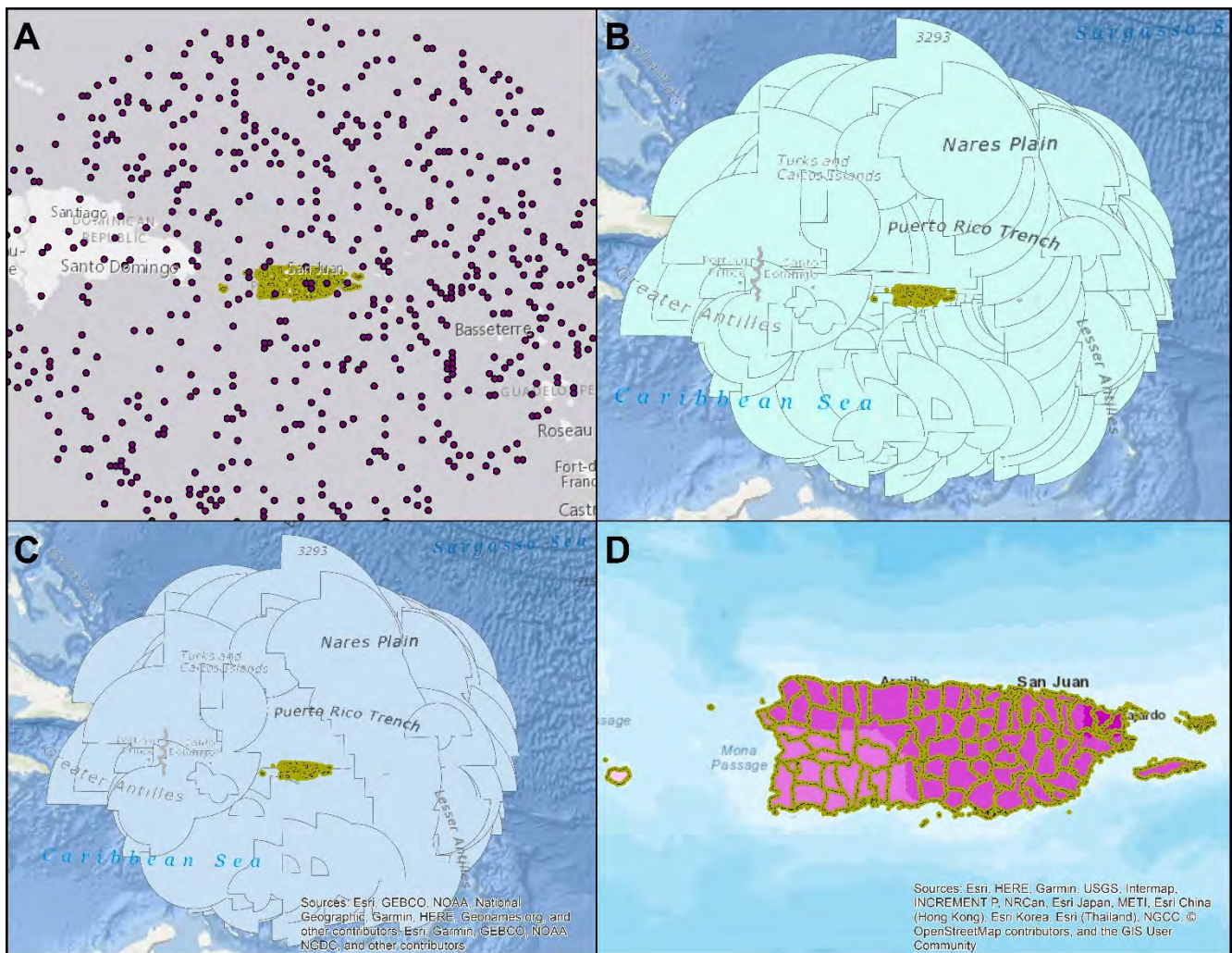


Figure 4: Hurricane Wind Hazard Frequency Analysis Process

Hazard Frequency Analysis Results

Eastern Puerto Rico has experienced more frequent hurricane wind speeds than the remainder of the island with the Isla de Mona experiencing the least number (8 instances) of hurricane force wind events. Fajardo and Luquillo Municipios are both completely within the highest category of hurricane frequency 19 – 21 with the islands east of Fajardo seeing 21 instances of hurricane winds during the last 30 years. Most of the remainder of central and northwestern Puerto Rico has seen between 16-18 hurricane-force wind events during this same time frame; and southeastern portions of the island have been impacted 13-15 times (Figure 5). Table 8 provides finer information about land area inside each hurricane-wind-frequency class by municipio. Table 9 details the percentage of total (municipio) land area in each zone for each municipio. Finally, Table 10 provides a breakdown of percentage of total island-wide land area in each category by municipio. This view can aid in an understanding of the differences across Puerto Rico in terms of hazard threats. Table 11 ranks each municipio by its overall hurricane wind frequency by land area.

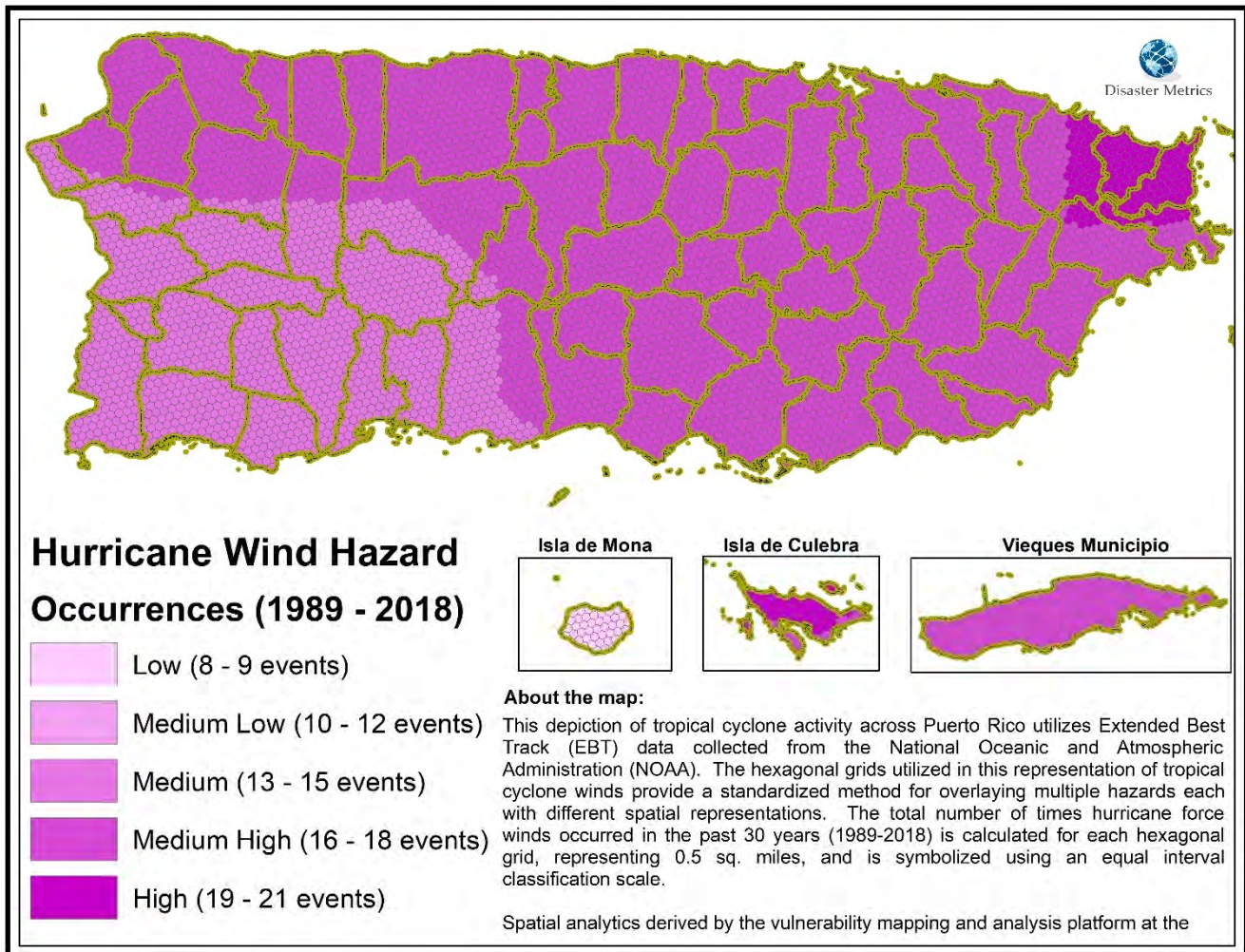


Figure 5: Hurricane Wind Hazard Areas

Table 8: Hurricane Wind Frequency by Municipio and Areal Extent

| Municipio | HEX GRID Area by Hurricane Hazard Frequency (Sq. miles) | | | | |
|--------------|---|---------------------------------------|-----------------------------------|--|--------------------------------|
| | Low (8 – 9 Hurricanes) | Medium Low (10 - 12 Hurricanes) | Medium (13 - 15 Hurricanes) | Medium High (16 - 18 Hurricanes) | High (19 -21 Hurricanes) |
| Adjuntas | | | 67.10 | | |
| Aguada | | | 2.58 | 28.34 | |
| Aguadilla | | | | 36.61 | |
| Aguas Buenas | | | | 30.10 | |
| Aibonito | | | | 31.34 | |
| Anasco | | | 32.21 | 7.35 | |
| Arecibo | | | | 126.97 | |
| Arroyo | | | | 15.05 | |
| Barceloneta | | | | 18.76 | |
| Barranquitas | | | | 34.28 | |
| Bayamon | | | | 44.51 | |
| Cabo Rojo | | | 73.12 | | |
| Caguas | | | | 59.07 | |
| Camuy | | | | 46.37 | |
| Canovanas | | | | 33.01 | |
| Cantano | | | | 47.30 | |
| Carolina | | | | 5.08 | |
| Cayey | | | | 51.96 | |
| Ceiba | | | | 18.29 | 12.08 |
| Ciales | | | | 66.71 | |
| Cidra | | | | 36.46 | |
| Coamo | | | | 78.03 | |
| Comerio | | | | 28.52 | |
| Corozal | | | | 42.58 | |
| Culebra | | | | 3.37 | 9.94 |
| Dorado | | | | 23.42 | |
| Fajardo | | | | | 30.51 |
| Florida | | | | 15.22 | |
| Guanica | | | 39.01 | | |
| Guayama | | | | 65.87 | |
| Guayanilla | | | 42.99 | | |
| Guaynabo | | | | 27.76 | |
| Gurabo | | | | 28.31 | |
| Hatillo | | | | 41.84 | |
| Hormigueros | | | 11.34 | | |
| Humacao | | | | 45.10 | |
| Isabela | | | | 55.41 | |

| | | | | | |
|--------------------|-------|---|--------|----------|--------|
| Jayuya | | | 7.08 | 37.46 | |
| Juana Diaz | | | | 60.73 | |
| Juncos | | | | 26.62 | |
| Lajas | | | 61.36 | | |
| Lares | | | 39.29 | 22.35 | |
| Las Marias | | | 46.50 | 0.00 | |
| Las Piedras | | | | 33.89 | |
| Loiza | | | | 20.53 | |
| Luquillo | | | | | 25.86 |
| Manati | | | | 46.82 | |
| Maricao | | | 36.63 | | |
| Maunabo | | | | 21.09 | |
| Mayaguez | 22.18 | | 55.79 | | |
| Moca | | | | 50.37 | |
| Morovis | | | | 38.93 | |
| Naguabo | | | | 45.57 | 6.31 |
| Naranjito | | | | 27.75 | |
| Orocovis | | | | 63.78 | |
| Patillas | | | | 47.22 | |
| Penuelas | | | 44.76 | | |
| Ponce | | | 73.97 | 43.01 | |
| Quebradillas | | | | 23.14 | |
| Rjo Grande | | | 14.11 | 0.28 | |
| Rincon | | | | 35.42 | 25.39 |
| Sabana Grande | | | 35.84 | | |
| Salinas | | | | 70.06 | |
| San German | | | 54.51 | | |
| San Juan | | | | 49.53 | |
| San Lorenzo | | | | 53.21 | |
| San Sebastian | | | 12.69 | 58.53 | |
| Santa Isabel | | | | 34.57 | |
| Toa Alta | | | | 27.56 | |
| Toa Baja | | | | 23.80 | |
| Trujillo Alto | | | | 21.38 | |
| Utua | | | 46.96 | 68.11 | |
| Vega Alta | | | | 27.74 | |
| Vega Baja | | | | 46.65 | |
| Vieques | | | | 53.18 | |
| Villalba | | | | 37.04 | |
| Yabucoa | | | | 55.41 | |
| Yauco | | | 68.82 | | |
| Grand Total | 22.18 | - | 866.65 | 2,464.70 | 110.10 |

Table 9: Percent of (Municipio) Hexagonal Area by Hurricane Wind Frequency per Municipio

| Municipio | Hurricane Wind Zone Percent Area by Total (Municipio) Land Area | | | | |
|--------------|---|---------------------------------------|-----------------------------------|--|--------------------------------|
| | Low (8 – 9 Hurricanes) | Medium Low (10 - 12 Hurricanes) | Medium (13 - 15 Hurricanes) | Medium High (16 - 18 Hurricanes) | High (19 -21 Hurricanes) |
| Adjuntas | 0.00% | 0.00% | 100.00% | 0.00% | 0.00% |
| Aguada | 0.00% | 0.00% | 8.35% | 91.65% | 0.00% |
| Aguadilla | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Aguas Buenas | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Aibonito | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Anasco | 0.00% | 0.00% | 81.42% | 18.58% | 0.00% |
| Arecibo | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Arroyo | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Barceloneta | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Barranquitas | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Bayamon | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Cabo Rojo | 0.00% | 0.00% | 100.00% | 0.00% | 0.00% |
| Caguas | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Camuy | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Canovanas | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Cantano | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Carolina | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Cayey | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Ceiba | 0.00% | 0.00% | 0.00% | 60.21% | 39.79% |
| Ciales | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Cidra | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Coamo | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Comerio | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Corozal | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Culebra | 0.00% | 0.00% | 0.00% | 25.31% | 74.69% |
| Dorado | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Fajardo | 0.00% | 0.00% | 0.00% | 0.00% | 100.00% |
| Florida | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Guanica | 0.00% | 0.00% | 100.00% | 0.00% | 0.00% |
| Guayama | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Guayanilla | 0.00% | 0.00% | 100.00% | 0.00% | 0.00% |
| Guaynabo | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Gurabo | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Hatillo | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Hormigueros | 0.00% | 0.00% | 100.00% | 0.00% | 0.00% |
| Humacao | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |

| | | | | | |
|---------------|--------|-------|---------|---------|---------|
| Isabela | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Jayuya | 0.00% | 0.00% | 15.89% | 84.11% | 0.00% |
| Juana Diaz | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Juncos | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Lajas | 0.00% | 0.00% | 100.00% | 0.00% | 0.00% |
| Lares | 0.00% | 0.00% | 63.74% | 36.26% | 0.00% |
| Las Marias | 0.00% | 0.00% | 100.00% | 0.00% | 0.00% |
| Las Piedras | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Loiza | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Luquillo | 0.00% | 0.00% | 0.00% | 0.00% | 100.00% |
| Manati | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Maricao | 0.00% | 0.00% | 100.00% | 0.00% | 0.00% |
| Maunabo | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Mayaguez | 28.45% | 0.00% | 71.55% | 0.00% | 0.00% |
| Moca | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Morovis | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Naguabo | 0.00% | 0.00% | 0.00% | 87.83% | 12.17% |
| Naranjito | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Orocovis | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Patillas | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Penuelas | 0.00% | 0.00% | 100.00% | 0.00% | 0.00% |
| Ponce | 0.00% | 0.00% | 63.23% | 36.77% | 0.00% |
| Quebradillas | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Rio Grande | 0.00% | 0.00% | 98.07% | 1.93% | 0.00% |
| Rincon | 0.00% | 0.00% | 0.00% | 58.25% | 41.75% |
| Sabana Grande | 0.00% | 0.00% | 100.00% | 0.00% | 0.00% |
| Salinas | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| San German | 0.00% | 0.00% | 100.00% | 0.00% | 0.00% |
| San Juan | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| San Lorenzo | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| San Sebastian | 0.00% | 0.00% | 17.81% | 82.19% | 0.00% |
| Santa Isabel | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Toa Alta | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Toa Baja | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Trujillo Alto | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Utuado | 0.00% | 0.00% | 40.81% | 59.19% | 0.00% |
| Vega Alta | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Vega Baja | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Vieques | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Villalba | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Yabucoa | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Yauco | 0.00% | 0.00% | 100.00% | 0.00% | 0.00% |

Table 10: Percent of (Island) Hexagonal Area by Hurricane Wind Frequency Category per Municipio

| Municipio | Hurricane Wind Percent Area by (Island) Land Area per Category | | | | |
|--------------|--|-----------------------|-----------------------|-----------------------|----------------------|
| | 8 - 9 Hurricanes | 10 - 12 Hurricanes | 13 - 15 Hurricanes | 16 - 18 Hurricanes | 19 -21 Hurricanes |
| Adjuntas | 0.00% | 0.00% | 7.74% | 0.00% | 0.00% |
| Aguada | 0.00% | 0.00% | 0.30% | 1.15% | 0.00% |
| Aguadilla | 0.00% | 0.00% | 0.00% | 1.49% | 0.00% |
| Aguas Buenas | 0.00% | 0.00% | 0.00% | 1.22% | 0.00% |
| Aibonito | 0.00% | 0.00% | 0.00% | 1.27% | 0.00% |
| Anasco | 0.00% | 0.00% | 3.72% | 0.30% | 0.00% |
| Arecibo | 0.00% | 0.00% | 0.00% | 5.15% | 0.00% |
| Arroyo | 0.00% | 0.00% | 0.00% | 0.61% | 0.00% |
| Barceloneta | 0.00% | 0.00% | 0.00% | 0.76% | 0.00% |
| Barranquitas | 0.00% | 0.00% | 0.00% | 1.39% | 0.00% |
| Bayamon | 0.00% | 0.00% | 0.00% | 1.81% | 0.00% |
| Cabo Rojo | 0.00% | 0.00% | 8.44% | 0.00% | 0.00% |
| Caguas | 0.00% | 0.00% | 0.00% | 2.40% | 0.00% |
| Camuy | 0.00% | 0.00% | 0.00% | 1.88% | 0.00% |
| Canovanas | 0.00% | 0.00% | 0.00% | 1.34% | 0.00% |
| Cantano | 0.00% | 0.00% | 0.00% | 1.92% | 0.00% |
| Carolina | 0.00% | 0.00% | 0.00% | 0.21% | 0.00% |
| Cayey | 0.00% | 0.00% | 0.00% | 2.11% | 0.00% |
| Ceiba | 0.00% | 0.00% | 0.00% | 0.74% | 10.98% |
| Ciales | 0.00% | 0.00% | 0.00% | 2.71% | 0.00% |
| Cidra | 0.00% | 0.00% | 0.00% | 1.48% | 0.00% |
| Coamo | 0.00% | 0.00% | 0.00% | 3.17% | 0.00% |
| Comerio | 0.00% | 0.00% | 0.00% | 1.16% | 0.00% |
| Corozal | 0.00% | 0.00% | 0.00% | 1.73% | 0.00% |
| Culebra | 0.00% | 0.00% | 0.00% | 0.14% | 9.03% |
| Dorado | 0.00% | 0.00% | 0.00% | 0.95% | 0.00% |
| Fajardo | 0.00% | 0.00% | 0.00% | 0.00% | 27.71% |
| Florida | 0.00% | 0.00% | 0.00% | 0.62% | 0.00% |
| Guanica | 0.00% | 0.00% | 4.50% | 0.00% | 0.00% |
| Guayama | 0.00% | 0.00% | 0.00% | 2.67% | 0.00% |
| Guayanilla | 0.00% | 0.00% | 4.96% | 0.00% | 0.00% |
| Guaynabo | 0.00% | 0.00% | 0.00% | 1.13% | 0.00% |
| Gurabo | 0.00% | 0.00% | 0.00% | 1.15% | 0.00% |
| Hatillo | 0.00% | 0.00% | 0.00% | 1.70% | 0.00% |
| Hormigueros | 0.00% | 0.00% | 1.31% | 0.00% | 0.00% |
| Humacao | 0.00% | 0.00% | 0.00% | 1.83% | 0.00% |
| Isabela | 0.00% | 0.00% | 0.00% | 2.25% | 0.00% |

| | | | | | |
|---------------|---------|-------|-------|-------|--------|
| Jayuya | 0.00% | 0.00% | 0.82% | 1.52% | 0.00% |
| Juana Diaz | 0.00% | 0.00% | 0.00% | 2.46% | 0.00% |
| Juncos | 0.00% | 0.00% | 0.00% | 1.08% | 0.00% |
| Lajas | 0.00% | 0.00% | 7.08% | 0.00% | 0.00% |
| Lares | 0.00% | 0.00% | 4.53% | 0.91% | 0.00% |
| Las Marias | 0.00% | 0.00% | 5.37% | 0.00% | 0.00% |
| Las Piedras | 0.00% | 0.00% | 0.00% | 1.38% | 0.00% |
| Loiza | 0.00% | 0.00% | 0.00% | 0.83% | 0.00% |
| Luquillo | 0.00% | 0.00% | 0.00% | 0.00% | 23.49% |
| Manati | 0.00% | 0.00% | 0.00% | 1.90% | 0.00% |
| Maricao | 0.00% | 0.00% | 4.23% | 0.00% | 0.00% |
| Maunabo | 0.00% | 0.00% | 0.00% | 0.86% | 0.00% |
| Mayaguez | 100.00% | 0.00% | 6.44% | 0.00% | 0.00% |
| Moca | 0.00% | 0.00% | 0.00% | 2.04% | 0.00% |
| Morovis | 0.00% | 0.00% | 0.00% | 1.58% | 0.00% |
| Naguabo | 0.00% | 0.00% | 0.00% | 1.85% | 5.73% |
| Naranjito | 0.00% | 0.00% | 0.00% | 1.13% | 0.00% |
| Orocovis | 0.00% | 0.00% | 0.00% | 2.59% | 0.00% |
| Patillas | 0.00% | 0.00% | 0.00% | 1.92% | 0.00% |
| Penuelas | 0.00% | 0.00% | 5.16% | 0.00% | 0.00% |
| Ponce | 0.00% | 0.00% | 8.54% | 1.74% | 0.00% |
| Quebradillas | 0.00% | 0.00% | 0.00% | 0.94% | 0.00% |
| Rjo Grande | 0.00% | 0.00% | 1.63% | 0.01% | 0.00% |
| Rincon | 0.00% | 0.00% | 0.00% | 1.44% | 23.06% |
| Sabana Grande | 0.00% | 0.00% | 4.14% | 0.00% | 0.00% |
| Salinas | 0.00% | 0.00% | 0.00% | 2.84% | 0.00% |
| San German | 0.00% | 0.00% | 6.29% | 0.00% | 0.00% |
| San Juan | 0.00% | 0.00% | 0.00% | 2.01% | 0.00% |
| San Lorenzo | 0.00% | 0.00% | 0.00% | 2.16% | 0.00% |
| San Sebastian | 0.00% | 0.00% | 1.46% | 2.37% | 0.00% |
| Santa Isabel | 0.00% | 0.00% | 0.00% | 1.40% | 0.00% |
| Toa Alta | 0.00% | 0.00% | 0.00% | 1.12% | 0.00% |
| Toa Baja | 0.00% | 0.00% | 0.00% | 0.97% | 0.00% |
| Trujillo Alto | 0.00% | 0.00% | 0.00% | 0.87% | 0.00% |
| Utua | 0.00% | 0.00% | 5.42% | 2.76% | 0.00% |
| Vega Alta | 0.00% | 0.00% | 0.00% | 1.13% | 0.00% |
| Vega Baja | 0.00% | 0.00% | 0.00% | 1.89% | 0.00% |
| Vieques | 0.00% | 0.00% | 0.00% | 2.16% | 0.00% |
| Villalba | 0.00% | 0.00% | 0.00% | 1.50% | 0.00% |
| Yabucoa | 0.00% | 0.00% | 0.00% | 2.25% | 0.00% |
| Yauco | 0.00% | 0.00% | 7.94% | 0.00% | 0.00% |

Table 11: Hurricane Wind Hazard Scores and Ranks by Municipio

| Municipio | Hurricane Wind Hazard Score (Log Multiplied) | | |
|---------------|--|-----------------------------|---------------------------|
| | Total Score | Standardized Score (0-1) | Rank of Score (1 – 78) |
| Fajardo | 10,000.0000 | 1 | 1 |
| Rincon | 8,601.2126 | 0.8599 | 2 |
| Luquillo | 8,475.2237 | 0.8473 | 3 |
| Ceiba | 4,104.5095 | 0.4095 | 4 |
| Culebra | 3,284.2523 | 0.3274 | 5 |
| Naguabo | 2,428.0921 | 0.2416 | 6 |
| Arecibo | 1,000.0000 | 0.0986 | 7 |
| Coamo | 614.5134 | 0.06 | 8 |
| Utua | 599.9014 | 0.0585 | 9 |
| Salinas | 551.7524 | 0.0537 | 10 |
| Ciales | 525.3555 | 0.0511 | 11 |
| Guayama | 518.7459 | 0.0504 | 12 |
| Orocovis | 502.2673 | 0.0488 | 13 |
| Juana Diaz | 478.2996 | 0.0464 | 14 |
| San Sebastian | 478.1357 | 0.0464 | 14 |
| Caguas | 465.1916 | 0.0451 | 16 |
| Ponce | 438.7213 | 0.0424 | 17 |
| Isabela | 436.3739 | 0.0422 | 18 |
| Yabucoa | 436.3638 | 0.0422 | 18 |
| San Lorenzo | 419.0336 | 0.0404 | 20 |
| Vieques | 418.8500 | 0.0404 | 20 |
| Cayey | 409.2251 | 0.0394 | 22 |
| Moca | 396.6589 | 0.0382 | 23 |
| San Juan | 390.0546 | 0.0375 | 24 |
| Cantano | 372.5497 | 0.0358 | 25 |
| Patillas | 371.8471 | 0.0357 | 26 |
| Manati | 368.7413 | 0.0354 | 27 |
| Vega Baja | 367.3796 | 0.0353 | 28 |
| Camuy | 365.2022 | 0.035 | 29 |
| Humacao | 355.2197 | 0.034 | 30 |
| Bayamon | 350.5788 | 0.0336 | 31 |
| Corozal | 335.3358 | 0.032 | 32 |
| Hatillo | 329.5046 | 0.0315 | 33 |
| Morovis | 306.5592 | 0.0292 | 34 |
| Jayuya | 304.5742 | 0.029 | 35 |
| Villalba | 291.6759 | 0.0277 | 36 |
| Aguadilla | 288.2883 | 0.0273 | 37 |
| Cidra | 287.1063 | 0.0272 | 38 |

| | | | |
|---------------|----------|--------|----|
| Santa Isabel | 272.2921 | 0.0257 | 39 |
| Barranquitas | 269.9971 | 0.0255 | 40 |
| Las Piedras | 266.9227 | 0.0252 | 41 |
| Canovanas | 259.9412 | 0.0245 | 42 |
| Aibonito | 246.8095 | 0.0232 | 43 |
| Aguas Buenas | 237.0228 | 0.0222 | 44 |
| Lares | 229.1414 | 0.0214 | 45 |
| Aguada | 226.6967 | 0.0212 | 46 |
| Comerio | 224.6438 | 0.021 | 47 |
| Gurabo | 222.9817 | 0.0208 | 48 |
| Guaynabo | 218.6637 | 0.0204 | 49 |
| Naranjito | 218.5338 | 0.0204 | 49 |
| Vega Alta | 218.4715 | 0.0203 | 51 |
| Toa Alta | 217.0454 | 0.0202 | 52 |
| Juncos | 209.6111 | 0.0195 | 53 |
| Toa Baja | 187.4664 | 0.0172 | 54 |
| Dorado | 184.4249 | 0.0169 | 55 |
| Quebradillas | 182.2401 | 0.0167 | 56 |
| Trujillo Alto | 168.3949 | 0.0153 | 57 |
| Maunabo | 166.0878 | 0.0151 | 58 |
| Loiza | 161.7209 | 0.0147 | 59 |
| Barceloneta | 147.7382 | 0.0133 | 60 |
| Florida | 119.8846 | 0.0105 | 61 |
| Arroyo | 118.5062 | 0.0103 | 62 |
| Anasco | 101.4330 | 0.0086 | 63 |
| Cabo Rojo | 98.8461 | 0.0084 | 64 |
| Yauco | 93.0341 | 0.0078 | 65 |
| Adjuntas | 90.7043 | 0.0075 | 66 |
| Lajas | 82.9554 | 0.0068 | 67 |
| Mayaguez | 76.4225 | 0.0061 | 68 |
| San German | 73.6886 | 0.0058 | 69 |
| Las Marias | 62.8786 | 0.0048 | 70 |
| Penuelas | 60.5045 | 0.0045 | 71 |
| Guayanilla | 58.1161 | 0.0043 | 72 |
| Guanica | 52.7389 | 0.0037 | 73 |
| Maricao | 49.5151 | 0.0034 | 74 |
| Sabana Grande | 48.4541 | 0.0033 | 75 |
| Carolina | 40.0417 | 0.0025 | 76 |
| Rio Grande | 21.2643 | 0.0006 | 77 |
| Hormigueros | 15.3358 | 0 | 78 |

Rain Induced Landslides

Hazard Overview

According to the Puerto Rico's State Hazard Mitigation Plan¹³, landslides occur when the conditions for the force of gravity exerts its influence on crustal materials. The term landslide includes a wide variety of land movement, such as rock falls, slope failures, and debris flow. This earth movement threatens life and property and can disrupt transit, dragging trees, houses, bridges and cars, among others.

Meteorological phenomena that cause intense and prolonged rainfall, such as tropical waves and tropical cyclones can trigger landslides. Poor construction practices and population movement into hazard zones exacerbates the susceptibility of Puerto Rico to experience landslides.

Among the many factors causing the formation of landslides, the most important are: soil type, slope or incline of the terrain, soil water saturation, erosion, the presence of depressions or cavities, human activities, and of course the occurrence of earthquakes. As stated in the Building Performance Assessment Team Report (BPAT) prepared after Hurricane Georges, "landslides will become a major problem in the future as more houses are built and there is more development in areas susceptible to these risks" (FEMA, March 1999).

Many of the landslides that occur in Puerto Rico are in a special category of landslides known as "debris flow". The flow occurs in mountainous areas with significant slopes during heavy rains. The rain saturates the soil and causes the ground level and peel strength loss, usually where the ground makes contact with the bedrock. There are many types of landslides, however, associated with soil saturation by water:

1. Slow landslides: slow and steady movement of soil or rock falls down the slope, often recognized by their content of tree trunks, twisted pieces of fences or retaining walls, tilted poles or fences.
2. Debris flow: fast-moving mass which combines loose soils, rocks, organic matter, air infiltration and water to form a viscous flow that slides down the slope.
3. Debris avalanche: fast, or extremely fast, debris flow range.
4. Mud flow: mass rapid flow of wet material containing at least 50 percent sand, silt and clay particles.

¹³ Puerto Rico Hazard Mitigation Plan - <https://recovery.pr/en/document-library>

Data and Methods

The United State Geological Survey (USGS) completed a study of rainfall-induced landslides on Puerto Rico in early 2020.¹⁴ The report summarizes creation of a new high-resolution model of rainfall-induced landslide susceptibility for the main island. The main island of Puerto Rico was classified at 5-meter pixel scale into categories of Low, Moderate, High, Very High, or Extremely High susceptibility to landsliding during and soon after intense rainfall, such as is produced during tropical cyclones. Resulting raster GIS output data, downloaded as georeferenced files, were used in this assessment to understand sub-municipio level landslide susceptibility. The output grid of susceptibility index (SI) values were summarized for each ½ mile hexagonal grid and a focus on average landslide values was generated. Average SI values were used here because they enable visualization of spatial variation across the island, whereas summarized maximum SI values skew the visualization towards a much less realistic landslide threat (Figure 6).

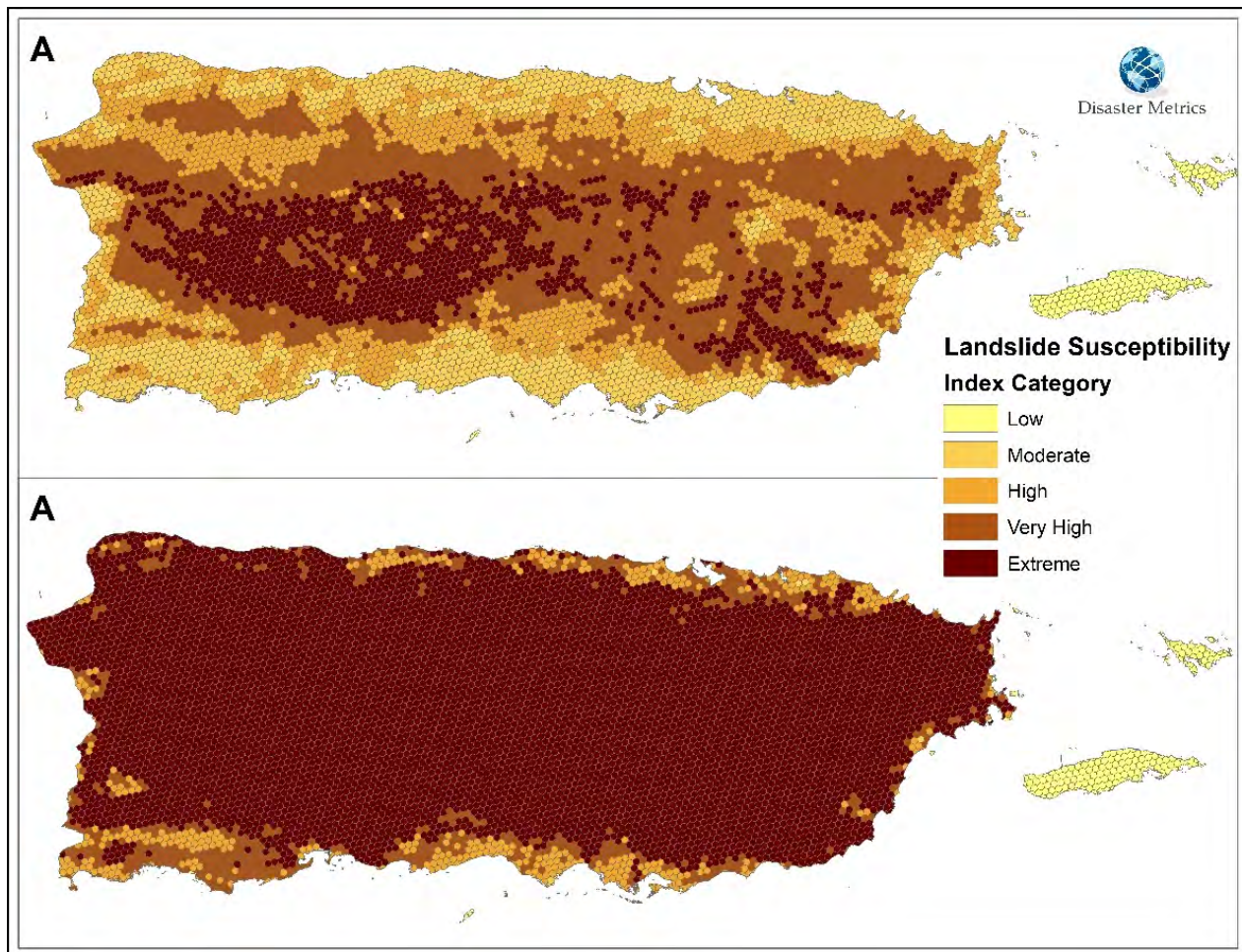


Figure 6: Rain Induced Landslide Susceptibility Index Average (A) vs Maximum (B) Score Comparison

¹⁴ <https://pubs.er.usgs.gov/publication/ofr20201022>

Hazard Frequency Analysis Results

Unlike flooding and hurricane hazards where coastal areas are more highly threatened, landslide hazards are mainly a hilly and mountainous area phenomena. Figure 6 illustrates higher landslide susceptibility along the west central portion of the island compared to the remainders of Puerto Rico. “Very high” landslide susceptibility trending from east to west coast and to the southeast indicates that landslide hazards are ever-present for many municipios.

Table 12 shows the total land area in each municipio by landslide susceptibility category. Here we see that places like Utuado (69 sq. mi.), Adjuntas (45.8 sq. mi.), and Ponce (40.6 sq. mi.) have the most land area in the “extreme” landslide category. However, Table 13 highlights places where more than 60% of their total land area in the “extreme” SI category. Included here are Maricao (94%), Jayuya (75%), Adjuntas (68%), and Las Marias (67%). Table 10 allows for a cross comparison between each municipio in reference to Puerto Rico as a whole. Finally, Table 15 shows rain induced landslide scores and ranks by municipio.

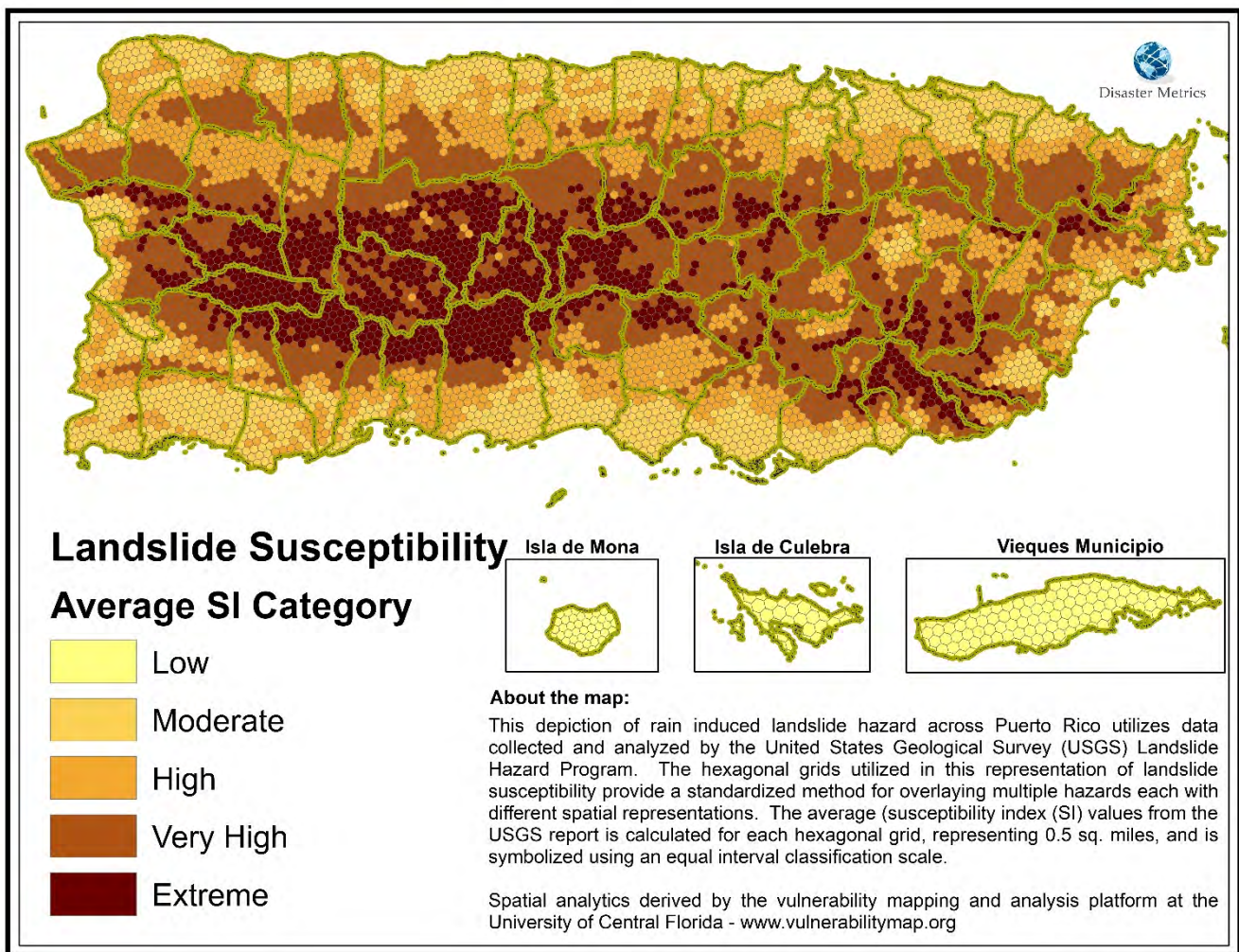


Figure 7: Rain Induced Landslide Susceptibility Areas

Table 12: Rain Induced Landslide Susceptibility by Municipio and Areal Extent

| Municipio | HEX GRID Area by Landslide Susceptibility (Sq. miles) | | | | |
|--------------|---|-------------------------|----------------------|---------------------------|---------------------|
| | Low (0 SI) | Moderate (1 - 25 SI) | High (25 - 50 SI) | Very High (50 - 75 SI) | Extreme (>75 SI) |
| Adjuntas | | | 0.50 | 20.80 | 45.79 |
| Aguada | | 6.08 | 8.24 | 15.92 | 0.68 |
| Aguadilla | | 19.13 | 17.47 | 0.01 | |
| Aguas Buenas | | | 0.27 | 25.35 | 4.48 |
| Aibonito | | | 5.00 | 21.75 | 4.59 |
| Anasco | | 8.88 | 4.34 | 13.44 | 12.90 |
| Arecibo | 0.00 | 38.82 | 46.28 | 41.87 | 0.00 |
| Arroyo | | 6.33 | 2.02 | 4.35 | 2.35 |
| Barceloneta | 0.01 | 11.91 | 6.35 | 0.49 | |
| Barranquitas | | | 0.49 | 27.95 | 5.84 |
| Bayamon | | 12.56 | 11.76 | 17.55 | 2.64 |
| Cabo Rojo | 0.00 | 44.70 | 24.41 | 4.01 | |
| Caguas | | 6.49 | 14.73 | 32.03 | 5.83 |
| Camuy | | 9.87 | 19.74 | 16.76 | |
| Canovanas | | 7.18 | 5.59 | 19.37 | 0.86 |
| Carolina | | 24.59 | 6.29 | 16.42 | 0.00 |
| Catano | | 5.08 | | | |
| Cayey | | 0.50 | 7.70 | 35.43 | 8.33 |
| Ceiba | 0.80 | 11.36 | 7.34 | 8.28 | 2.59 |
| Ciales | | | 2.05 | 42.04 | 22.62 |
| Cidra | | | 9.73 | 25.77 | 0.96 |
| Coamo | | 1.20 | 36.91 | 28.14 | 11.78 |
| Comerio | | | 0.00 | 21.30 | 7.22 |
| Corozal | | | 1.43 | 30.89 | 10.25 |
| Culebra | 13.31 | | | | |
| Dorado | | 13.01 | 8.91 | 1.50 | |
| Fajardo | 0.56 | 5.85 | 15.09 | 6.21 | 2.80 |
| Florida | | | 10.83 | 4.40 | |
| Guanica | 0.01 | 29.69 | 9.31 | | |
| Guayama | 0.13 | 23.31 | 11.41 | 24.24 | 6.78 |
| Guayanilla | 0.14 | 11.40 | 14.15 | 8.47 | 8.83 |
| Guaynabo | | 3.98 | 7.93 | 14.85 | 1.00 |
| Gurabo | | 0.51 | 12.22 | 15.17 | 0.41 |
| Hatillo | | 10.57 | 20.74 | 10.53 | |
| Hormigueros | | 6.34 | 1.50 | 3.51 | |

| | | | | | |
|----------------------|-------|-------|-------|-------|-------|
| Humacao | 0.18 | 11.15 | 17.87 | 15.90 | |
| Isabela | | 17.54 | 15.54 | 22.32 | |
| Jayuya | | | 0.50 | 10.54 | 33.50 |
| Juana Diaz | 0.12 | 26.52 | 18.97 | 8.59 | 6.53 |
| Juncos | | | 12.36 | 10.88 | 3.38 |
| Lajas | 0.17 | 45.90 | 12.94 | 2.35 | |
| Lares | | | 14.24 | 20.61 | 26.80 |
| Las Marias | | | | 15.11 | 31.39 |
| Las Piedras | | | 12.88 | 19.43 | 1.59 |
| Loiza | | 20.45 | 0.08 | | |
| Luquillo | | 2.62 | 9.55 | 13.06 | 0.63 |
| Manati | 0.20 | 17.63 | 22.29 | 6.71 | |
| Maricao | | | | 2.26 | 34.37 |
| Maunabo | 0.00 | 1.38 | 5.14 | 5.76 | 8.81 |
| Mayaguez | 22.77 | 10.98 | 7.42 | 26.82 | 9.99 |
| Moca | | 2.47 | 20.80 | 27.09 | 0.01 |
| Morovis | | | 11.47 | 14.76 | 12.69 |
| Naguabo | 0.01 | 7.19 | 18.32 | 21.17 | 5.18 |
| Naranjito | | | 0.02 | 20.23 | 7.49 |
| Orocovis | | | | 27.76 | 36.01 |
| Patillas | 0.00 | 2.47 | 4.90 | 15.52 | 24.32 |
| Penuelas | 0.13 | 3.32 | 16.90 | 7.46 | 16.95 |
| Ponce | 0.65 | 34.91 | 21.01 | 19.86 | 40.55 |
| Quebradillas | | 5.95 | 10.51 | 6.69 | |
| Rincon | 0.09 | 0.62 | 4.29 | 8.62 | 0.77 |
| Rio Grande | | 12.90 | 13.37 | 33.25 | 1.29 |
| Sabana Grande | | 5.37 | 10.74 | 12.37 | 7.37 |
| Salinas | 0.39 | 33.75 | 21.66 | 14.06 | 0.20 |
| San German | | 6.12 | 13.25 | 29.41 | 5.73 |
| San Juan | 0.00 | 24.57 | 17.05 | 7.91 | |
| San Lorenzo | | | 4.90 | 33.37 | 14.94 |
| San Sebastian | | | 35.10 | 29.13 | 6.99 |
| Santa Isabel | 0.11 | 28.99 | 5.34 | 0.13 | |
| Toa Alta | | 0.18 | 17.64 | 9.74 | |
| Toa Baja | 0.00 | 16.63 | 7.17 | | |
| Trujillo Alto | | | 7.95 | 13.43 | |
| Utua | | | 3.69 | 42.33 | 69.05 |
| Vega Alta | | 7.32 | 13.16 | 7.27 | |
| Vega Baja | 0.00 | 21.73 | 16.83 | 8.08 | |
| Vieques | 53.18 | | | | |
| Villalba | | | 6.37 | 21.99 | 8.68 |
| Yabucoa | | 11.09 | 8.71 | 26.79 | 8.82 |

| | | | | | |
|--------------------|--------------|---------------|---------------|----------------|---------------|
| Yauco | | 7.75 | 11.63 | 21.99 | 27.45 |
| Grand Total | 92.98 | 706.84 | 823.29 | 1219.52 | 621.00 |

Table 13: Percent of (Municipio) Hexagonal Area by Rain Induced Landslide Susceptibility per Municipio

| Municipio | Landslide Susceptibility Percent Area by Total (Municipio) Land Area | | | | |
|--------------|--|-------------------------|----------------------|---------------------------|---------------------|
| | Low (0 SI) | Moderate (1 - 25 SI) | High (25 - 50 SI) | Very High (50 - 75 SI) | Extreme (>75 SI) |
| Adjuntas | 0.00% | 0.00% | 0.75% | 31.01% | 68.25% |
| Aguada | 0.00% | 19.67% | 26.65% | 51.49% | 2.19% |
| Aguadilla | 0.00% | 52.25% | 47.73% | 0.02% | 0.00% |
| Aguas Buenas | 0.00% | 0.00% | 0.89% | 84.22% | 14.90% |
| Aibonito | 0.00% | 0.00% | 15.95% | 69.41% | 14.63% |
| Anasco | 0.00% | 22.45% | 10.98% | 33.98% | 32.60% |
| Arecibo | 0.00% | 30.57% | 36.45% | 32.98% | 0.00% |
| Arroyo | 0.00% | 42.07% | 13.46% | 28.88% | 15.59% |
| Barceloneta | 0.06% | 63.49% | 33.86% | 2.59% | 0.00% |
| Barranquitas | 0.00% | 0.00% | 1.44% | 81.53% | 17.03% |
| Bayamon | 0.00% | 28.21% | 26.42% | 39.43% | 5.93% |
| Cabo Rojo | 0.00% | 61.13% | 33.38% | 5.48% | 0.00% |
| Caguas | 0.00% | 10.99% | 24.93% | 54.22% | 9.86% |
| Camuy | 0.00% | 21.28% | 42.57% | 36.15% | 0.00% |
| Canovanas | 0.00% | 21.77% | 16.93% | 58.70% | 2.61% |
| Carolina | 0.00% | 51.99% | 13.29% | 34.71% | 0.01% |
| Catano | 0.00% | 100.00% | 0.00% | 0.00% | 0.00% |
| Cayey | 0.00% | 0.96% | 14.82% | 68.19% | 16.03% |
| Ceiba | 2.63% | 37.40% | 24.18% | 27.26% | 8.53% |
| Ciales | 0.00% | 0.00% | 3.07% | 63.02% | 33.92% |
| Cidra | 0.00% | 0.00% | 26.69% | 70.69% | 2.63% |
| Coamo | 0.00% | 1.54% | 47.30% | 36.06% | 15.10% |
| Comerio | 0.00% | 0.00% | 0.00% | 74.68% | 25.32% |
| Corozal | 0.00% | 0.00% | 3.37% | 72.55% | 24.08% |
| Culebra | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Dorado | 0.00% | 55.56% | 38.04% | 6.41% | 0.00% |
| Fajardo | 1.83% | 19.16% | 49.47% | 20.35% | 9.19% |
| Florida | 0.00% | 0.00% | 71.12% | 28.88% | 0.00% |
| Guanica | 0.03% | 76.12% | 23.85% | 0.00% | 0.00% |
| Guayama | 0.19% | 35.39% | 17.33% | 36.79% | 10.29% |
| Guayanilla | 0.33% | 26.52% | 32.90% | 19.70% | 20.54% |
| Guaynabo | 0.00% | 14.33% | 28.57% | 53.50% | 3.60% |
| Gurabo | 0.00% | 1.80% | 43.17% | 53.60% | 1.44% |
| Hatillo | 0.00% | 25.25% | 49.58% | 25.17% | 0.00% |
| Hormigueros | 0.00% | 55.86% | 13.24% | 30.91% | 0.00% |

| | | | | | |
|----------------------|---------|--------|--------|--------|--------|
| Humacao | 0.40% | 24.73% | 39.61% | 35.25% | 0.00% |
| Isabela | 0.00% | 31.66% | 28.05% | 40.29% | 0.00% |
| Jayuya | 0.00% | 0.00% | 1.12% | 23.66% | 75.22% |
| Juana Diaz | 0.19% | 43.67% | 31.23% | 14.15% | 10.75% |
| Juncos | 0.00% | 0.00% | 46.43% | 40.86% | 12.70% |
| Lajas | 0.28% | 74.81% | 21.09% | 3.83% | 0.00% |
| Lares | 0.00% | 0.00% | 23.10% | 33.43% | 43.47% |
| Las Marias | 0.00% | 0.00% | 0.00% | 32.50% | 67.50% |
| Las Piedras | 0.00% | 0.00% | 38.00% | 57.32% | 4.68% |
| Loiza | 0.00% | 99.60% | 0.40% | 0.00% | 0.00% |
| Luquillo | 0.00% | 10.11% | 36.94% | 50.51% | 2.44% |
| Manati | 0.43% | 37.65% | 47.60% | 14.32% | 0.00% |
| Maricao | 0.00% | 0.00% | 0.00% | 6.17% | 93.83% |
| Maunabo | 0.00% | 6.55% | 24.38% | 27.31% | 41.76% |
| Mayaguez | 29.20% | 14.08% | 9.51% | 34.40% | 12.81% |
| Moca | 0.00% | 4.90% | 41.29% | 53.79% | 0.02% |
| Morovis | 0.00% | 0.00% | 29.47% | 37.93% | 32.61% |
| Naguabo | 0.02% | 13.86% | 35.31% | 40.81% | 9.99% |
| Naranjito | 0.00% | 0.00% | 0.08% | 72.92% | 27.00% |
| Orocovis | 0.00% | 0.00% | 0.00% | 43.53% | 56.47% |
| Patillas | 0.01% | 5.24% | 10.38% | 32.87% | 51.50% |
| Penuelas | 0.30% | 7.41% | 37.76% | 16.66% | 37.87% |
| Ponce | 0.55% | 29.84% | 17.96% | 16.97% | 34.66% |
| Quebradillas | 0.00% | 25.70% | 45.40% | 28.90% | 0.00% |
| Rincon | 0.60% | 4.33% | 29.79% | 59.93% | 5.36% |
| Rio Grande | 0.00% | 21.21% | 21.99% | 54.68% | 2.12% |
| Sabana Grande | 0.00% | 14.97% | 29.96% | 34.50% | 20.57% |
| Salinas | 0.56% | 48.17% | 30.92% | 20.06% | 0.29% |
| San German | 0.00% | 11.23% | 24.30% | 53.96% | 10.51% |
| San Juan | 0.00% | 49.62% | 34.42% | 15.96% | 0.00% |
| San Lorenzo | 0.00% | 0.00% | 9.20% | 62.72% | 28.07% |
| San Sebastian | 0.00% | 0.00% | 49.29% | 40.90% | 9.81% |
| Santa Isabel | 0.32% | 83.86% | 15.44% | 0.38% | 0.00% |
| Toa Alta | 0.00% | 0.66% | 64.00% | 35.34% | 0.00% |
| Toa Baja | 0.00% | 69.87% | 30.13% | 0.00% | 0.00% |
| Trujillo Alto | 0.00% | 0.00% | 37.20% | 62.80% | 0.00% |
| Utua | 0.00% | 0.00% | 3.20% | 36.79% | 60.01% |
| Vega Alta | 0.00% | 26.38% | 47.43% | 26.19% | 0.00% |
| Vega Baja | 0.00% | 46.59% | 36.09% | 17.32% | 0.00% |
| Vieques | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Villalba | 0.00% | 0.00% | 17.20% | 59.36% | 23.44% |
| Yabucoa | 0.00% | 20.01% | 15.72% | 48.35% | 15.91% |

| | | | | | |
|--------------|-------|--------|--------|--------|--------|
| Yauco | 0.00% | 11.26% | 16.91% | 31.95% | 39.89% |
|--------------|-------|--------|--------|--------|--------|

Table 14: Percent of (Island) Hexagonal Area by Rain Induced Landslide Susceptibility per Municipio

| Municipio | Landslide Susceptibility Percent Area by Total (Island) Land Area Per Category | | | | |
|---------------------|---|---------------------------------|------------------------------|-----------------------------------|--------------------------------|
| | Low (0 SI) | Moderate (1 - 25 SI) | High (25 - 50 SI) | Very High (50 - 75 SI) | Extreme (>75 SI) |
| Adjuntas | 0.00% | 0.00% | 0.00% | 2.00% | 7.00% |
| Aguada | 0.00% | 1.00% | 1.00% | 1.00% | 0.00% |
| Aguadilla | 0.00% | 3.00% | 2.00% | 0.00% | 0.00% |
| Aguas Buenas | 0.00% | 0.00% | 0.00% | 2.00% | 1.00% |
| Aibonito | 0.00% | 0.00% | 1.00% | 2.00% | 1.00% |
| Anasco | 0.00% | 1.00% | 1.00% | 1.00% | 2.00% |
| Arecibo | 0.00% | 5.00% | 6.00% | 3.00% | 0.00% |
| Arroyo | 0.00% | 1.00% | 0.00% | 0.00% | 0.00% |
| Barceloneta | 0.00% | 2.00% | 1.00% | 0.00% | 0.00% |
| Barranquitas | 0.00% | 0.00% | 0.00% | 2.00% | 1.00% |
| Bayamon | 0.00% | 2.00% | 1.00% | 1.00% | 0.00% |
| Cabo Rojo | 0.00% | 6.00% | 3.00% | 0.00% | 0.00% |
| Caguas | 0.00% | 1.00% | 2.00% | 3.00% | 1.00% |
| Camuy | 0.00% | 1.00% | 2.00% | 1.00% | 0.00% |
| Canovanas | 0.00% | 1.00% | 1.00% | 2.00% | 0.00% |
| Carolina | 0.00% | 3.00% | 1.00% | 1.00% | 0.00% |
| Catano | 0.00% | 1.00% | 0.00% | 0.00% | 0.00% |
| Cayey | 0.00% | 0.00% | 1.00% | 3.00% | 1.00% |
| Ceiba | 1.00% | 2.00% | 1.00% | 1.00% | 0.00% |
| Ciales | 0.00% | 0.00% | 0.00% | 3.00% | 4.00% |
| Cidra | 0.00% | 0.00% | 1.00% | 2.00% | 0.00% |
| Coamo | 0.00% | 0.00% | 4.00% | 2.00% | 2.00% |
| Comerio | 0.00% | 0.00% | 0.00% | 2.00% | 1.00% |
| Corozal | 0.00% | 0.00% | 0.00% | 3.00% | 2.00% |
| Culebra | 14.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Dorado | 0.00% | 2.00% | 1.00% | 0.00% | 0.00% |
| Fajardo | 1.00% | 1.00% | 2.00% | 1.00% | 0.00% |
| Florida | 0.00% | 0.00% | 1.00% | 0.00% | 0.00% |
| Guanica | 0.00% | 4.00% | 1.00% | 0.00% | 0.00% |
| Guayama | 0.00% | 3.00% | 1.00% | 2.00% | 1.00% |
| Guayanilla | 0.00% | 2.00% | 2.00% | 1.00% | 1.00% |
| Guaynabo | 0.00% | 1.00% | 1.00% | 1.00% | 0.00% |
| Gurabo | 0.00% | 0.00% | 1.00% | 1.00% | 0.00% |
| Hatillo | 0.00% | 1.00% | 3.00% | 1.00% | 0.00% |
| Hormigueros | 0.00% | 1.00% | 0.00% | 0.00% | 0.00% |
| Humacao | 0.00% | 2.00% | 2.00% | 1.00% | 0.00% |

| | | | | | |
|---------------|--------|-------|-------|-------|--------|
| Isabela | 0.00% | 2.00% | 2.00% | 2.00% | 0.00% |
| Jayuya | 0.00% | 0.00% | 0.00% | 1.00% | 5.00% |
| Juana Diaz | 0.00% | 4.00% | 2.00% | 1.00% | 1.00% |
| Juncos | 0.00% | 0.00% | 2.00% | 1.00% | 1.00% |
| Lajas | 0.00% | 6.00% | 2.00% | 0.00% | 0.00% |
| Lares | 0.00% | 0.00% | 2.00% | 2.00% | 4.00% |
| Las Marias | 0.00% | 0.00% | 0.00% | 1.00% | 5.00% |
| Las Piedras | 0.00% | 0.00% | 2.00% | 2.00% | 0.00% |
| Loiza | 0.00% | 3.00% | 0.00% | 0.00% | 0.00% |
| Luquillo | 0.00% | 0.00% | 1.00% | 1.00% | 0.00% |
| Manati | 0.00% | 2.00% | 3.00% | 1.00% | 0.00% |
| Maricao | 0.00% | 0.00% | 0.00% | 0.00% | 6.00% |
| Maunabo | 0.00% | 0.00% | 1.00% | 0.00% | 1.00% |
| Mayaguez | 24.00% | 2.00% | 1.00% | 2.00% | 2.00% |
| Moca | 0.00% | 0.00% | 3.00% | 2.00% | 0.00% |
| Morovis | 0.00% | 0.00% | 1.00% | 1.00% | 2.00% |
| Naguabo | 0.00% | 1.00% | 2.00% | 2.00% | 1.00% |
| Naranjito | 0.00% | 0.00% | 0.00% | 2.00% | 1.00% |
| Orocovis | 0.00% | 0.00% | 0.00% | 2.00% | 6.00% |
| Patillas | 0.00% | 0.00% | 1.00% | 1.00% | 4.00% |
| Penuelas | 0.00% | 0.00% | 2.00% | 1.00% | 3.00% |
| Ponce | 1.00% | 5.00% | 3.00% | 2.00% | 7.00% |
| Quebradillas | 0.00% | 1.00% | 1.00% | 1.00% | 0.00% |
| Rincon | 0.00% | 0.00% | 1.00% | 1.00% | 0.00% |
| Rio Grande | 0.00% | 2.00% | 2.00% | 3.00% | 0.00% |
| Sabana Grande | 0.00% | 1.00% | 1.00% | 1.00% | 1.00% |
| Salinas | 0.00% | 5.00% | 3.00% | 1.00% | 0.00% |
| San German | 0.00% | 1.00% | 2.00% | 2.00% | 1.00% |
| San Juan | 0.00% | 3.00% | 2.00% | 1.00% | 0.00% |
| San Lorenzo | 0.00% | 0.00% | 1.00% | 3.00% | 2.00% |
| San Sebastian | 0.00% | 0.00% | 4.00% | 2.00% | 1.00% |
| Santa Isabel | 0.00% | 4.00% | 1.00% | 0.00% | 0.00% |
| Toa Alta | 0.00% | 0.00% | 2.00% | 1.00% | 0.00% |
| Toa Baja | 0.00% | 2.00% | 1.00% | 0.00% | 0.00% |
| Trujillo Alto | 0.00% | 0.00% | 1.00% | 1.00% | 0.00% |
| Utua | 0.00% | 0.00% | 0.00% | 3.00% | 11.00% |
| Vega Alta | 0.00% | 1.00% | 2.00% | 1.00% | 0.00% |
| Vega Baja | 0.00% | 3.00% | 2.00% | 1.00% | 0.00% |
| Vieques | 57.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Villalba | 0.00% | 0.00% | 1.00% | 2.00% | 1.00% |
| Yabucoa | 0.00% | 2.00% | 1.00% | 2.00% | 1.00% |
| Yauco | 0.00% | 1.00% | 1.00% | 2.00% | 4.00% |

Table 15: Rain Induced Landslide Hazard Scores and Ranks by Municipio

| Municipio | Rain Induced Landslide Hazard Score (Log Multiplied) | | |
|---------------|--|--------------------------|-----------------------|
| | Total Score | Standardized Score (0-1) | Rank of Score (1 -78) |
| Utua | 11,007.9658 | 1 | 1 |
| Adjuntas | 7,124.2914 | 0.6472 | 2 |
| Ponce | 6,394.7789 | 0.5809 | 3 |
| Orocovis | 5,871.2660 | 0.5334 | 4 |
| Jayuya | 5,101.2950 | 0.4634 | 5 |
| Maricao | 5,030.6125 | 0.457 | 6 |
| Las Marias | 4,903.4308 | 0.4454 | 7 |
| Yauco | 4,521.8364 | 0.4108 | 8 |
| Lares | 4,398.3440 | 0.3995 | 9 |
| Ciales | 4,273.9571 | 0.3882 | 10 |
| Patillas | 3,899.4960 | 0.3542 | 11 |
| San Lorenzo | 2,961.9372 | 0.2691 | 12 |
| Penuelas | 2,668.3423 | 0.2424 | 13 |
| Coamo | 2,450.5625 | 0.2226 | 14 |
| Corozal | 2,217.8701 | 0.2015 | 15 |
| Morovis | 2,211.6440 | 0.2009 | 16 |
| Anasco | 2,196.3652 | 0.1995 | 17 |
| Mayaguez | 2,098.8878 | 0.1907 | 18 |
| Cayey | 2,059.6981 | 0.1871 | 19 |
| Yabucoa | 1,931.0546 | 0.1754 | 20 |
| Villalba | 1,790.1072 | 0.1626 | 21 |
| San Sebastian | 1,776.1361 | 0.1613 | 22 |
| Caguas | 1,633.3541 | 0.1484 | 23 |
| Guayama | 1,584.0420 | 0.1439 | 24 |
| Naranjito | 1,563.0970 | 0.142 | 25 |
| San German | 1,554.7317 | 0.1412 | 26 |
| Comerio | 1,549.2521 | 0.1407 | 27 |
| Guayanilla | 1,512.2217 | 0.1374 | 28 |
| Barranquitas | 1,506.8275 | 0.1369 | 29 |
| Maunabo | 1,422.8750 | 0.1292 | 30 |
| Sabana Grande | 1,384.4359 | 0.1257 | 31 |
| Naguabo | 1,291.9654 | 0.1173 | 32 |
| Aguas Buenas | 1,248.5177 | 0.1134 | 33 |
| Juana Diaz | 1,195.6958 | 0.1086 | 34 |
| Aibonito | 1,188.8122 | 0.108 | 35 |
| Arecibo | 1,097.5492 | 0.0997 | 36 |
| Rio Grande | 1,004.0051 | 0.0912 | 37 |
| Bayamon | 825.1892 | 0.0749 | 38 |

| | | | |
|---------------|----------|--------|----|
| Juncos | 773.2950 | 0.0702 | 39 |
| Cidra | 768.3763 | 0.0698 | 40 |
| Las Piedras | 716.3653 | 0.0651 | 41 |
| Moca | 686.9647 | 0.0624 | 42 |
| Canovanas | 595.9398 | 0.0541 | 43 |
| Ceiba | 589.2291 | 0.0535 | 44 |
| Fajardo | 586.7743 | 0.0533 | 45 |
| Isabela | 564.7305 | 0.0513 | 46 |
| Guaynabo | 513.6940 | 0.0466 | 47 |
| Aguada | 493.4421 | 0.0448 | 48 |
| Arroyo | 448.1762 | 0.0407 | 49 |
| Gurabo | 443.8242 | 0.0403 | 50 |
| Camuy | 440.7746 | 0.04 | 51 |
| Luquillo | 421.0537 | 0.0382 | 52 |
| Humacao | 416.6406 | 0.0378 | 53 |
| Salinas | 415.5659 | 0.0377 | 54 |
| Carolina | 407.3304 | 0.037 | 55 |
| Trujillo Alto | 334.3882 | 0.0304 | 56 |
| Rincon | 324.8197 | 0.0295 | 57 |
| Hatillo | 295.8386 | 0.0269 | 58 |
| Toa Alta | 268.1891 | 0.0243 | 59 |
| Vega Baja | 231.9846 | 0.0211 | 60 |
| San Juan | 228.9270 | 0.0208 | 61 |
| Manati | 210.3993 | 0.0191 | 62 |
| Vega Alta | 201.6417 | 0.0183 | 63 |
| Quebradillas | 181.9432 | 0.0165 | 64 |
| Cabo Rojo | 157.1405 | 0.0143 | 65 |
| Florida | 127.2404 | 0.0115 | 66 |
| Lajas | 93.4171 | 0.0085 | 67 |
| Hormigueros | 87.4430 | 0.0079 | 68 |
| Dorado | 57.5182 | 0.0052 | 69 |
| Aguadilla | 42.0751 | 0.0038 | 70 |
| Barceloneta | 27.8045 | 0.0025 | 71 |
| Guanica | 26.5750 | 0.0024 | 72 |
| Santa Isabel | 20.9251 | 0.0019 | 73 |
| Toa Baja | 19.1187 | 0.0017 | 74 |
| Loiza | 4.6317 | 0.0004 | 75 |
| Catano | 1.1076 | 0.0001 | 76 |
| Vieques | 1.0000 | 0.0001 | 76 |
| Culebra | 0.2502 | 0 | 78 |

Severe Storms

Hazard Overview

Severe thunderstorms are defined by the National Weather Service as storms that have wind speeds of 58 miles per hour or higher, produce hail at least ¼ inches in diameter, or produces tornadoes. Thunderstorms simply require moisture to form clouds and rain, coupled with an unstable mass of warm air that can rise rapidly.

Thunderstorms affect relatively small areas when compared with hurricanes and winter storms, as the average storm is 15 miles in diameter and lasts an average of 30 minutes. Nearly 1,800 thunderstorms are occurring at any moment around the world. However, of the estimated 100,000 thunderstorms that occur each year in the United States only about 10 percent are classified as severe. Thunderstorms are most likely to happen in the spring and summer months and during the afternoon and evening hours but can occur year-round and at all hours.

Despite their small size, all thunderstorms are dangerous and capable of threatening life and property in localized areas. Every thunderstorm produces lightning, which results from the buildup and discharge of electrical energy between positively and negatively charged areas. Each year across the US, lightning is responsible for an average of 93 deaths (more than tornados), 300 injuries, and several hundred million dollars in damage to property and forests.

Thunderstorms can also produce large, damaging hail, which causes nearly \$1 billion in damage to property and crops annually. Straight-line winds, which in extreme cases have the potential to exceed 100 miles per hour, are responsible for most thunderstorm wind damage. One type of straight-line wind, the downburst, can cause damage equivalent to a strong tornado and can be extremely dangerous to aviation. Thunderstorms are also capable of producing tornados and heavy rain that can lead to flash flooding.

Data and Methods

Severe storm warnings are issued by Puerto Rico's National Weather Service Forecast Office. Severe Thunderstorm Warnings will include where the storm was located, what towns will be affected by the severe thunderstorm, and the primary threat associated with the severe thunderstorm warning.¹⁵ Archived severe storm warnings are collected and archived by Iowa State University's Environmental Mesonet.¹⁶ Across Puerto Rico, there have been forty-four severe storm warnings issued between 2002-2019 (Figure 8). Each hexagonal grid was appraised based on the number of watch boxes

¹⁵ <https://www.weather.gov/bgm/severedefinitions>

¹⁶ <https://mesonet.agron.iastate.edu/>

touching it over the time period of record. This summation was then divided by the number of years in record to develop an average annual number of severe storms, and mapped.

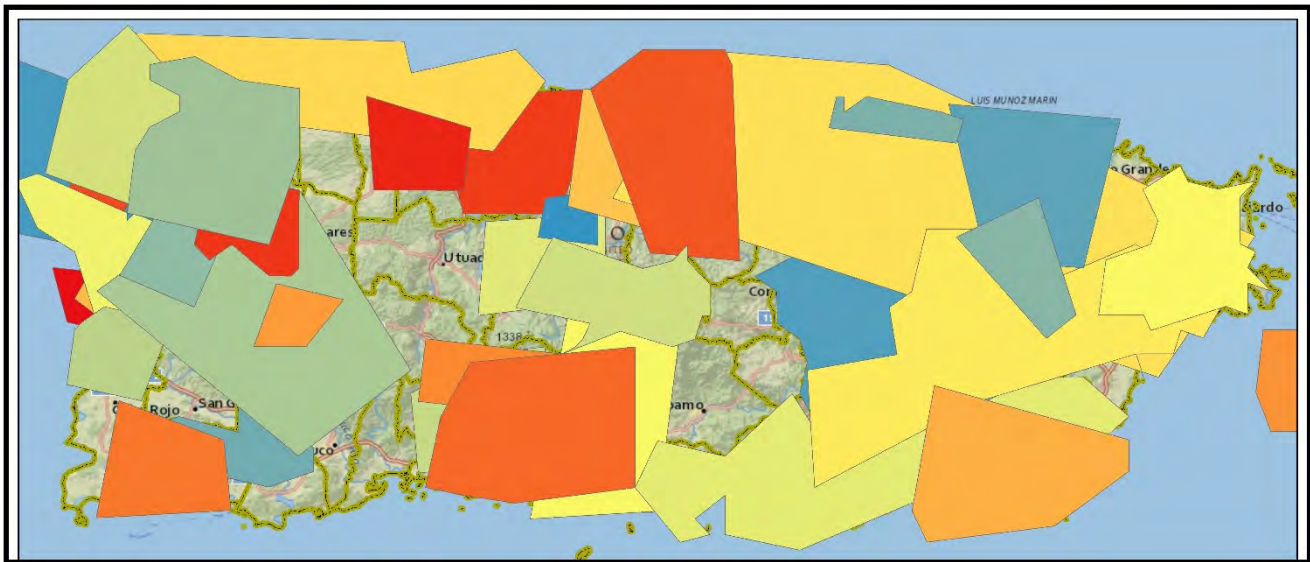


Figure 8: Severe Storm Watch Boxes for Puerto Rico 2002-2019.

Hazard Frequency Analysis Results

The relatively low number of severe storm warnings across the island, (3.6 per year) indicates that severe storms occur less often in relation to other portions of the United States. However, because severe storms can have dire consequences no matter how infrequently they occur. Western portions of the island tend to have a higher number of severe storms than other portions; nearly 70% of San Sebastián’s land area is in a high severe storm zone (Figure 9). Six municipios across Puerto Rico have some area in high hazard zones and another 27 have some area in medium high severe storm zones (Table 16). Municipios such as Anasco, and Las Marias have around 25% of their land area in high severe storm hazard zones (Table 17). Table 18 provides a breakdown of total island land areas by severe storm category and municipio and Table 19 sums and ranks severe storm risk for each municipio across the island.

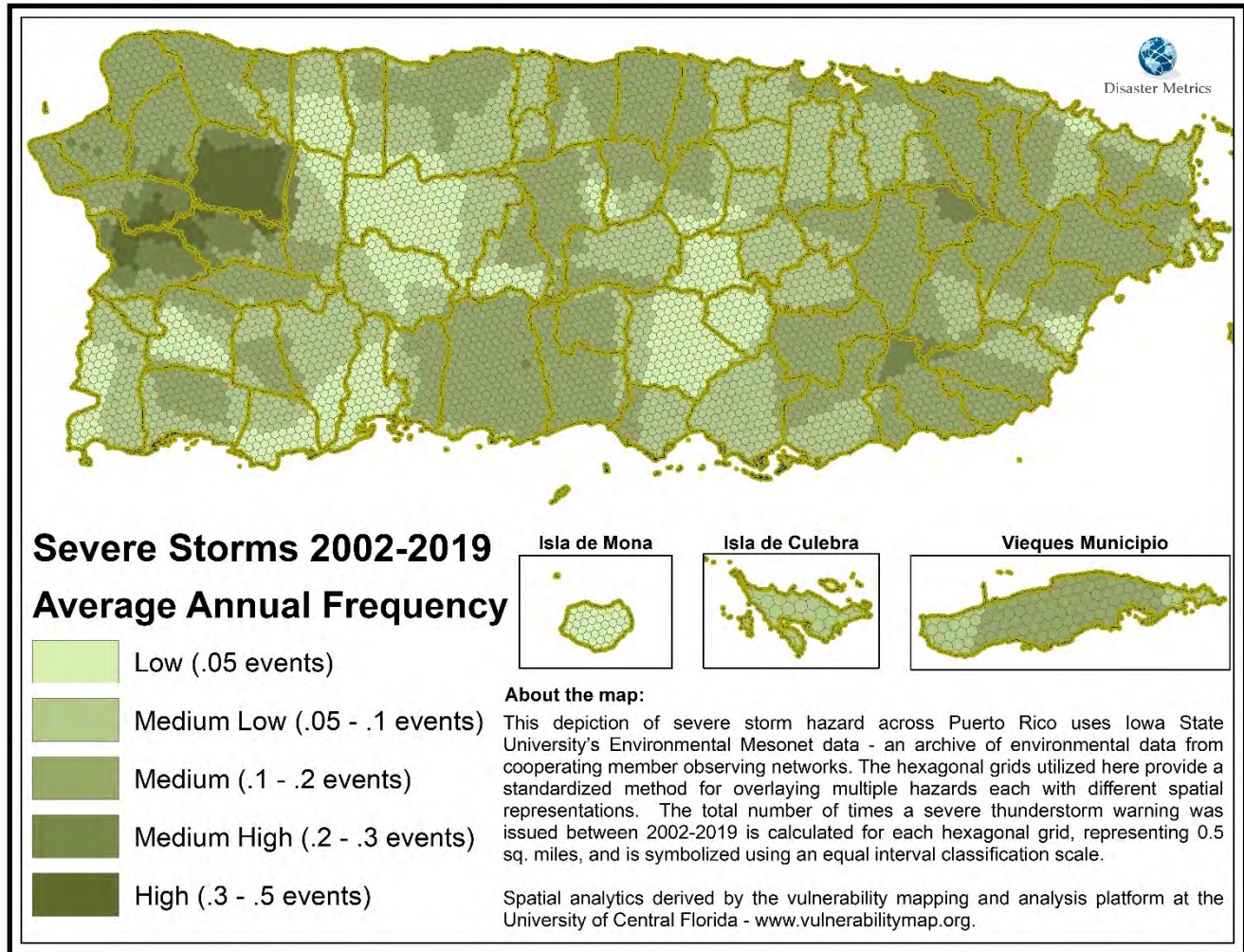


Figure 9: Severe Storm Hazard Frequency Areas

Table 16: Severe Storm Hazard Frequency by Municipio and Areal Extent

| Municipio | HEX GRID Area by Severe Storm Frequency (Sq. miles) | | | | |
|--------------|---|---|--------------------------------------|---|------------------------------------|
| | Low (<math><.05</math> events) | Medium Low ($.05 - .1$ events) | Medium ($.1 - .2$ events) | Medium High ($.2 - .3$ events) | High ($.3 - .5$ events) |
| Adjuntas | 30.42 | 34.88 | 1.79 | | |
| Aguada | | | 28.64 | 2.29 | |
| Aguadilla | | | 36.46 | 0.14 | |
| Aguas Buenas | | 8.70 | 21.40 | | |
| Aibonito | 25.14 | 5.89 | 0.31 | | |
| Anasco | | 1.21 | 14.97 | 14.44 | 8.95 |
| Arecibo | 8.70 | 60.14 | 58.13 | | |
| Arroyo | | 2.37 | 12.68 | 0.00 | |
| Barceloneta | 0.01 | 17.43 | 1.31 | | |
| Barranquitas | 29.17 | 5.11 | | | |
| Bayamon | | 40.11 | 4.40 | | |
| Cabo Rojo | 25.67 | 46.45 | 1.00 | | |

| | | | | | |
|-------------|-------|-------|-------|-------|-------|
| Caguas | | 0.15 | 58.92 | | |
| Camuy | 26.04 | 18.56 | 1.72 | 0.05 | |
| Canovanas | | | 31.87 | 1.14 | |
| Cantano | | | 45.51 | 1.80 | |
| Carolina | | 0.74 | 4.35 | | |
| Cayey | | 0.52 | 51.19 | 0.26 | |
| Ceiba | 2.67 | 9.00 | 18.70 | | |
| Ciales | 4.45 | 12.54 | 49.72 | | |
| Cidra | 0.03 | 29.68 | 6.74 | | |
| Coamo | 55.80 | 19.96 | 2.27 | | |
| Comerio | 0.42 | 26.55 | 1.56 | | |
| Corozal | 6.90 | 18.21 | 17.47 | | |
| Culebra | 0.65 | 12.66 | | | |
| Dorado | | 22.34 | 1.07 | | |
| Fajardo | 2.25 | 10.31 | 17.95 | | |
| Florida | | 10.18 | 5.05 | | |
| Guanica | 21.73 | 16.49 | 0.79 | | |
| Guayama | | 33.64 | 32.16 | 0.06 | |
| Guayanilla | 34.32 | 8.67 | | | |
| Guaynabo | | 23.31 | 4.45 | | |
| Gurabo | | | 18.33 | 9.99 | |
| Hatillo | 10.66 | 19.62 | 11.56 | | |
| Hormigueros | 0.72 | 10.60 | 0.03 | | |
| Humacao | 8.14 | 10.74 | 26.22 | | |
| Isabela | | 7.29 | 48.06 | 0.06 | |
| Jayuya | 14.89 | 11.45 | 18.03 | 0.16 | |
| Juana Diaz | 0.12 | 4.66 | 55.71 | 0.25 | |
| Juncos | | 1.31 | 23.83 | 1.48 | |
| Lajas | 1.29 | 31.89 | 28.18 | | |
| Lares | 13.47 | 29.51 | 12.85 | 5.82 | 0.00 |
| Las Marias | | 1.14 | 14.06 | 19.42 | 11.89 |
| Las Piedras | | 8.86 | 25.03 | | |
| Loiza | | 7.16 | 13.37 | | |
| Luquillo | 0.15 | 10.22 | 15.49 | | |
| Manati | | 12.98 | 33.84 | | |
| Maricao | | 6.98 | 29.62 | 0.03 | |
| Maunabo | | | 21.09 | | |
| Mayaguez | 22.77 | 4.04 | 13.00 | 25.14 | 13.02 |
| Moca | | | 40.96 | 7.68 | 1.73 |
| Morovis | 3.55 | 12.29 | 23.08 | | |
| Naguabo | | 0.39 | 51.49 | | |
| Naranjito | 3.32 | 22.43 | 2.00 | | |

| | | | | | |
|---------------|--------|----------|----------|--------|-------|
| Orocovis | 0.27 | 43.03 | 20.04 | 0.44 | |
| Patillas | 0.00 | 0.16 | 37.10 | 9.96 | |
| Penuelas | 5.76 | 11.77 | 27.22 | | |
| Ponce | 1.05 | 6.05 | 109.23 | 0.65 | |
| Quebradillas | 0.08 | 9.96 | 13.02 | 0.07 | |
| Rjo Grande | | 0.09 | 14.30 | | |
| Rincon | 6.31 | 26.62 | 27.88 | | |
| Sabana Grande | | 16.91 | 18.93 | | |
| Salinas | 0.11 | 58.51 | 11.43 | | |
| San German | 22.25 | 18.08 | 14.18 | | |
| San Juan | | 32.34 | 17.19 | | |
| San Lorenzo | | 19.52 | 29.24 | 4.44 | |
| San Sebastian | 0.04 | 2.01 | 5.40 | 14.35 | 49.41 |
| Santa Isabel | 0.33 | 24.42 | 9.82 | | |
| Toa Alta | | 26.79 | 0.77 | | |
| Toa Baja | | 19.01 | 4.80 | | |
| Trujillo Alto | | 7.95 | 11.33 | 2.10 | |
| Utuado | 78.13 | 35.24 | 1.71 | | |
| Vega Alta | | 1.55 | 26.19 | | |
| Vega Baja | | 0.03 | 46.62 | | |
| Vieques | | 12.85 | 40.33 | | |
| Villalba | | 8.48 | 28.56 | | |
| Yabucoa | | 20.23 | 32.89 | 2.28 | |
| Yauco | 16.62 | 47.25 | 4.95 | | |
| Grand Total | 484.45 | 1,158.16 | 1,611.54 | 124.49 | 85.00 |

Table 17: Percent of (Municipio) Hexagonal Area by Severe Storm Hazard Frequency per Municipio

| Municipio | Severe Storm Percent Area by Total (Municipio) Land Area | | | | |
|--------------|--|---------------------------------|----------------------------|---------------------------------|--------------------------|
| | Low (<.05 events) | Medium Low (.05 - .1 events) | Medium (.1 - .2 events) | Medium High (.2 - .3 events) | High (.3 - .5 events) |
| Adjuntas | 45.35% | 51.98% | 2.67% | 0.00% | 0.00% |
| Aguada | 0.00% | 0.00% | 92.60% | 7.40% | 0.00% |
| Aguadilla | 0.00% | 0.00% | 99.61% | 0.39% | 0.00% |
| Aguas Buenas | 0.00% | 28.91% | 71.09% | 0.00% | 0.00% |
| Aibonito | 80.23% | 18.78% | 0.99% | 0.00% | 0.00% |
| Anasco | 0.00% | 3.05% | 37.84% | 36.49% | 22.62% |
| Arecibo | 6.86% | 47.36% | 45.78% | 0.00% | 0.00% |
| Arroyo | 0.00% | 15.72% | 84.27% | 0.01% | 0.00% |
| Barceloneta | 0.06% | 92.94% | 7.00% | 0.00% | 0.00% |
| Barranquitas | 85.09% | 14.91% | 0.00% | 0.00% | 0.00% |
| Bayamon | 0.00% | 90.11% | 9.89% | 0.00% | 0.00% |
| Cabo Rojo | 35.11% | 63.52% | 1.37% | 0.00% | 0.00% |

| | | | | | |
|-------------|--------|--------|---------|--------|--------|
| Caguas | 0.00% | 0.25% | 99.75% | 0.00% | 0.00% |
| Camuy | 56.16% | 40.03% | 3.70% | 0.11% | 0.00% |
| Canovanas | 0.00% | 0.00% | 96.55% | 3.45% | 0.00% |
| Cantano | 0.00% | 0.00% | 96.20% | 3.80% | 0.00% |
| Carolina | 0.00% | 14.50% | 85.50% | 0.00% | 0.00% |
| Cayey | 0.00% | 0.99% | 98.51% | 0.49% | 0.00% |
| Ceiba | 8.81% | 29.64% | 61.55% | 0.00% | 0.00% |
| Ciales | 6.67% | 18.80% | 74.53% | 0.00% | 0.00% |
| Cidra | 0.09% | 81.42% | 18.49% | 0.00% | 0.00% |
| Coamo | 71.51% | 25.58% | 2.91% | 0.00% | 0.00% |
| Comerio | 1.48% | 93.06% | 5.46% | 0.00% | 0.00% |
| Corozal | 16.20% | 42.76% | 41.04% | 0.00% | 0.00% |
| Culebra | 4.89% | 95.11% | 0.00% | 0.00% | 0.00% |
| Dorado | 0.00% | 95.41% | 4.59% | 0.00% | 0.00% |
| Fajardo | 7.39% | 33.79% | 58.82% | 0.00% | 0.00% |
| Florida | 0.00% | 66.85% | 33.15% | 0.00% | 0.00% |
| Guanica | 55.70% | 42.27% | 2.02% | 0.00% | 0.00% |
| Guayama | 0.00% | 51.08% | 48.83% | 0.09% | 0.00% |
| Guayanilla | 79.84% | 20.16% | 0.00% | 0.00% | 0.00% |
| Guaynabo | 0.00% | 83.97% | 16.03% | 0.00% | 0.00% |
| Gurabo | 0.00% | 0.00% | 64.73% | 35.27% | 0.00% |
| Hatillo | 25.48% | 46.89% | 27.63% | 0.00% | 0.00% |
| Hormigueros | 6.37% | 93.40% | 0.23% | 0.00% | 0.00% |
| Humacao | 18.05% | 23.81% | 58.13% | 0.00% | 0.00% |
| Isabela | 0.00% | 13.16% | 86.74% | 0.10% | 0.00% |
| Jayuya | 33.44% | 25.71% | 40.49% | 0.36% | 0.00% |
| Juana Diaz | 0.19% | 7.67% | 91.73% | 0.42% | 0.00% |
| Juncos | 0.00% | 4.92% | 89.53% | 5.54% | 0.00% |
| Lajas | 2.10% | 51.97% | 45.93% | 0.00% | 0.00% |
| Lares | 21.85% | 47.87% | 20.84% | 9.44% | 0.00% |
| Las Marias | 0.00% | 2.44% | 30.22% | 41.77% | 25.57% |
| Las Piedras | 0.00% | 26.14% | 73.86% | 0.00% | 0.00% |
| Loiza | 0.00% | 34.88% | 65.12% | 0.00% | 0.00% |
| Luquillo | 0.56% | 39.52% | 59.92% | 0.00% | 0.00% |
| Manati | 0.00% | 27.73% | 72.27% | 0.00% | 0.00% |
| Maricao | 0.00% | 19.06% | 80.86% | 0.09% | 0.00% |
| Maunabo | 0.00% | 0.00% | 100.00% | 0.00% | 0.00% |
| Mayaguez | 29.20% | 5.18% | 16.67% | 32.25% | 16.70% |
| Moca | 0.00% | 0.00% | 81.32% | 15.25% | 3.43% |
| Morovis | 9.12% | 31.58% | 59.30% | 0.00% | 0.00% |
| Naguabo | 0.00% | 0.75% | 99.25% | 0.00% | 0.00% |
| Naranjito | 11.97% | 80.84% | 7.19% | 0.00% | 0.00% |

| | | | | | |
|---------------|--------|--------|--------|--------|--------|
| Orocovis | 0.43% | 67.46% | 31.42% | 0.69% | 0.00% |
| Patillas | 0.01% | 0.33% | 78.57% | 21.09% | 0.00% |
| Penuelas | 12.87% | 26.30% | 60.82% | 0.00% | 0.00% |
| Ponce | 0.89% | 5.18% | 93.38% | 0.55% | 0.00% |
| Quebradillas | 0.37% | 43.06% | 56.27% | 0.31% | 0.00% |
| Río Grande | 0.00% | 0.60% | 99.40% | 0.00% | 0.00% |
| Rincon | 10.37% | 43.77% | 45.85% | 0.00% | 0.00% |
| Sabana Grande | 0.00% | 47.17% | 52.83% | 0.00% | 0.00% |
| Salinas | 0.16% | 83.52% | 16.32% | 0.00% | 0.00% |
| San German | 40.82% | 33.16% | 26.02% | 0.00% | 0.00% |
| San Juan | 0.00% | 65.30% | 34.70% | 0.00% | 0.00% |
| San Lorenzo | 0.00% | 36.69% | 54.95% | 8.35% | 0.00% |
| San Sebastian | 0.06% | 2.83% | 7.59% | 20.15% | 69.38% |
| Santa Isabel | 0.97% | 70.64% | 28.40% | 0.00% | 0.00% |
| Toa Alta | 0.00% | 97.20% | 2.80% | 0.00% | 0.00% |
| Toa Baja | 0.00% | 79.85% | 20.15% | 0.00% | 0.00% |
| Trujillo Alto | 0.00% | 37.19% | 52.99% | 9.83% | 0.00% |
| Utuado | 67.90% | 30.62% | 1.48% | 0.00% | 0.00% |
| Vega Alta | 0.00% | 5.60% | 94.40% | 0.00% | 0.00% |
| Vega Baja | 0.00% | 0.06% | 99.94% | 0.00% | 0.00% |
| Vieques | 0.00% | 24.16% | 75.84% | 0.00% | 0.00% |
| Villalba | 0.00% | 22.89% | 77.11% | 0.00% | 0.00% |
| Yabucoa | 0.00% | 36.52% | 59.37% | 4.11% | 0.00% |
| Yauco | 24.15% | 68.66% | 7.19% | 0.00% | 0.00% |

Table 18: Percent of (Island) Hexagonal Area by Severe Storm Hazard Frequency per Municipio

| Municipio | Severe Storm Percent Area by Total (Island) Land Area | | | | |
|--------------|---|---------------------------------|----------------------------|---------------------------------|--------------------------|
| | Low (<.05 events) | Medium Low (.05 - .1 events) | Medium (.1 - .2 events) | Medium High (.2 - .3 events) | High (.3 - .5 events) |
| Adjuntas | 6.28% | 0.00% | 0.11% | 0.00% | 0.00% |
| Aguada | 0.00% | 0.00% | 1.78% | 1.84% | 0.00% |
| Aguadilla | 0.00% | 0.00% | 2.26% | 0.11% | 0.00% |
| Aguas Buenas | 0.00% | 0.00% | 1.33% | 0.00% | 0.00% |
| Aibonito | 5.19% | 0.00% | 0.02% | 0.00% | 0.00% |
| Anasco | 0.00% | 0.00% | 0.93% | 11.60% | 10.53% |
| Arecibo | 1.80% | 0.00% | 3.61% | 0.00% | 0.00% |
| Arroyo | 0.00% | 0.00% | 0.79% | 0.00% | 0.00% |
| Barceloneta | 0.00% | 0.00% | 0.08% | 0.00% | 0.00% |
| Barranquitas | 6.02% | 0.00% | 0.00% | 0.00% | 0.00% |
| Bayamon | 0.00% | 0.00% | 0.27% | 0.00% | 0.00% |
| Cabo Rojo | 5.30% | 0.00% | 0.06% | 0.00% | 0.00% |
| Caguas | 0.00% | 0.00% | 3.66% | 0.00% | 0.00% |

| | | | | | |
|-------------|--------|-------|-------|--------|--------|
| Camuy | 5.38% | 0.00% | 0.11% | 0.04% | 0.00% |
| Canovanas | 0.00% | 0.00% | 1.98% | 0.92% | 0.00% |
| Cantano | 0.00% | 0.00% | 2.82% | 1.44% | 0.00% |
| Carolina | 0.00% | 0.00% | 0.27% | 0.00% | 0.00% |
| Cayey | 0.00% | 0.00% | 3.18% | 0.21% | 0.00% |
| Ceiba | 0.55% | 0.00% | 1.16% | 0.00% | 0.00% |
| Ciales | 0.92% | 0.00% | 3.09% | 0.00% | 0.00% |
| Cidra | 0.01% | 0.00% | 0.42% | 0.00% | 0.00% |
| Coamo | 11.52% | 0.00% | 0.14% | 0.00% | 0.00% |
| Comerio | 0.09% | 0.00% | 0.10% | 0.00% | 0.00% |
| Corozal | 1.42% | 0.00% | 1.08% | 0.00% | 0.00% |
| Culebra | 0.13% | 0.00% | 0.00% | 0.00% | 0.00% |
| Dorado | 0.00% | 0.00% | 0.07% | 0.00% | 0.00% |
| Fajardo | 0.47% | 0.00% | 1.11% | 0.00% | 0.00% |
| Florida | 0.00% | 0.00% | 0.31% | 0.00% | 0.00% |
| Guanica | 4.49% | 0.00% | 0.05% | 0.00% | 0.00% |
| Guayama | 0.00% | 0.00% | 2.00% | 0.05% | 0.00% |
| Guayanilla | 7.09% | 0.00% | 0.00% | 0.00% | 0.00% |
| Guaynabo | 0.00% | 0.00% | 0.28% | 0.00% | 0.00% |
| Gurabo | 0.00% | 0.00% | 1.14% | 8.02% | 0.00% |
| Hatillo | 2.20% | 0.00% | 0.72% | 0.00% | 0.00% |
| Hormigueros | 0.15% | 0.00% | 0.00% | 0.00% | 0.00% |
| Humacao | 1.68% | 0.00% | 1.63% | 0.00% | 0.00% |
| Isabela | 0.00% | 0.00% | 2.98% | 0.04% | 0.00% |
| Jayuya | 3.07% | 0.00% | 1.12% | 0.13% | 0.00% |
| Juana Diaz | 0.02% | 0.00% | 3.46% | 0.20% | 0.00% |
| Juncos | 0.00% | 0.00% | 1.48% | 1.19% | 0.00% |
| Lajas | 0.27% | 0.00% | 1.75% | 0.00% | 0.00% |
| Lares | 2.78% | 0.00% | 0.80% | 4.67% | 0.00% |
| Las Marias | 0.00% | 0.00% | 0.87% | 15.60% | 13.99% |
| Las Piedras | 0.00% | 0.00% | 1.55% | 0.00% | 0.00% |
| Loiza | 0.00% | 0.00% | 0.83% | 0.00% | 0.00% |
| Luquillo | 0.03% | 0.00% | 0.96% | 0.00% | 0.00% |
| Manati | 0.00% | 0.00% | 2.10% | 0.00% | 0.00% |
| Maricao | 0.00% | 0.00% | 1.84% | 0.03% | 0.00% |
| Maunabo | 0.00% | 0.00% | 1.31% | 0.00% | 0.00% |
| Mayaguez | 4.70% | 0.00% | 0.81% | 20.20% | 15.32% |
| Moca | 0.00% | 0.00% | 2.54% | 6.17% | 2.03% |
| Morovis | 0.73% | 0.00% | 1.43% | 0.00% | 0.00% |
| Naguabo | 0.00% | 0.00% | 3.20% | 0.00% | 0.00% |
| Naranjito | 0.69% | 0.00% | 0.12% | 0.00% | 0.00% |
| Orocovis | 0.06% | 0.00% | 1.24% | 0.35% | 0.00% |

| | | | | | |
|---------------|--------|-------|-------|--------|--------|
| Patillas | 0.00% | 0.00% | 2.30% | 8.00% | 0.00% |
| Penuelas | 1.19% | 0.00% | 1.69% | 0.00% | 0.00% |
| Ponce | 0.22% | 0.00% | 6.78% | 0.52% | 0.00% |
| Quebradillas | 0.02% | 0.00% | 0.81% | 0.06% | 0.00% |
| Rio Grande | 0.00% | 0.00% | 0.89% | 0.00% | 0.00% |
| Rincon | 1.30% | 0.00% | 1.73% | 0.00% | 0.00% |
| Sabana Grande | 0.00% | 0.00% | 1.17% | 0.00% | 0.00% |
| Salinas | 0.02% | 0.00% | 0.71% | 0.00% | 0.00% |
| San German | 4.59% | 0.00% | 0.88% | 0.00% | 0.00% |
| San Juan | 0.00% | 0.00% | 1.07% | 0.00% | 0.00% |
| San Lorenzo | 0.00% | 0.00% | 1.81% | 3.57% | 0.00% |
| San Sebastian | 0.01% | 0.00% | 0.34% | 11.53% | 58.13% |
| Santa Isabel | 0.07% | 0.00% | 0.61% | 0.00% | 0.00% |
| Toa Alta | 0.00% | 0.00% | 0.05% | 0.00% | 0.00% |
| Toa Baja | 0.00% | 0.00% | 0.30% | 0.00% | 0.00% |
| Trujillo Alto | 0.00% | 0.00% | 0.70% | 1.69% | 0.00% |
| Utua | 16.13% | 0.00% | 0.11% | 0.00% | 0.00% |
| Vega Alta | 0.00% | 0.00% | 1.62% | 0.00% | 0.00% |
| Vega Baja | 0.00% | 0.00% | 2.89% | 0.00% | 0.00% |
| Vieques | 0.00% | 0.00% | 2.50% | 0.00% | 0.00% |
| Villalba | 0.00% | 0.00% | 1.77% | 0.00% | 0.00% |
| Yabucoa | 0.00% | 0.00% | 2.04% | 1.83% | 0.00% |
| Yauco | 3.43% | 0.00% | 0.31% | 0.00% | 0.00% |

Table 19: Severe Storm Hazard Scores and Ranks by Municipio

| Municipio | Severe Storm Hazard Score (Log Multiplied) | | |
|---------------|--|--------------------------|----------------------|
| | Total Score | Standardized Score (0-1) | Rank of Score (1-78) |
| San Sebastian | 10,575.9905 | 1.0000 | 1 |
| Mayaguez | 3,648.6263 | 0.3449 | 2 |
| Las Marias | 3,192.0979 | 0.3017 | 3 |
| Anasco | 2,398.9407 | 0.2267 | 4 |
| Moca | 692.6825 | 0.0654 | 5 |
| Patillas | 429.9594 | 0.0405 | 6 |
| Gurabo | 413.9245 | 0.0390 | 7 |
| Lares | 248.4782 | 0.0234 | 8 |
| San Lorenzo | 206.7745 | 0.0194 | 9 |
| Ponce | 126.7889 | 0.0119 | 10 |
| Yabucoa | 124.1260 | 0.0116 | 11 |
| Aguada | 117.2069 | 0.0110 | 12 |
| Cantano | 113.1789 | 0.0106 | 13 |
| Trujillo Alto | 95.2469 | 0.0089 | 14 |

| | | | |
|---------------|---------|--------|----|
| Juncos | 80.7070 | 0.0075 | 15 |
| Canovanas | 74.4881 | 0.0069 | 16 |
| Arecibo | 63.3328 | 0.0059 | 17 |
| Juana Diaz | 61.8052 | 0.0057 | 18 |
| Cayey | 57.1671 | 0.0053 | 19 |
| Caguas | 53.9661 | 0.0050 | 20 |
| Ciales | 47.6588 | 0.0044 | 21 |
| Isabela | 47.4188 | 0.0044 | 21 |
| Naguabo | 47.2061 | 0.0043 | 23 |
| Orocovis | 42.9951 | 0.0040 | 24 |
| Vega Baja | 42.6846 | 0.0039 | 25 |
| Aguadilla | 39.0161 | 0.0036 | 26 |
| Vieques | 39.0613 | 0.0036 | 26 |
| Guayama | 37.4511 | 0.0034 | 28 |
| Manati | 33.1364 | 0.0030 | 29 |
| Lajas | 31.1218 | 0.0028 | 30 |
| Maricao | 29.5223 | 0.0027 | 31 |
| Rincon | 30.0355 | 0.0027 | 31 |
| Villalba | 27.5551 | 0.0025 | 33 |
| Penuelas | 26.9532 | 0.0024 | 34 |
| Humacao | 25.8939 | 0.0023 | 35 |
| Jayuya | 24.9660 | 0.0022 | 36 |
| Las Piedras | 24.3905 | 0.0022 | 36 |
| Vega Alta | 24.2323 | 0.0022 | 36 |
| Morovis | 23.2200 | 0.0021 | 39 |
| Aguas Buenas | 21.0339 | 0.0019 | 40 |
| San Juan | 21.1129 | 0.0019 | 40 |
| Sabana Grande | 20.1455 | 0.0018 | 42 |
| Salinas | 20.1993 | 0.0018 | 42 |
| Corozal | 19.1122 | 0.0017 | 44 |
| Maunabo | 19.3065 | 0.0017 | 44 |
| Ceiba | 18.6464 | 0.0016 | 46 |
| Fajardo | 18.1730 | 0.0016 | 46 |
| Luquillo | 15.8852 | 0.0014 | 48 |
| Quebradillas | 16.4306 | 0.0014 | 48 |
| San German | 16.2746 | 0.0014 | 48 |
| Hatillo | 13.9830 | 0.0012 | 51 |
| Loiza | 13.4336 | 0.0012 | 51 |
| Rjo Grande | 13.1091 | 0.0011 | 53 |
| Santa Isabel | 13.0538 | 0.0011 | 53 |
| Yauco | 12.6028 | 0.0011 | 53 |
| Arroyo | 12.0840 | 0.0010 | 56 |

| | | | |
|--------------|---------|--------|----|
| Bayamon | 10.7016 | 0.0009 | 57 |
| Cidra | 11.1079 | 0.0009 | 57 |
| Cabo Rojo | 8.9676 | 0.0007 | 59 |
| Utua | 8.4211 | 0.0007 | 59 |
| Adjuntas | 7.8321 | 0.0006 | 61 |
| Guaynabo | 7.9513 | 0.0006 | 61 |
| Toa Baja | 7.5512 | 0.0006 | 61 |
| Camuy | 6.9609 | 0.0005 | 64 |
| Coamo | 6.1087 | 0.0005 | 64 |
| Florida | 6.3114 | 0.0005 | 64 |
| Comerio | 5.8458 | 0.0004 | 67 |
| Naranjito | 5.5998 | 0.0004 | 67 |
| Toa Alta | 5.1611 | 0.0004 | 67 |
| Barceloneta | 4.1016 | 0.0003 | 70 |
| Carolina | 4.1021 | 0.0003 | 70 |
| Dorado | 4.6986 | 0.0003 | 70 |
| Guanica | 3.7434 | 0.0002 | 73 |
| Culebra | 2.1129 | 0.0001 | 74 |
| Guayanilla | 1.8803 | 0.0001 | 74 |
| Hormigueros | 1.7947 | 0.0001 | 74 |
| Aibonito | 1.5841 | 0.0000 | 77 |
| Barranquitas | 1.2231 | 0.0000 | 77 |

Hurricane Storm Surges

Hazard Overview

A storm surge is an elevated water level that is pushed towards the shore by the force of strong winds that result in the piling up of water. The advancing surge combines with the normal tides, which in extreme cases can increase the normal water height over 20 feet. The storm surge arrives ahead of the storm's actual landfall and the more intense the hurricane is, the sooner the surge arrives. Water rise can be very rapid and can move far inland, posing a serious threat to those who have not yet evacuated flood-prone areas. Debris carried by the waves can also contribute to the devastation. As the storm approaches shore, the greatest storm surge will be to the north of the hurricane eye, in the right-front quadrant of the direction in which the hurricane is moving. Such a surge of high water topped by waves driven by hurricane force winds can be devastating to coastal regions, causing severe beach erosion and property damage along the immediate coast. Storm surge heights, and associated waves, are dependent upon the shape of the continental shelf (narrow or wide) and the depth of the ocean bottom (bathymetry). A narrow shelf, or one that drops steeply from the shoreline and subsequently produces deep water close to the shoreline, tends to produce a lower surge but higher and more powerful storm waves. While disassociated with the Saffir-Simpson Scale, storm surge remains the leading killer of residents along immediate coastal areas.¹⁷

Data and Methods

This assessment utilized Sea, Lake and Overland Surges from Hurricanes (SLOSH) datasets to map storm surge inundation for the conterminous United States provided by National Oceanic and Atmospheric Administration (NOAA) National Storm Surge Hazard Maps.¹⁸ SLOSH is a computerized model that estimates storm surge heights from tropical cyclones using pressure, size, forward speed, and track data to create a model of the wind field which pushes water. In each SLOSH basin or grid, tens of thousands of hypothetical tropical cyclones are simulated, and the potential storm surge are calculated. The model is best used for defining the potential flooding from storm surge for a location from a threatening hurricane, rather than as a predictor of the specific areas that will be inundated during a particular event. In island regions such as Puerto Rico, NOAA has coupled the SLOSH model and the Simulating Waves Nearshore (SWAN) third-generation wave model, developed at Delft University of Technology, to model storm surge and create MEOW and MOM products. For this assessment average Maximum of the Maximum Envelope of High Water (MEOW), or MOM provides a worst-case snapshot for a particular storm category under "perfect" storm conditions.¹⁹ Each MOM considers combinations of forward speed, trajectory, and initial tide level. These products are

¹⁷ Adapted from <https://www.scmd.org/media/1391/sc-hazard-mitigation-plan-2018-update.pdf>

¹⁸ <https://www.nhc.noaa.gov/nationalsurge>

¹⁹ <https://www.nhc.noaa.gov/surge/momOverview.php>

compiled when a SLOSH basin is developed or updated. It should be noted that no single hurricane will produce the regional flooding depicted in the MOMs. Instead, MOMs are intended to capture the worst case high water value at a particular location for hurricane evacuation planning. For this assessment, MOM water depth associated with each hurricane category was calculated for each hex-grid.

Hazard Frequency Analysis Results

Hurricane storm surges, a uniquely coastal phenomena show differential hazardousness across the island. Far eastern municipios, including Isla de Culebra and Vieques Municipio, as well as the eastern coast of the main island are categorized with deeper water depths from storm surge. The northeastern municipios have more land area in storm surge zones for lower category hurricanes, but deeper surge depth for more intense hurricanes (Figure 10 - Figure 14). Still, no coastline is immune from the possibility of hurricane storm surges. For each category storm, the SLOSH model indicates a differing amount of land area inundated to different depths in each municipio (Table 20, Table 24, Table 28, Table 28, Table 32, Table 36). As a result, the percentage of each municipio's land area changes for each SLOSH model run and category storm (Table 21, Table 25, Table 29, Table 33, Table 37). The percent of each municipio's total island-wide land area also changes for different storms (Table 22, Table 26, Table 30, Table 34, Table 38). Finally, a table showing municipio scores and ranks for each category storm surge provides perspective on which areas of the island are more highly threatened by hazardous storm surge conditions (Table 23, Table 27, Table 31, Table 35, Table 39).

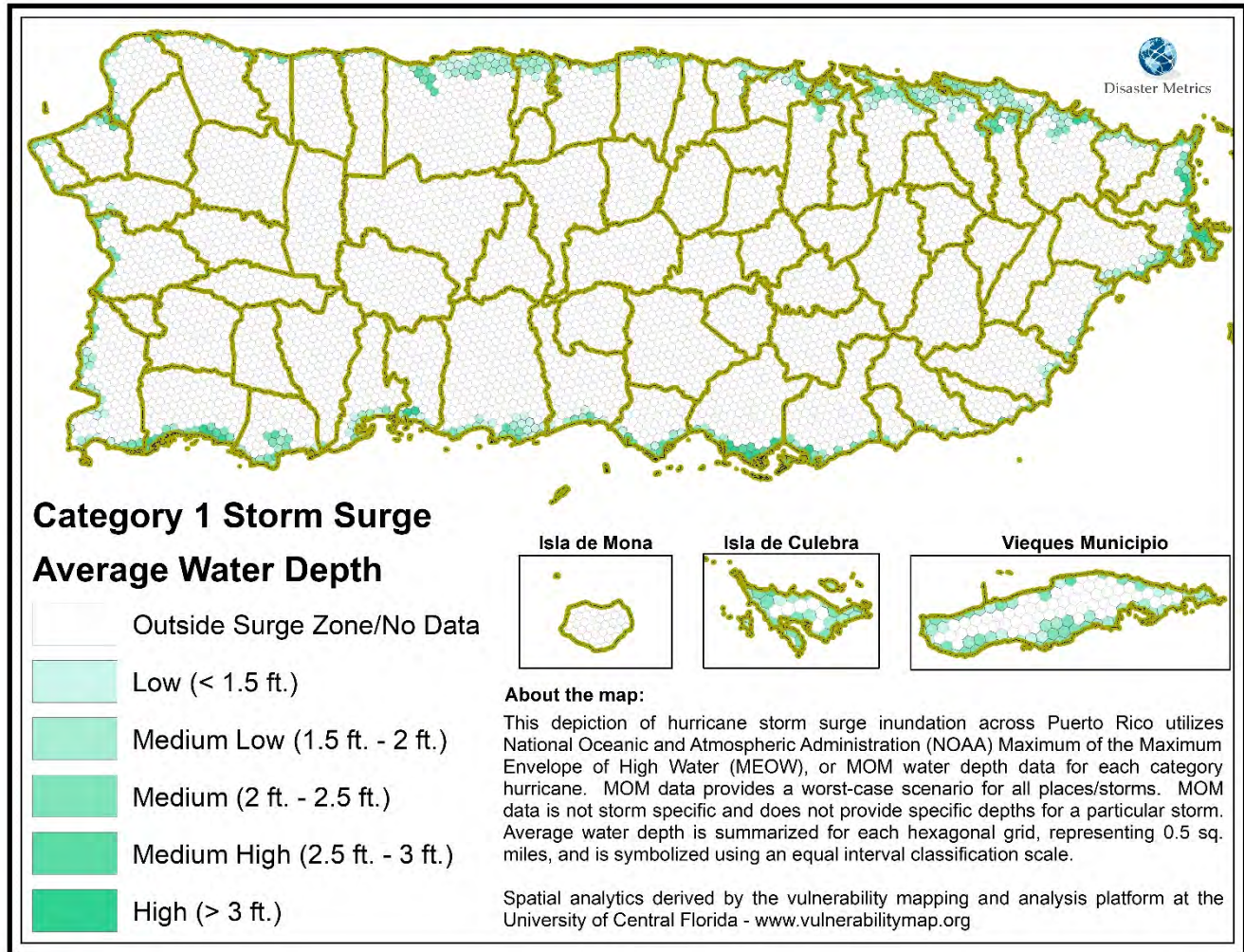


Figure 10: Hurricane Category 1 Storm Surge Hazard Areas

Table 20: Hurricane Category 1 Storm Surge Hazard by Municipio and Areal Extent

| Municipio | HEX GRID Area by Category 1 Storm Surge Water Depth (Sq. miles) | | | | | |
|--------------|---|-----------------|--------------------------|----------------------|---------------------------|---------------|
| | None | Low (< 1.5 ft.) | Medium Low (1.5 - 2 ft.) | Medium (2 - 2.5 ft.) | Medium High (2.5 - 3 ft.) | High (>3 ft.) |
| Adjuntas | 67.10 | | | | | |
| Aguada | 27.11 | | 1.27 | 1.35 | 1.21 | |
| Aguadilla | 31.14 | 0.50 | 1.92 | 1.66 | 1.33 | 0.05 |
| Aguas Buenas | 30.10 | | | | | |
| Aibonito | 31.34 | | | | | |
| Anasco | 37.32 | 0.15 | 0.87 | 0.93 | 0.28 | |
| Arecibo | 107.71 | 5.78 | 9.31 | 2.17 | 2.00 | |
| Arroyo | 13.41 | 0.68 | 0.48 | 0.48 | | |
| Barceloneta | 11.41 | 1.60 | 4.92 | 0.83 | | |
| Barranquitas | 34.28 | | | | | |
| Bayamon | 42.66 | 0.18 | 0.73 | 0.45 | 0.50 | |
| Cabo Rojo | 57.15 | 4.24 | 5.80 | 3.96 | 1.88 | 0.10 |

| | | | | | | |
|-------------|-------|------|------|------|------|------|
| Caguas | 59.07 | | | | | |
| Camuy | 44.49 | 0.43 | 0.70 | 0.35 | 0.39 | |
| Canovanas | 27.75 | 0.94 | 0.52 | 1.48 | 2.31 | |
| Carolina | 33.70 | 4.52 | 5.78 | 2.85 | 0.44 | |
| Catano | 0.75 | 0.55 | 2.73 | 1.05 | | |
| Cayey | 51.96 | | | | | |
| Ceiba | 19.29 | 1.79 | 1.47 | 4.08 | 1.24 | 2.50 |
| Ciales | 66.71 | | | | | |
| Cidra | 36.46 | | | | | |
| Coamo | 78.03 | | | | | |
| Comerio | 28.52 | | | | | |
| Corozal | 42.58 | | | | | |
| Culebra | 3.30 | 0.50 | 4.90 | 4.23 | 0.38 | |
| Dorado | 18.48 | 0.93 | 2.32 | 1.69 | | |
| Fajardo | 21.96 | 0.00 | 1.44 | 2.73 | 2.41 | 1.96 |
| Florida | 15.22 | | | | | |
| Guanica | 29.76 | 1.38 | 3.14 | 3.59 | 1.14 | 0.00 |
| Guayama | 57.50 | | 1.74 | 3.44 | 2.33 | 0.85 |
| Guayanilla | 36.47 | 2.70 | 2.31 | 1.50 | | |
| Guaynabo | 26.55 | 0.33 | 0.80 | 0.08 | | |
| Gurabo | 28.31 | | | | | |
| Hatillo | 39.62 | 0.80 | 0.91 | | 0.51 | |
| Hormigueros | 11.34 | | | | | |
| Humacao | 39.83 | 2.05 | 1.98 | 1.24 | | |
| Isabela | 51.71 | 0.25 | 1.71 | 0.56 | 0.74 | 0.45 |
| Jayuya | 44.53 | | | | | |
| Juana Diaz | 56.06 | 1.85 | 1.47 | 0.80 | 0.55 | |
| Juncos | 26.62 | | | | | |
| Lajas | 52.12 | | 0.80 | 3.19 | 2.74 | 2.51 |
| Lares | 61.64 | | | | | |
| Las Marias | 46.51 | | | | | |
| Las Piedras | 33.89 | | | | | |
| Loiza | 4.16 | 3.87 | 9.05 | 3.20 | 0.25 | |
| Luquillo | 21.60 | 1.17 | 2.02 | 1.07 | | |
| Manati | 41.50 | 0.90 | 3.42 | 1.00 | | |
| Maricao | 36.63 | | | | | |
| Maunabo | 19.63 | | 0.71 | 0.44 | 0.31 | |
| Mayaguez | 72.70 | 0.00 | 1.12 | 3.45 | 0.69 | |
| Moca | 50.37 | | | | | |
| Morovis | 38.93 | | | | | |
| Naguabo | 44.10 | 3.88 | 1.33 | 0.98 | 0.54 | 1.05 |
| Naranjito | 27.75 | | | | | |

| | | | | | | | |
|--------------------|----------------|--------------|---------------|--------------|--------------|--------------|--|
| Orocovis | 63.78 | | | | | | |
| Patillas | 44.16 | 0.65 | 1.36 | 1.04 | | | |
| Penuelas | 40.47 | 1.27 | 1.85 | 0.08 | 0.07 | 1.01 | |
| Ponce | 103.97 | 5.12 | 4.33 | 2.41 | 1.16 | | |
| Quebradillas | 21.27 | 0.38 | 0.19 | 0.94 | 0.36 | | |
| Rincon | 10.97 | | 2.12 | 1.28 | 0.01 | | |
| Rio Grande | 51.24 | 3.08 | 3.10 | 2.16 | 0.73 | 0.50 | |
| Sabana Grande | 35.84 | | | | | | |
| Salinas | 60.65 | | 1.64 | 1.02 | 2.77 | 3.99 | |
| San German | 54.51 | | | | | | |
| San Juan | 37.57 | 3.86 | 4.84 | 2.68 | 0.58 | | |
| San Lorenzo | 53.21 | | | | | | |
| San Sebastian | 71.22 | | | | | | |
| Santa Isabel | 27.47 | 2.27 | 1.48 | 0.80 | 2.44 | 0.12 | |
| Toa Alta | 27.56 | | | | | | |
| Toa Baja | 16.87 | 2.97 | 2.07 | 1.21 | 0.68 | | |
| Trujillo Alto | 21.38 | | | | | | |
| Utuado | 115.07 | | | | | | |
| Vega Alta | 26.83 | | 0.39 | 0.52 | | | |
| Vega Baja | 41.70 | 1.99 | 1.48 | 1.47 | | | |
| Vieques | 28.31 | 3.89 | 10.89 | 9.42 | 0.66 | | |
| Villalba | 37.04 | | | | | | |
| Yabucoa | 51.62 | 1.50 | 1.65 | 0.63 | | | |
| Yauco | 68.37 | | | 0.45 | | | |
| Grand Total | 3149.92 | 68.97 | 115.08 | 80.93 | 33.64 | 15.09 | |

Table 21: Percent of (Municipio) Hexagonal Area by Hurricane Category 1 Storm Surge Hazard per Municipio

| Municipio | Category 1 Storm Surge Water Depth Percent Area by Total (Municipio) Land Area | | | | | |
|--------------|--|-----------------|--------------------------|----------------------|---------------------------|---------------|
| | None | Low (< 1.5 ft.) | Medium Low (1.5 - 2 ft.) | Medium (2 - 2.5 ft.) | Medium High (2.5 - 3 ft.) | High (>3 ft.) |
| Adjuntas | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Aguada | 87.65% | 0.00% | 4.09% | 4.35% | 3.91% | 0.00% |
| Aguadilla | 85.07% | 1.36% | 5.25% | 4.54% | 3.65% | 0.13% |
| Aguas Buenas | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Aibonito | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Anasco | 94.35% | 0.38% | 2.21% | 2.35% | 0.71% | 0.00% |
| Arecibo | 84.83% | 4.55% | 7.34% | 1.71% | 1.58% | 0.00% |
| Arroyo | 89.12% | 4.52% | 3.18% | 3.19% | 0.00% | 0.00% |
| Barceloneta | 60.83% | 8.54% | 26.22% | 4.40% | 0.00% | 0.00% |
| Barranquitas | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Bayamon | 95.83% | 0.40% | 1.63% | 1.01% | 1.12% | 0.00% |

| | | | | | | |
|-------------|---------|--------|--------|--------|-------|-------|
| Cabo Rojo | 78.16% | 5.80% | 7.93% | 5.41% | 2.57% | 0.13% |
| Caguas | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Camuy | 95.95% | 0.93% | 1.50% | 0.76% | 0.85% | 0.00% |
| Canovanas | 84.09% | 2.84% | 1.57% | 4.49% | 7.01% | 0.00% |
| Carolina | 71.25% | 9.56% | 12.23% | 6.02% | 0.93% | 0.00% |
| Catano | 14.81% | 10.82% | 53.69% | 20.68% | 0.00% | 0.00% |
| Cayey | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Ceiba | 63.53% | 5.89% | 4.85% | 13.42% | 4.08% | 8.22% |
| Ciales | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Cidra | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Coamo | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Comerio | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Corozal | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Culebra | 24.80% | 3.79% | 36.80% | 31.80% | 2.82% | 0.00% |
| Dorado | 78.91% | 3.97% | 9.92% | 7.20% | 0.00% | 0.00% |
| Fajardo | 71.99% | 0.00% | 4.72% | 8.93% | 7.91% | 6.44% |
| Florida | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Guanica | 76.29% | 3.54% | 8.04% | 9.20% | 2.93% | 0.00% |
| Guayama | 87.30% | 0.00% | 2.64% | 5.22% | 3.54% | 1.30% |
| Guayanilla | 84.84% | 6.29% | 5.38% | 3.49% | 0.00% | 0.00% |
| Guaynabo | 95.63% | 1.19% | 2.89% | 0.29% | 0.00% | 0.00% |
| Gurabo | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Hatillo | 94.70% | 1.91% | 2.18% | 0.00% | 1.21% | 0.00% |
| Hormigueros | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Humacao | 88.32% | 4.55% | 4.39% | 2.74% | 0.00% | 0.00% |
| Isabela | 93.33% | 0.44% | 3.08% | 1.01% | 1.33% | 0.81% |
| Jayuya | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Juana Diaz | 92.31% | 3.05% | 2.42% | 1.32% | 0.90% | 0.00% |
| Juncos | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Lajas | 84.94% | 0.00% | 1.31% | 5.20% | 4.46% | 4.09% |
| Lares | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Las Marias | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Las Piedras | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Loiza | 20.28% | 18.86% | 44.09% | 15.58% | 1.19% | 0.00% |
| Luquillo | 83.51% | 4.54% | 7.80% | 4.14% | 0.00% | 0.00% |
| Manati | 88.63% | 1.92% | 7.30% | 2.15% | 0.00% | 0.00% |
| Maricao | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Maunabo | 93.08% | 0.00% | 3.37% | 2.08% | 1.48% | 0.00% |
| Mayaguez | 93.24% | 0.00% | 1.44% | 4.43% | 0.89% | 0.00% |
| Moca | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Morovis | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Naguabo | 84.99% | 7.48% | 2.57% | 1.89% | 1.04% | 2.03% |

| | | | | | | |
|---------------|---------|--------|--------|--------|-------|-------|
| Naranjito | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Orocovis | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Patillas | 93.53% | 1.39% | 2.88% | 2.20% | 0.00% | 0.00% |
| Penuelas | 90.43% | 2.84% | 4.13% | 0.18% | 0.16% | 2.26% |
| Ponce | 88.88% | 4.38% | 3.70% | 2.06% | 0.99% | 0.00% |
| Quebradillas | 91.90% | 1.66% | 0.82% | 4.05% | 1.57% | 0.00% |
| Rincon | 76.26% | 0.00% | 14.76% | 8.89% | 0.08% | 0.00% |
| Rio Grande | 84.26% | 5.06% | 5.10% | 3.56% | 1.21% | 0.82% |
| Sabana Grande | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Salinas | 86.57% | 0.00% | 2.34% | 1.46% | 3.95% | 5.69% |
| San German | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| San Juan | 75.85% | 7.80% | 9.76% | 5.42% | 1.17% | 0.00% |
| San Lorenzo | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| San Sebastian | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Santa Isabel | 79.44% | 6.55% | 4.29% | 2.30% | 7.07% | 0.34% |
| Toa Alta | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Toa Baja | 70.88% | 12.47% | 8.70% | 5.09% | 2.85% | 0.00% |
| Trujillo Alto | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Utuado | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Vega Alta | 96.72% | 0.00% | 1.42% | 1.86% | 0.00% | 0.00% |
| Vega Baja | 89.40% | 4.26% | 3.18% | 3.16% | 0.00% | 0.00% |
| Vieques | 53.24% | 7.31% | 20.48% | 17.72% | 1.25% | 0.00% |
| Villalba | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Yabucoa | 93.17% | 2.70% | 2.98% | 1.14% | 0.00% | 0.00% |
| Yauco | 99.35% | 0.00% | 0.00% | 0.65% | 0.00% | 0.00% |

Table 22: Percent of (Island) Hexagonal Area by Hurricane Category 1 Storm Surge Hazard per Municipio

| Municipio | Category 1 Storm Surge Water Depth Percent Area by Total (Island) Land Area | | | | | |
|--------------|---|--------------------|-----------------------------|-------------------------|------------------------------|------------------|
| | None | Low (< 1.5 ft.) | Medium Low (1.5 - 2 ft.) | Medium (2 - 2.5 ft.) | Medium High (2.5 - 3 ft.) | High (>3 ft.) |
| Adjuntas | 2.13% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Aguada | 0.86% | 0.00% | 1.10% | 1.66% | 3.59% | 0.00% |
| Aguadilla | 0.99% | 0.72% | 1.67% | 2.05% | 3.97% | 0.33% |
| Aguas Buenas | 0.96% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Aibonito | 0.99% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Anasco | 1.18% | 0.22% | 0.76% | 1.15% | 0.84% | 0.00% |
| Arecibo | 3.42% | 8.38% | 8.09% | 2.68% | 5.94% | 0.00% |
| Arroyo | 0.43% | 0.99% | 0.42% | 0.59% | 0.00% | 0.00% |
| Barceloneta | 0.36% | 2.32% | 4.27% | 1.02% | 0.00% | 0.00% |
| Barranquitas | 1.09% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Bayamon | 1.35% | 0.26% | 0.63% | 0.56% | 1.49% | 0.00% |
| Cabo Rojo | 1.81% | 6.15% | 5.04% | 4.89% | 5.58% | 0.63% |

| | | | | | | |
|-------------|-------|-------|-------|-------|-------|--------|
| Caguas | 1.88% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Camuy | 1.41% | 0.63% | 0.61% | 0.44% | 1.17% | 0.00% |
| Canovanas | 0.88% | 1.36% | 0.45% | 1.83% | 6.87% | 0.00% |
| Carolina | 1.07% | 6.56% | 5.03% | 3.52% | 1.31% | 0.00% |
| Catano | 0.02% | 0.80% | 2.37% | 1.30% | 0.00% | 0.00% |
| Cayey | 1.65% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Ceiba | 0.61% | 2.60% | 1.28% | 5.04% | 3.68% | 16.56% |
| Ciales | 2.12% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Cidra | 1.16% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Coamo | 2.48% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Comerio | 0.91% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Corozal | 1.35% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Culebra | 0.10% | 0.73% | 4.26% | 5.23% | 1.11% | 0.00% |
| Dorado | 0.59% | 1.35% | 2.02% | 2.08% | 0.00% | 0.00% |
| Fajardo | 0.70% | 0.00% | 1.25% | 3.37% | 7.18% | 13.02% |
| Florida | 0.48% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Guanica | 0.94% | 2.00% | 2.72% | 4.43% | 3.40% | 0.00% |
| Guayama | 1.83% | 0.00% | 1.51% | 4.25% | 6.94% | 5.66% |
| Guayanilla | 1.16% | 3.92% | 2.01% | 1.85% | 0.00% | 0.00% |
| Guaynabo | 0.84% | 0.48% | 0.70% | 0.10% | 0.00% | 0.00% |
| Gurabo | 0.90% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Hatillo | 1.26% | 1.16% | 0.79% | 0.00% | 1.50% | 0.00% |
| Hormigueros | 0.36% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Humacao | 1.26% | 2.97% | 1.72% | 1.53% | 0.00% | 0.00% |
| Isabela | 1.64% | 0.36% | 1.48% | 0.69% | 2.20% | 2.97% |
| Jayuya | 1.41% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Juana Diaz | 1.78% | 2.68% | 1.28% | 0.99% | 1.63% | 0.00% |
| Juncos | 0.84% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Lajas | 1.65% | 0.00% | 0.70% | 3.94% | 8.13% | 16.63% |
| Lares | 1.96% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Las Marias | 1.48% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Las Piedras | 1.08% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Loiza | 0.13% | 5.62% | 7.87% | 3.95% | 0.73% | 0.00% |
| Luquillo | 0.69% | 1.70% | 1.75% | 1.32% | 0.00% | 0.00% |
| Manati | 1.32% | 1.31% | 2.97% | 1.24% | 0.00% | 0.00% |
| Maricao | 1.16% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Maunabo | 0.62% | 0.00% | 0.62% | 0.54% | 0.92% | 0.00% |
| Mayaguez | 2.31% | 0.00% | 0.98% | 4.27% | 2.06% | 0.00% |
| Moca | 1.60% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Morovis | 1.24% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Naguabo | 1.40% | 5.62% | 1.16% | 1.21% | 1.61% | 6.99% |
| Naranjito | 0.88% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |

| | | | | | | |
|---------------|-------|-------|-------|--------|-------|--------|
| Orocovis | 2.02% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Patillas | 1.40% | 0.95% | 1.18% | 1.29% | 0.00% | 0.00% |
| Penuelas | 1.28% | 1.84% | 1.61% | 0.10% | 0.22% | 6.70% |
| Ponce | 3.30% | 7.43% | 3.76% | 2.97% | 3.44% | 0.00% |
| Quebradillas | 0.68% | 0.56% | 0.16% | 1.16% | 1.08% | 0.00% |
| Rincon | 0.35% | 0.00% | 1.85% | 1.58% | 0.04% | 0.00% |
| Rio Grande | 1.63% | 4.46% | 2.70% | 2.67% | 2.18% | 3.31% |
| Sabana Grande | 1.14% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Salinas | 1.93% | 0.00% | 1.42% | 1.26% | 8.22% | 26.42% |
| San German | 1.73% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| San Juan | 1.19% | 5.60% | 4.20% | 3.32% | 1.72% | 0.00% |
| San Lorenzo | 1.69% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| San Sebastian | 2.26% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Santa Isabel | 0.87% | 3.29% | 1.29% | 0.98% | 7.26% | 0.78% |
| Toa Alta | 0.87% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Toa Baja | 0.54% | 4.30% | 1.80% | 1.50% | 2.02% | 0.00% |
| Trujillo Alto | 0.68% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Utuado | 3.65% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Vega Alta | 0.85% | 0.00% | 0.34% | 0.64% | 0.00% | 0.00% |
| Vega Baja | 1.32% | 2.88% | 1.29% | 1.82% | 0.00% | 0.00% |
| Vieques | 0.90% | 5.64% | 9.46% | 11.64% | 1.98% | 0.00% |
| Villalba | 1.18% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Yabucoa | 1.64% | 2.17% | 1.44% | 0.78% | 0.00% | 0.00% |
| Yauco | 2.17% | 0.00% | 0.00% | 0.56% | 0.00% | 0.00% |

Table 23: Category 1 Storm Surge Hazard Scores and Ranks by Municipio

| Municipio | Hurricane Category 1 Storm Surge Hazard Score (Log Multiplied) | | |
|--------------|--|--------------------------|----------------------|
| | Total Score | Standardized Score (0-1) | Rank of Score (1-78) |
| Salinas | 11,012.3392 | 1.0000 | 1 |
| Lajas | 7,319.6752 | 0.6647 | 2 |
| Ceiba | 6,759.7123 | 0.6138 | 3 |
| Fajardo | 5,832.7770 | 0.5297 | 4 |
| Guayama | 3,025.3604 | 0.2747 | 5 |
| Naguabo | 2,851.8917 | 0.259 | 6 |
| Penuelas | 2,564.5751 | 0.2329 | 7 |
| Rio Grande | 1,544.3216 | 0.1402 | 8 |
| Isabela | 1,399.2052 | 0.1271 | 9 |
| Santa Isabel | 1,190.7419 | 0.1081 | 10 |
| Cabo Rojo | 965.0713 | 0.0876 | 11 |
| Canovanas | 852.7585 | 0.0774 | 12 |
| Arecibo | 755.8573 | 0.0686 | 13 |

| | | | |
|--------------|----------|--------|----|
| Aguadilla | 625.7940 | 0.0568 | 14 |
| Guanica | 455.9592 | 0.0414 | 15 |
| Aguada | 452.4046 | 0.0411 | 16 |
| Ponce | 449.2464 | 0.0408 | 17 |
| Vieques | 351.0842 | 0.0319 | 18 |
| Mayaguez | 288.3089 | 0.0262 | 19 |
| Toa Baja | 260.7117 | 0.0237 | 20 |
| San Juan | 242.3464 | 0.022 | 21 |
| Juana Diaz | 207.9446 | 0.0189 | 22 |
| Carolina | 196.1911 | 0.0178 | 23 |
| Bayamon | 186.2984 | 0.0169 | 24 |
| Culebra | 185.1242 | 0.0168 | 25 |
| Hatillo | 183.7600 | 0.0167 | 26 |
| Camuy | 146.7445 | 0.0133 | 27 |
| Quebradillas | 141.4283 | 0.0128 | 28 |
| Loiza | 131.6589 | 0.012 | 29 |
| Maunabo | 117.8503 | 0.0107 | 30 |
| Anasco | 112.3745 | 0.0102 | 31 |
| Dorado | 20.1756 | 0.0018 | 32 |
| Rincon | 19.8531 | 0.0018 | 32 |
| Guayanilla | 18.5028 | 0.0017 | 34 |
| Vega Baja | 17.3384 | 0.0016 | 35 |
| Humacao | 15.2985 | 0.0014 | 36 |
| Manati | 13.9547 | 0.0013 | 37 |
| Barceloneta | 13.5590 | 0.0012 | 38 |
| Catano | 13.7595 | 0.0012 | 38 |
| Luquillo | 13.4212 | 0.0012 | 38 |
| Patillas | 12.3980 | 0.0011 | 41 |
| Yabucoa | 8.4954 | 0.0008 | 42 |
| Arroyo | 5.6453 | 0.0005 | 43 |
| Vega Alta | 5.8366 | 0.0005 | 43 |
| Yauco | 4.7742 | 0.0004 | 45 |
| Guaynabo | 1.6606 | 0.0002 | 46 |
| Adjuntas | 0.0000 | 0.0000 | 47 |
| Aguas Buenas | 0.0000 | 0.0000 | 47 |
| Aibonito | 0.0000 | 0.0000 | 47 |
| Barranquitas | 0.0000 | 0.0000 | 47 |
| Caguas | 0.0000 | 0.0000 | 47 |
| Cayey | 0.0000 | 0.0000 | 47 |
| Ciales | 0.0000 | 0.0000 | 47 |
| Cidra | 0.0000 | 0.0000 | 47 |
| Coamo | 0.0000 | 0.0000 | 47 |

| | | | |
|---------------|--------|--------|----|
| Comerio | 0.0000 | 0.0000 | 47 |
| Corozal | 0.0000 | 0.0000 | 47 |
| Florida | 0.0000 | 0.0000 | 47 |
| Gurabo | 0.0000 | 0.0000 | 47 |
| Hormigueros | 0.0000 | 0.0000 | 47 |
| Jayuya | 0.0000 | 0.0000 | 47 |
| Juncos | 0.0000 | 0.0000 | 47 |
| Lares | 0.0000 | 0.0000 | 47 |
| Las Marias | 0.0000 | 0.0000 | 47 |
| Las Piedras | 0.0000 | 0.0000 | 47 |
| Maricao | 0.0000 | 0.0000 | 47 |
| Moca | 0.0000 | 0.0000 | 47 |
| Morovis | 0.0000 | 0.0000 | 47 |
| Naranjito | 0.0000 | 0.0000 | 47 |
| Orocovis | 0.0000 | 0.0000 | 47 |
| Sabana Grande | 0.0000 | 0.0000 | 47 |
| San German | 0.0000 | 0.0000 | 47 |
| San Lorenzo | 0.0000 | 0.0000 | 47 |
| San Sebastian | 0.0000 | 0.0000 | 47 |
| Toa Alta | 0.0000 | 0.0000 | 47 |
| Trujillo Alto | 0.0000 | 0.0000 | 47 |
| Utado | 0.0000 | 0.0000 | 47 |
| Villalba | 0.0000 | 0.0000 | 47 |

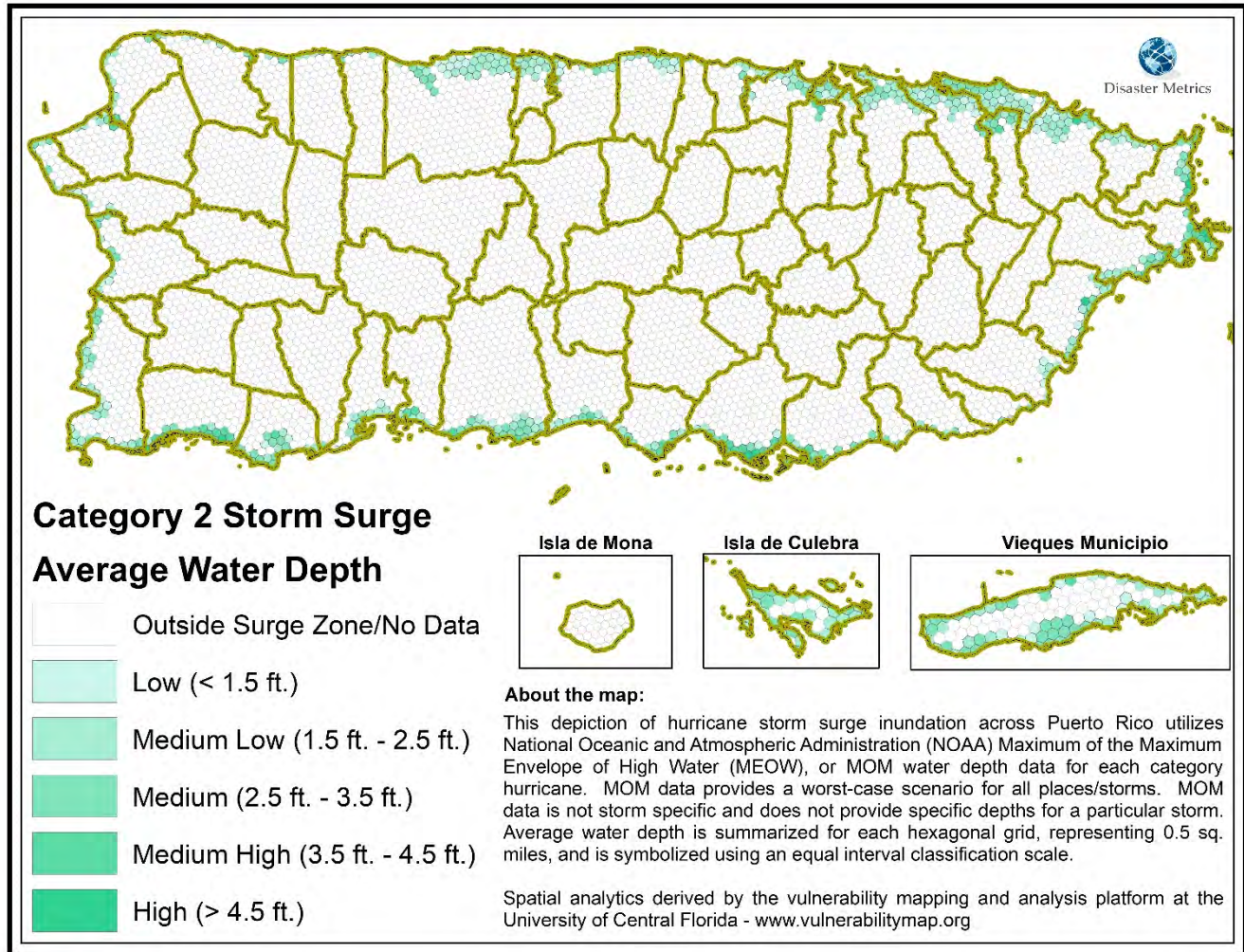


Figure 11: Hurricane Category 2 Storm Surge Hazard Areas

Table 24: Hurricane Category 2 Storm Surge Hazard by Municipio and Areal Extent

| Municipio | HEX GRID Area by Category 2 Storm Surge Water Depth (Sq. miles) | | | | | |
|--------------|---|-----------------|----------------------------|------------------------|-----------------------------|------------------|
| | None | Low (< 1.5 ft.) | Medium Low (1.5 - 2.5 ft.) | Medium (2.5 - 3.5 ft.) | Medium High (3.5 - 4.5 ft.) | High (> 4.5 ft.) |
| Adjuntas | 67.10 | | | | | |
| Aguada | 27.11 | | 2.26 | 0.87 | 0.69 | |
| Aguadilla | 31.14 | | 2.90 | 1.75 | 0.81 | |
| Aguas Buenas | 30.10 | | | | | |
| Aibonito | 31.34 | | | | | |
| Anasco | 36.83 | 0.49 | 1.03 | 0.92 | 0.28 | |
| Arecibo | 107.23 | 4.88 | 11.66 | 3.20 | | |
| Arroyo | 13.41 | | 0.76 | 0.88 | | |
| Barceloneta | 11.41 | 0.51 | 5.95 | 0.89 | | |
| Barranquitas | 34.28 | | | | | |
| Bayamon | 42.66 | 0.18 | 0.23 | 0.50 | 0.95 | |

| | | | | | | |
|-------------|-------|------|-------|------|------|------|
| Cabo Rojo | 53.98 | 2.67 | 11.33 | 4.39 | 0.56 | 0.19 |
| Caguas | 59.07 | | | | | |
| Camuy | 44.49 | 0.08 | 1.40 | 0.39 | | |
| Canovanas | 27.75 | 0.41 | 0.77 | 3.45 | 0.62 | |
| Carolina | 32.36 | 3.34 | 8.60 | 2.62 | 0.38 | |
| Catano | 0.25 | 0.99 | 2.49 | 1.30 | 0.05 | |
| Cayey | 51.96 | | | | | |
| Ceiba | 19.29 | | 2.05 | 5.74 | 1.89 | 1.40 |
| Ciales | 66.71 | | | | | |
| Cidra | 36.46 | | | | | |
| Coamo | 78.03 | | | | | |
| Comerio | 28.52 | | | | | |
| Corozal | 42.58 | | | | | |
| Culebra | 3.30 | 0.00 | 6.38 | 3.63 | | |
| Dorado | 18.08 | 1.28 | 2.66 | 1.40 | | |
| Fajardo | 21.96 | | 1.98 | 4.30 | 1.52 | 0.74 |
| Florida | 15.22 | | | | | |
| Guanica | 28.76 | 1.17 | 2.70 | 5.67 | 0.71 | |
| Guayama | 57.50 | | 0.77 | 4.54 | 2.70 | 0.35 |
| Guayanilla | 35.66 | 0.86 | 4.22 | 2.25 | | |
| Guaynabo | 26.04 | 0.81 | 0.83 | 0.08 | | |
| Gurabo | 28.31 | | | | | |
| Hatillo | 39.62 | | 1.50 | 0.72 | | |
| Hormigueros | 11.34 | | | | | |
| Humacao | 36.59 | 0.86 | 4.95 | 2.20 | | 0.50 |
| Isabela | 51.21 | 0.56 | 2.34 | 0.96 | 0.34 | |
| Jayuya | 44.53 | | | | | |
| Juana Diaz | 55.06 | 0.53 | 3.92 | 0.72 | 0.50 | |
| Juncos | 26.62 | | | | | |
| Lajas | 52.12 | | 0.95 | 2.11 | 4.81 | 1.37 |
| Lares | 61.64 | | | | | |
| Las Marias | 46.51 | | | | | |
| Las Piedras | 33.89 | | | | | |
| Loiza | 2.01 | 3.35 | 9.15 | 6.03 | | |
| Luquillo | 20.60 | 0.50 | 4.55 | 0.21 | | |
| Manati | 41.00 | 1.00 | 3.58 | 1.24 | | |
| Maricao | 36.63 | | | | | |
| Maunabo | 19.63 | | 0.35 | 1.11 | | |
| Mayaguez | 72.20 | 0.93 | 2.00 | 2.63 | 0.22 | |
| Moca | 50.37 | | | | | |
| Morovis | 38.93 | | | | | |
| Naguabo | 44.07 | | 4.54 | 2.08 | 0.88 | 0.31 |

| | | | | | | | |
|---------------|---------|-------|--------|--------|-------|------|--|
| Naranjito | 27.75 | | | | | | |
| Orocovis | 63.78 | | | | | | |
| Patillas | 44.16 | | 1.81 | 1.24 | | | |
| Penuelas | 40.47 | | 3.07 | 0.11 | 1.11 | | |
| Ponce | 102.47 | 1.51 | 5.31 | 6.54 | 1.16 | | |
| Quebradillas | 21.27 | 0.00 | 1.01 | 0.70 | 0.16 | | |
| Rincon | 10.97 | | 1.60 | 1.81 | | | |
| Rio Grande | 47.74 | 3.41 | 7.51 | 1.42 | 0.23 | 0.50 | |
| Sabana Grande | 35.84 | | | | | | |
| Salinas | 59.65 | 1.00 | 1.03 | 2.42 | 3.98 | 1.98 | |
| San German | 54.51 | | | | | | |
| San Juan | 36.66 | 1.10 | 9.70 | 2.07 | | | |
| San Lorenzo | 53.21 | | | | | | |
| San Sebastian | 71.22 | | | | | | |
| Santa Isabel | 27.47 | 0.47 | 2.84 | 2.13 | 1.55 | 0.12 | |
| Toa Alta | 27.56 | | | | | | |
| Toa Baja | 15.77 | 1.25 | 4.66 | 2.12 | | | |
| Trujillo Alto | 21.38 | | | | | | |
| Utua | 115.07 | | | | | | |
| Vega Alta | 26.79 | 0.04 | 0.39 | 0.52 | | | |
| Vega Baja | 40.24 | 2.45 | 2.48 | 1.47 | | | |
| Vieques | 26.93 | 4.01 | 10.58 | 11.19 | 0.47 | | |
| Villalba | 37.04 | | | | | | |
| Yabucoa | 51.12 | 1.49 | 2.28 | 0.52 | | | |
| Yauco | 68.37 | 0.02 | | 0.43 | | | |
| Grand Total | 3120.88 | 42.11 | 163.09 | 103.50 | 26.58 | 7.46 | |

Table 25: Percent of (Municipio) Hexagonal Area by Hurricane Category 2 Storm Surge Hazard per Municipio

| Municipio | Category 2 Storm Surge Water Depth Percent Area by Total (Municipio) Land Area | | | | | |
|--------------|--|--------------------|-------------------------------|---------------------------|--------------------------------|---------------------|
| | None | Low (< 1.5 ft.) | Medium Low (1.5 - 2.5 ft.) | Medium (2.5 - 3.5 ft.) | Medium High (3.5 - 4.5 ft.) | High (> 4.5 ft.) |
| Adjuntas | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Aguada | 87.65% | 0.00% | 7.31% | 2.81% | 2.22% | 0.00% |
| Aguadilla | 85.07% | 0.00% | 7.92% | 4.79% | 2.22% | 0.00% |
| Aguas Buenas | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Aibonito | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Anasco | 93.10% | 1.25% | 2.61% | 2.33% | 0.71% | 0.00% |
| Arecibo | 84.45% | 3.84% | 9.19% | 2.52% | 0.00% | 0.00% |
| Arroyo | 89.12% | 0.00% | 5.03% | 5.85% | 0.00% | 0.00% |
| Barceloneta | 60.83% | 2.69% | 31.73% | 4.75% | 0.00% | 0.00% |
| Barranquitas | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Bayamon | 95.83% | 0.40% | 0.51% | 1.13% | 2.12% | 0.00% |

| | | | | | | |
|-------------|---------|--------|--------|--------|-------|-------|
| Cabo Rojo | 73.82% | 3.65% | 15.50% | 6.01% | 0.77% | 0.25% |
| Caguas | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Camuy | 95.95% | 0.17% | 3.03% | 0.85% | 0.00% | 0.00% |
| Canovanas | 84.09% | 1.23% | 2.35% | 10.47% | 1.87% | 0.00% |
| Carolina | 68.42% | 7.06% | 18.18% | 5.54% | 0.81% | 0.00% |
| Catano | 4.97% | 19.48% | 48.97% | 25.49% | 1.08% | 0.00% |
| Cayey | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Ceiba | 63.53% | 0.00% | 6.75% | 18.89% | 6.23% | 4.60% |
| Ciales | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Cidra | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Coamo | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Comerio | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Corozal | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Culebra | 24.79% | 0.01% | 47.95% | 27.25% | 0.00% | 0.00% |
| Dorado | 77.20% | 5.47% | 11.34% | 5.98% | 0.00% | 0.00% |
| Fajardo | 71.99% | 0.00% | 6.50% | 14.11% | 5.00% | 2.41% |
| Florida | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Guanica | 73.73% | 2.99% | 6.93% | 14.54% | 1.81% | 0.00% |
| Guayama | 87.30% | 0.00% | 1.17% | 6.90% | 4.09% | 0.54% |
| Guayanilla | 82.95% | 2.01% | 9.81% | 5.23% | 0.00% | 0.00% |
| Guaynabo | 93.77% | 2.93% | 3.00% | 0.29% | 0.00% | 0.00% |
| Gurabo | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Hatillo | 94.70% | 0.00% | 3.58% | 1.72% | 0.00% | 0.00% |
| Hormigueros | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Humacao | 81.13% | 1.90% | 10.98% | 4.88% | 0.00% | 1.11% |
| Isabela | 92.43% | 1.00% | 4.22% | 1.73% | 0.62% | 0.00% |
| Jayuya | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Juana Diaz | 90.67% | 0.87% | 6.45% | 1.19% | 0.82% | 0.00% |
| Juncos | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Lajas | 84.94% | 0.00% | 1.56% | 3.44% | 7.84% | 2.23% |
| Lares | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Las Marias | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Las Piedras | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Loiza | 9.77% | 16.30% | 44.56% | 29.37% | 0.00% | 0.00% |
| Luquillo | 79.65% | 1.93% | 17.61% | 0.81% | 0.00% | 0.00% |
| Manati | 87.56% | 2.14% | 7.65% | 2.65% | 0.00% | 0.00% |
| Maricao | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Maunabo | 93.08% | 0.00% | 1.67% | 5.25% | 0.00% | 0.00% |
| Mayaguez | 92.59% | 1.19% | 2.56% | 3.38% | 0.28% | 0.00% |
| Moca | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Morovis | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Naguabo | 84.95% | 0.00% | 8.75% | 4.01% | 1.69% | 0.60% |

| | | | | | | |
|---------------|---------|-------|--------|--------|-------|-------|
| Naranjito | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Orocovis | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Patillas | 93.53% | 0.00% | 3.84% | 2.63% | 0.00% | 0.00% |
| Penuelas | 90.43% | 0.00% | 6.85% | 0.24% | 2.48% | 0.00% |
| Ponce | 87.59% | 1.29% | 4.54% | 5.59% | 0.99% | 0.00% |
| Quebradillas | 91.90% | 0.01% | 4.38% | 3.03% | 0.68% | 0.00% |
| Rincon | 76.26% | 0.00% | 11.13% | 12.61% | 0.00% | 0.00% |
| Rio Grande | 78.50% | 5.60% | 12.35% | 2.34% | 0.38% | 0.82% |
| Sabana Grande | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Salinas | 85.14% | 1.43% | 1.46% | 3.45% | 5.68% | 2.83% |
| San German | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| San Juan | 74.02% | 2.22% | 19.59% | 4.18% | 0.00% | 0.00% |
| San Lorenzo | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| San Sebastian | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Santa Isabel | 79.44% | 1.35% | 8.22% | 6.16% | 4.49% | 0.34% |
| Toa Alta | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Toa Baja | 66.27% | 5.26% | 19.59% | 8.89% | 0.00% | 0.00% |
| Trujillo Alto | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Utua | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Vega Alta | 96.57% | 0.15% | 1.42% | 1.86% | 0.00% | 0.00% |
| Vega Baja | 86.27% | 5.24% | 5.33% | 3.16% | 0.00% | 0.00% |
| Vieques | 50.64% | 7.53% | 19.89% | 21.05% | 0.89% | 0.00% |
| Villalba | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Yabucoa | 92.27% | 2.68% | 4.11% | 0.94% | 0.00% | 0.00% |
| Yauco | 99.35% | 0.02% | 0.00% | 0.63% | 0.00% | 0.00% |

Table 26: Percent of (Island) Hexagonal Area by Hurricane Category 1 Storm Surge Hazard per Municipio

| Municipio | Category 2 Storm Surge Water Depth Percent Area by Total (Island) Land Area | | | | | |
|--------------|---|--------------------|-------------------------------|---------------------------|--------------------------------|---------------------|
| | None | Low (< 1.5 ft.) | Medium Low (1.5 - 2.5 ft.) | Medium (2.5 - 3.5 ft.) | Medium High (3.5 - 4.5 ft.) | High (> 4.5 ft.) |
| Adjuntas | 2.15% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Aguada | 0.87% | 0.00% | 1.39% | 0.84% | 2.58% | 0.00% |
| Aguadilla | 1.00% | 0.00% | 1.78% | 1.69% | 3.06% | 0.00% |
| Aguas Buenas | 0.96% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Aibonito | 1.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Anasco | 1.18% | 1.17% | 0.63% | 0.89% | 1.06% | 0.00% |
| Arecibo | 3.44% | 11.59% | 7.15% | 3.10% | 0.00% | 0.00% |
| Arroyo | 0.43% | 0.00% | 0.46% | 0.85% | 0.00% | 0.00% |
| Barceloneta | 0.37% | 1.20% | 3.65% | 0.86% | 0.00% | 0.00% |
| Barranquitas | 1.10% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Bayamon | 1.37% | 0.43% | 0.14% | 0.49% | 3.56% | 0.00% |
| Cabo Rojo | 1.73% | 6.34% | 6.95% | 4.24% | 2.13% | 2.50% |

| | | | | | | |
|-------------|-------|-------|-------|-------|--------|--------|
| Caguas | 1.89% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Camuy | 1.43% | 0.19% | 0.86% | 0.38% | 0.00% | 0.00% |
| Canovanas | 0.89% | 0.96% | 0.48% | 3.34% | 2.32% | 0.00% |
| Carolina | 1.04% | 7.93% | 5.27% | 2.53% | 1.44% | 0.00% |
| Catano | 0.01% | 2.35% | 1.53% | 1.25% | 0.21% | 0.00% |
| Cayey | 1.66% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Ceiba | 0.62% | 0.00% | 1.26% | 5.54% | 7.12% | 18.75% |
| Ciales | 2.14% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Cidra | 1.17% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Coamo | 2.50% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Comerio | 0.91% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Corozal | 1.36% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Culebra | 0.11% | 0.00% | 3.91% | 3.50% | 0.00% | 0.00% |
| Dorado | 0.58% | 3.04% | 1.63% | 1.35% | 0.00% | 0.00% |
| Fajardo | 0.70% | 0.00% | 1.22% | 4.16% | 5.74% | 9.86% |
| Florida | 0.49% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Guanica | 0.92% | 2.77% | 1.66% | 5.48% | 2.66% | 0.00% |
| Guayama | 1.84% | 0.00% | 0.47% | 4.39% | 10.14% | 4.75% |
| Guayanilla | 1.14% | 2.05% | 2.59% | 2.17% | 0.00% | 0.00% |
| Guaynabo | 0.83% | 1.93% | 0.51% | 0.08% | 0.00% | 0.00% |
| Gurabo | 0.91% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Hatillo | 1.27% | 0.00% | 0.92% | 0.70% | 0.00% | 0.00% |
| Hormigueros | 0.36% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Humacao | 1.17% | 2.04% | 3.04% | 2.13% | 0.00% | 6.71% |
| Isabela | 1.64% | 1.32% | 1.43% | 0.92% | 1.29% | 0.00% |
| Jayuya | 1.43% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Juana Diaz | 1.76% | 1.25% | 2.40% | 0.70% | 1.88% | 0.00% |
| Juncos | 0.85% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Lajas | 1.67% | 0.00% | 0.59% | 2.04% | 18.09% | 18.34% |
| Lares | 1.98% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Las Marias | 1.49% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Las Piedras | 1.09% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Loiza | 0.06% | 7.95% | 5.61% | 5.83% | 0.00% | 0.00% |
| Luquillo | 0.66% | 1.19% | 2.79% | 0.20% | 0.00% | 0.00% |
| Manati | 1.31% | 2.38% | 2.20% | 1.20% | 0.00% | 0.00% |
| Maricao | 1.17% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Maunabo | 0.63% | 0.00% | 0.22% | 1.07% | 0.00% | 0.00% |
| Mayaguez | 2.31% | 2.20% | 1.22% | 2.54% | 0.82% | 0.00% |
| Moca | 1.61% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Morovis | 1.25% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Naguabo | 1.41% | 0.00% | 2.78% | 2.01% | 3.30% | 4.19% |
| Naranjito | 0.89% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |

| | | | | | | |
|---------------|-------|-------|-------|--------|--------|--------|
| Orocovis | 2.04% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Patillas | 1.42% | 0.00% | 1.11% | 1.20% | 0.00% | 0.00% |
| Penuelas | 1.30% | 0.00% | 1.88% | 0.10% | 4.18% | 0.00% |
| Ponce | 3.28% | 3.58% | 3.26% | 6.32% | 4.36% | 0.00% |
| Quebradillas | 0.68% | 0.01% | 0.62% | 0.68% | 0.59% | 0.00% |
| Rincon | 0.35% | 0.00% | 0.98% | 1.75% | 0.00% | 0.00% |
| Rio Grande | 1.53% | 8.09% | 4.60% | 1.38% | 0.88% | 6.70% |
| Sabana Grande | 1.15% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Salinas | 1.91% | 2.37% | 0.63% | 2.34% | 14.98% | 26.62% |
| San German | 1.75% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| San Juan | 1.17% | 2.61% | 5.95% | 2.00% | 0.00% | 0.00% |
| San Lorenzo | 1.70% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| San Sebastian | 2.28% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Santa Isabel | 0.88% | 1.11% | 1.74% | 2.06% | 5.84% | 1.59% |
| Toa Alta | 0.88% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Toa Baja | 0.51% | 2.97% | 2.86% | 2.04% | 0.00% | 0.00% |
| Trujillo Alto | 0.69% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Utuado | 3.69% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Vega Alta | 0.86% | 0.10% | 0.24% | 0.50% | 0.00% | 0.00% |
| Vega Baja | 1.29% | 5.81% | 1.52% | 1.42% | 0.00% | 0.00% |
| Vieques | 0.86% | 9.51% | 6.49% | 10.82% | 1.78% | 0.00% |
| Villalba | 1.19% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Yabucoa | 1.64% | 3.53% | 1.40% | 0.50% | 0.00% | 0.00% |
| Yauco | 2.19% | 0.04% | 0.00% | 0.42% | 0.00% | 0.00% |

Table 27: Category 2 Storm Surge Hazard Scores and Ranks by Municipio

| Municipio | Hurricane Category 2 Storm Surge Hazard Score (Log Multiplied) | | |
|--------------|--|--------------------------|----------------------|
| | Total Score | Standardized Score (0-1) | Rank of Score (1-78) |
| Salinas | 10,850.3746 | 1.0000 | 1 |
| Lajas | 7,910.4827 | 0.7291 | 2 |
| Ceiba | 7,490.4817 | 0.6903 | 3 |
| Fajardo | 4,060.5159 | 0.3742 | 4 |
| Rio Grande | 2,583.9722 | 0.2381 | 5 |
| Humacao | 2,543.0197 | 0.2344 | 6 |
| Guayama | 2,386.8035 | 0.22 | 7 |
| Naguabo | 1,779.2064 | 0.164 | 8 |
| Cabo Rojo | 1,106.0364 | 0.1019 | 9 |
| Santa Isabel | 940.0166 | 0.0866 | 10 |
| Ponce | 304.0644 | 0.028 | 11 |
| Penuelas | 234.6822 | 0.0216 | 12 |
| Vieques | 208.5049 | 0.0192 | 13 |

| | | | |
|--------------|----------|--------|----|
| Bayamon | 201.2286 | 0.0185 | 14 |
| Guanica | 200.2752 | 0.0185 | 14 |
| Aguadilla | 187.1568 | 0.0172 | 16 |
| Canovanas | 159.8593 | 0.0147 | 17 |
| Aguada | 152.5667 | 0.0141 | 18 |
| Juana Diaz | 113.8662 | 0.0105 | 19 |
| Carolina | 111.1162 | 0.0102 | 20 |
| Isabela | 82.1409 | 0.0076 | 21 |
| Mayaguez | 70.9130 | 0.0065 | 22 |
| Anasco | 67.6849 | 0.0062 | 23 |
| Loiza | 62.3984 | 0.0058 | 24 |
| Arecibo | 39.6148 | 0.0037 | 25 |
| Quebradillas | 39.6068 | 0.0037 | 25 |
| Culebra | 37.8577 | 0.0035 | 27 |
| San Juan | 27.0163 | 0.0025 | 28 |
| Catano | 25.3399 | 0.0023 | 29 |
| Guayanilla | 23.8670 | 0.0022 | 30 |
| Toa Baja | 23.1510 | 0.0021 | 31 |
| Rincon | 17.5813 | 0.0016 | 32 |
| Vega Baja | 15.7903 | 0.0015 | 33 |
| Dorado | 15.0554 | 0.0014 | 34 |
| Manati | 14.3757 | 0.0013 | 35 |
| Barceloneta | 13.1580 | 0.0012 | 36 |
| Patillas | 12.6497 | 0.0012 | 36 |
| Maunabo | 10.1910 | 0.0009 | 38 |
| Arroyo | 8.5102 | 0.0008 | 39 |
| Hatillo | 7.7264 | 0.0007 | 40 |
| Yabucoa | 6.9036 | 0.0006 | 41 |
| Luquillo | 5.8746 | 0.0005 | 42 |
| Vega Alta | 4.9550 | 0.0005 | 42 |
| Camuy | 4.7339 | 0.0004 | 44 |
| Yauco | 3.8798 | 0.0004 | 44 |
| Guaynabo | 1.6100 | 0.0001 | 46 |
| Adjuntas | 0.0000 | 0.0000 | 47 |
| Aguas Buenas | 0.0000 | 0.0000 | 47 |
| Aibonito | 0.0000 | 0.0000 | 47 |
| Barranquitas | 0.0000 | 0.0000 | 47 |
| Caguas | 0.0000 | 0.0000 | 47 |
| Cayey | 0.0000 | 0.0000 | 47 |
| Ciales | 0.0000 | 0.0000 | 47 |
| Cidra | 0.0000 | 0.0000 | 47 |
| Coamo | 0.0000 | 0.0000 | 47 |

| | | | |
|---------------|--------|--------|----|
| Comerio | 0.0000 | 0.0000 | 47 |
| Corozal | 0.0000 | 0.0000 | 47 |
| Florida | 0.0000 | 0.0000 | 47 |
| Gurabo | 0.0000 | 0.0000 | 47 |
| Hormigueros | 0.0000 | 0.0000 | 47 |
| Jayuya | 0.0000 | 0.0000 | 47 |
| Juncos | 0.0000 | 0.0000 | 47 |
| Lares | 0.0000 | 0.0000 | 47 |
| Las Marias | 0.0000 | 0.0000 | 47 |
| Las Piedras | 0.0000 | 0.0000 | 47 |
| Maricao | 0.0000 | 0.0000 | 47 |
| Moca | 0.0000 | 0.0000 | 47 |
| Morovis | 0.0000 | 0.0000 | 47 |
| Naranjito | 0.0000 | 0.0000 | 47 |
| Orocovis | 0.0000 | 0.0000 | 47 |
| Sabana Grande | 0.0000 | 0.0000 | 47 |
| San German | 0.0000 | 0.0000 | 47 |
| San Lorenzo | 0.0000 | 0.0000 | 47 |
| San Sebastian | 0.0000 | 0.0000 | 47 |
| Toa Alta | 0.0000 | 0.0000 | 47 |
| Trujillo Alto | 0.0000 | 0.0000 | 47 |
| Utado | 0.0000 | 0.0000 | 47 |
| Villalba | 0.0000 | 0.0000 | 47 |

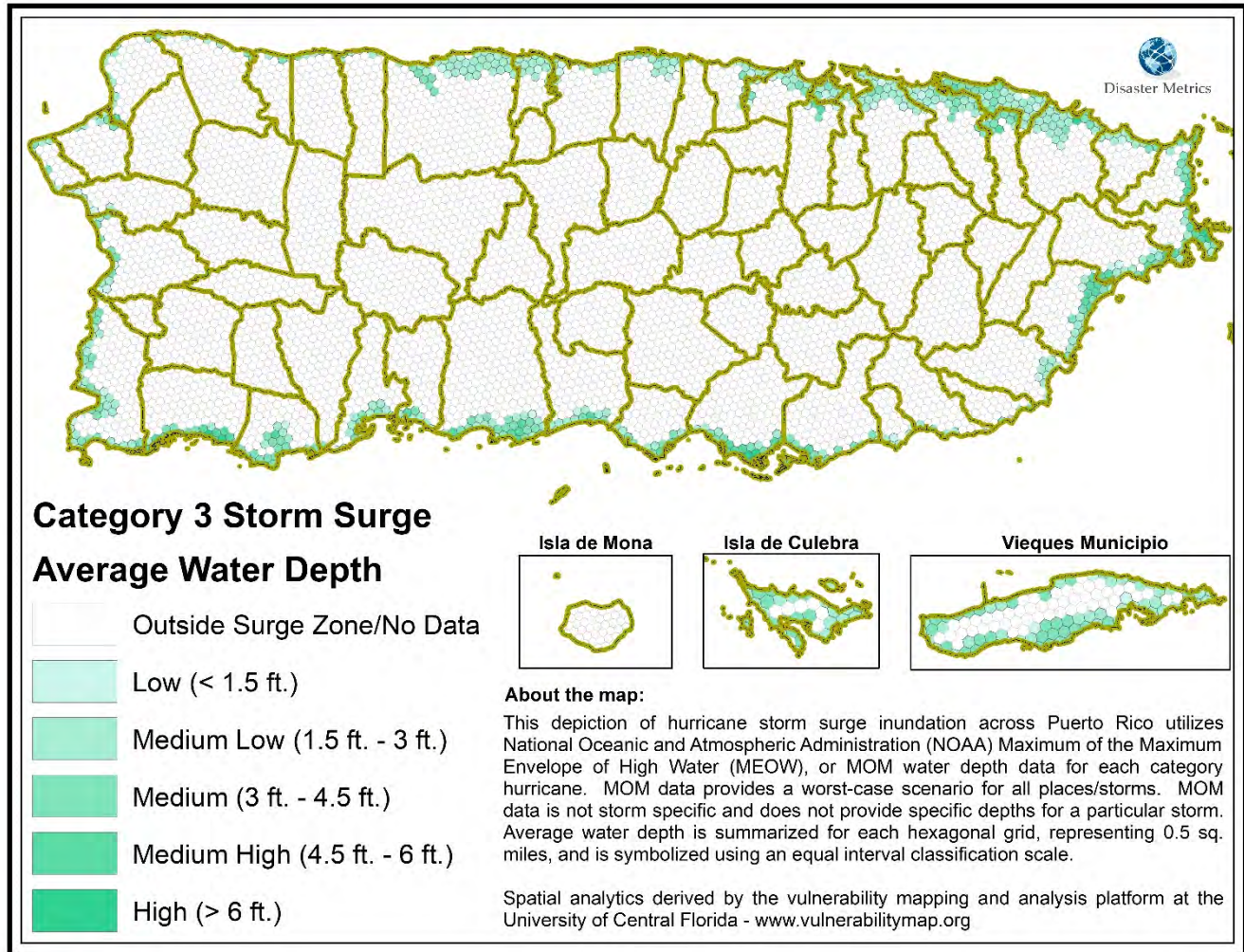


Figure 12: Hurricane Category 3 Storm Surge Hazard Areas

Table 28: Hurricane Category 3 Storm Surge Hazard by Municipio and Areal Extent

| Municipio | HEX GRID Area by Category 3 Storm Surge Water Depth (Sq. miles) | | | | | |
|--------------|---|-----------------|--------------------------|----------------------|---------------------------|----------------|
| | None | Low (< 1.5 ft.) | Medium Low (1.5 - 3 ft.) | Medium (3 - 4.5 ft.) | Medium High (4.5 - 6 ft.) | High (> 6 ft.) |
| Adjuntas | 67.10 | | | | | |
| Aguada | 27.11 | | 2.28 | 1.34 | 0.20 | |
| Aguadilla | 31.14 | | 4.09 | 0.58 | 0.80 | |
| Aguas Buenas | 30.10 | | | | | |
| Aibonito | 31.34 | | | | | |
| Anasco | 36.33 | 1.42 | 1.44 | 0.37 | | |
| Arecibo | 107.23 | 1.48 | 15.17 | 3.09 | | |
| Arroyo | 12.53 | 0.88 | 1.64 | | | |
| Barceloneta | 11.41 | 0.50 | 6.85 | | | |
| Barranquitas | 34.28 | | | | | |
| Bayamon | 41.76 | 0.90 | 0.41 | 0.50 | 0.95 | |
| Cabo Rojo | 50.52 | 1.00 | 12.77 | 8.08 | 0.72 | 0.03 |

| | | | | | | | |
|-------------|-------|------|-------|------|------|------|--|
| Caguas | 59.07 | | | | | | |
| Camuy | 44.49 | | 1.23 | 0.64 | | | |
| Canovanas | 27.75 | | 1.06 | 3.33 | 0.87 | | |
| Carolina | 32.36 | 1.00 | 8.87 | 5.04 | 0.03 | | |
| Catano | 0.25 | 0.50 | 3.16 | 1.12 | 0.05 | | |
| Cayey | 51.96 | | | | | | |
| Ceiba | 18.79 | | 3.39 | 4.16 | 2.63 | 1.40 | |
| Ciales | 66.71 | | | | | | |
| Cidra | 36.46 | | | | | | |
| Coamo | 78.03 | | | | | | |
| Comerio | 28.52 | | | | | | |
| Corozal | 42.58 | | | | | | |
| Culebra | 3.30 | 0.00 | 5.50 | 4.51 | | | |
| Dorado | 17.41 | 0.94 | 3.65 | 1.42 | | | |
| Fajardo | 21.46 | | 1.83 | 4.95 | 2.05 | 0.21 | |
| Florida | 15.22 | | | | | | |
| Guanica | 27.76 | 0.50 | 2.17 | 7.88 | 0.71 | | |
| Guayama | 57.50 | | 0.95 | 4.62 | 2.80 | | |
| Guayanilla | 35.16 | 0.31 | 4.50 | 2.72 | 0.30 | | |
| Guaynabo | 25.99 | 0.53 | 1.02 | 0.22 | | | |
| Gurabo | 28.31 | | | | | | |
| Hatillo | 39.62 | | 2.11 | 0.11 | | | |
| Hormigueros | 11.34 | | | | | | |
| Humacao | 32.20 | 0.89 | 4.83 | 3.50 | 3.68 | | |
| Isabela | 51.21 | 0.50 | 2.42 | 1.28 | | | |
| Jayuya | 44.53 | | | | | | |
| Juana Diaz | 54.06 | 0.50 | 4.03 | 1.45 | 0.68 | | |
| Juncos | 26.62 | | | | | | |
| Lajas | 52.12 | | 0.95 | 2.45 | 4.84 | 1.00 | |
| Lares | 61.64 | | | | | | |
| Las Marias | 46.51 | | | | | | |
| Las Piedras | 33.89 | | | | | | |
| Loiza | 1.01 | 1.00 | 10.40 | 7.53 | 0.60 | | |
| Luquillo | 20.10 | 0.50 | 3.89 | 1.37 | | | |
| Manati | 41.00 | 1.00 | 4.82 | | | | |
| Maricao | 36.63 | | | | | | |
| Maunabo | 19.63 | | 0.35 | 1.11 | | | |
| Mayaguez | 71.31 | 1.34 | 2.00 | 3.32 | | | |
| Moca | 50.37 | | | | | | |
| Morovis | 38.93 | | | | | | |
| Naguabo | 42.47 | 1.61 | 3.14 | 1.74 | 2.94 | | |
| Naranjito | 27.75 | | | | | | |

| | | | | | | | |
|---------------|---------|-------|--------|--------|-------|------|--|
| Orocovis | 63.78 | | | | | | |
| Patillas | 44.04 | 0.12 | 2.04 | 1.01 | | | |
| Penuelas | 40.47 | | 2.86 | 0.76 | 0.66 | | |
| Ponce | 100.97 | 0.50 | 5.12 | 7.74 | 2.65 | | |
| Quebradillas | 21.27 | | 1.22 | 0.65 | | | |
| Rincon | 10.97 | | 2.22 | 1.19 | | | |
| Rio Grande | 46.74 | 0.50 | 10.57 | 2.27 | 0.23 | 0.50 | |
| Sabana Grande | 35.84 | | | | | | |
| Salinas | 59.15 | | 2.53 | 2.84 | 3.52 | 2.02 | |
| San German | 54.51 | | | | | | |
| San Juan | 35.66 | 1.53 | 11.39 | 0.94 | | | |
| San Lorenzo | 53.21 | | | | | | |
| San Sebastian | 71.22 | | | | | | |
| Santa Isabel | 27.47 | | 2.93 | 2.82 | 1.25 | 0.10 | |
| Toa Alta | 27.56 | | | | | | |
| Toa Baja | 14.89 | 0.95 | 5.59 | 2.38 | | | |
| Trujillo Alto | 21.38 | | | | | | |
| Utuado | 115.07 | | | | | | |
| Vega Alta | 26.79 | 0.04 | 0.39 | 0.52 | | | |
| Vega Baja | 39.24 | 1.95 | 4.02 | 1.43 | | | |
| Vieques | 24.93 | 1.38 | 13.97 | 12.89 | 0.01 | | |
| Villalba | 37.04 | | | | | | |
| Yabucoa | 50.12 | 0.50 | 4.38 | 0.40 | | | |
| Yauco | 68.37 | | 0.02 | 0.43 | | | |
| Grand Total | 3093.54 | 24.78 | 190.17 | 116.71 | 33.18 | 5.26 | |

Table 29: Percent of (Municipio) Hexagonal Area by Hurricane Category 3 Storm Surge Hazard per Municipio

| Municipio | Category 3 Storm Surge Water Depth Percent Area by Total (Municipio) Land Area | | | | | |
|--------------|--|-----------------|--------------------------|----------------------|---------------------------|----------------|
| | None | Low (< 1.5 ft.) | Medium Low (1.5 - 3 ft.) | Medium (3 - 4.5 ft.) | Medium High (4.5 - 6 ft.) | High (> 6 ft.) |
| Adjuntas | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Aguada | 87.65% | 0.00% | 7.36% | 4.34% | 0.64% | 0.00% |
| Aguadilla | 85.07% | 0.00% | 11.17% | 1.57% | 2.19% | 0.00% |
| Aguas Buenas | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Aibonito | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Anasco | 91.83% | 3.60% | 3.63% | 0.94% | 0.00% | 0.00% |
| Arecibo | 84.45% | 1.17% | 11.95% | 2.44% | 0.00% | 0.00% |
| Arroyo | 83.29% | 5.83% | 10.88% | 0.00% | 0.00% | 0.00% |
| Barceloneta | 60.83% | 2.67% | 36.50% | 0.00% | 0.00% | 0.00% |
| Barranquitas | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Bayamon | 93.80% | 2.03% | 0.91% | 1.13% | 2.12% | 0.00% |

| | | | | | | |
|-------------|---------|-------|--------|--------|-------|-------|
| Cabo Rojo | 69.09% | 1.37% | 17.46% | 11.05% | 0.98% | 0.04% |
| Caguas | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Camuy | 95.95% | 0.00% | 2.66% | 1.39% | 0.00% | 0.00% |
| Canovanas | 84.09% | 0.00% | 3.20% | 10.08% | 2.63% | 0.00% |
| Carolina | 68.42% | 2.11% | 18.76% | 10.66% | 0.06% | 0.00% |
| Catano | 4.97% | 9.83% | 62.09% | 22.02% | 1.08% | 0.00% |
| Cayey | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Ceiba | 61.88% | 0.00% | 11.15% | 13.70% | 8.66% | 4.60% |
| Ciales | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Cidra | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Coamo | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Comerio | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Corozal | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Culebra | 24.79% | 0.01% | 41.33% | 33.87% | 0.00% | 0.00% |
| Dorado | 74.37% | 4.01% | 15.57% | 6.06% | 0.00% | 0.00% |
| Fajardo | 70.35% | 0.00% | 6.01% | 16.23% | 6.72% | 0.69% |
| Florida | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Guanica | 71.17% | 1.28% | 5.55% | 20.19% | 1.81% | 0.00% |
| Guayama | 87.30% | 0.00% | 1.44% | 7.01% | 4.25% | 0.00% |
| Guayanilla | 81.79% | 0.73% | 10.47% | 6.32% | 0.69% | 0.00% |
| Guaynabo | 93.61% | 1.91% | 3.69% | 0.79% | 0.00% | 0.00% |
| Gurabo | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Hatillo | 94.70% | 0.00% | 5.04% | 0.26% | 0.00% | 0.00% |
| Hormigueros | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Humacao | 71.39% | 1.98% | 10.71% | 7.75% | 8.17% | 0.00% |
| Isabela | 92.43% | 0.90% | 4.37% | 2.30% | 0.00% | 0.00% |
| Jayuya | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Juana Diaz | 89.02% | 0.82% | 6.64% | 2.40% | 1.12% | 0.00% |
| Juncos | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Lajas | 84.94% | 0.00% | 1.56% | 3.99% | 7.89% | 1.62% |
| Lares | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Las Marias | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Las Piedras | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Loiza | 4.90% | 4.87% | 50.64% | 36.66% | 2.94% | 0.00% |
| Luquillo | 77.71% | 1.93% | 15.04% | 5.31% | 0.00% | 0.00% |
| Manati | 87.56% | 2.14% | 10.30% | 0.00% | 0.00% | 0.00% |
| Maricao | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Maunabo | 93.08% | 0.00% | 1.67% | 5.25% | 0.00% | 0.00% |
| Mayaguez | 91.46% | 1.72% | 2.56% | 4.26% | 0.00% | 0.00% |
| Moca | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Morovis | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Naguabo | 81.85% | 3.10% | 6.04% | 3.35% | 5.66% | 0.00% |

| | | | | | | |
|---------------|---------|-------|--------|--------|-------|-------|
| Naranjito | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Orocovis | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Patillas | 93.27% | 0.26% | 4.32% | 2.14% | 0.00% | 0.00% |
| Penuelas | 90.43% | 0.00% | 6.39% | 1.70% | 1.48% | 0.00% |
| Ponce | 86.31% | 0.43% | 4.38% | 6.62% | 2.27% | 0.00% |
| Quebradillas | 91.90% | 0.00% | 5.28% | 2.82% | 0.00% | 0.00% |
| Rincon | 76.26% | 0.00% | 15.46% | 8.28% | 0.00% | 0.00% |
| Rio Grande | 76.86% | 0.82% | 17.38% | 3.74% | 0.38% | 0.82% |
| Sabana Grande | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Salinas | 84.43% | 0.00% | 3.61% | 4.05% | 5.03% | 2.89% |
| San German | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| San Juan | 72.00% | 3.08% | 23.01% | 1.91% | 0.00% | 0.00% |
| San Lorenzo | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| San Sebastian | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Santa Isabel | 79.44% | 0.00% | 8.49% | 8.17% | 3.61% | 0.30% |
| Toa Alta | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Toa Baja | 62.54% | 3.99% | 23.48% | 9.99% | 0.00% | 0.00% |
| Trujillo Alto | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Utua | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Vega Alta | 96.57% | 0.15% | 1.42% | 1.86% | 0.00% | 0.00% |
| Vega Baja | 84.13% | 4.17% | 8.63% | 3.07% | 0.00% | 0.00% |
| Vieques | 46.88% | 2.60% | 26.27% | 24.24% | 0.02% | 0.00% |
| Villalba | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Yabucoa | 90.46% | 0.90% | 7.91% | 0.72% | 0.00% | 0.00% |
| Yauco | 99.35% | 0.00% | 0.02% | 0.63% | 0.00% | 0.00% |

Table 30: Percent of (Island) Hexagonal Area by Hurricane Category 1 Storm Surge Hazard per Municipio

| Municipio | Category 3 Storm Surge Water Depth Percent Area by Total (Island) Land Area | | | | | |
|--------------|---|---------------------|-----------------------------|-------------------------|------------------------------|--------------------|
| | None | Low (< 1.5 ft.) | Medium Low (1.5 - 3 ft.) | Medium (3 - 4.5 ft.) | Medium High (4.5 - 6 ft.) | High (> 6 ft.) |
| Adjuntas | 2.17% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Aguada | 0.88% | 0.00% | 1.20% | 1.15% | 0.60% | 0.00% |
| Aguadilla | 1.01% | 0.00% | 2.15% | 0.49% | 2.41% | 0.00% |
| Aguas Buenas | 0.97% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Aibonito | 1.01% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Anasco | 1.17% | 5.75% | 0.75% | 0.32% | 0.00% | 0.00% |
| Arecibo | 3.47% | 5.99% | 7.98% | 2.65% | 0.00% | 0.00% |
| Arroyo | 0.41% | 3.54% | 0.86% | 0.00% | 0.00% | 0.00% |
| Barceloneta | 0.37% | 2.02% | 3.60% | 0.00% | 0.00% | 0.00% |
| Barranquitas | 1.11% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Bayamon | 1.35% | 3.64% | 0.21% | 0.43% | 2.85% | 0.00% |
| Cabo Rojo | 1.63% | 4.04% | 6.72% | 6.92% | 2.17% | 0.61% |

| | | | | | | | |
|-------------|-------|-------|-------|-------|--------|--------|-------|
| Caguas | 1.91% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Camuy | 1.44% | 0.00% | 0.65% | 0.55% | 0.00% | 0.00% | 0.00% |
| Canovanas | 0.90% | 0.00% | 0.55% | 2.85% | 2.62% | 0.00% | 0.00% |
| Carolina | 1.05% | 4.02% | 4.67% | 4.32% | 0.08% | 0.00% | 0.00% |
| Catano | 0.01% | 2.02% | 1.66% | 0.96% | 0.17% | 0.00% | 0.00% |
| Cayey | 1.68% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Ceiba | 0.61% | 0.00% | 1.78% | 3.57% | 7.93% | 26.58% | 0.00% |
| Ciales | 2.16% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Cidra | 1.18% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Coamo | 2.52% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Comerio | 0.92% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Corozal | 1.38% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Culebra | 0.11% | 0.01% | 2.89% | 3.86% | 0.00% | 0.00% | 0.00% |
| Dorado | 0.56% | 3.79% | 1.92% | 1.22% | 0.00% | 0.00% | 0.00% |
| Fajardo | 0.69% | 0.00% | 0.96% | 4.24% | 6.18% | 3.98% | 0.00% |
| Florida | 0.49% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Guanica | 0.90% | 2.02% | 1.14% | 6.75% | 2.13% | 0.00% | 0.00% |
| Guayama | 1.86% | 0.00% | 0.50% | 3.96% | 8.44% | 0.00% | 0.00% |
| Guayanilla | 1.14% | 1.27% | 2.37% | 2.33% | 0.90% | 0.00% | 0.00% |
| Guaynabo | 0.84% | 2.14% | 0.54% | 0.19% | 0.00% | 0.00% | 0.00% |
| Gurabo | 0.92% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Hatillo | 1.28% | 0.00% | 1.11% | 0.09% | 0.00% | 0.00% | 0.00% |
| Hormigueros | 0.37% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Humacao | 1.04% | 3.61% | 2.54% | 2.99% | 11.11% | 0.00% | 0.00% |
| Isabela | 1.66% | 2.01% | 1.27% | 1.09% | 0.00% | 0.00% | 0.00% |
| Jayuya | 1.44% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Juana Diaz | 1.75% | 2.02% | 2.12% | 1.25% | 2.05% | 0.00% | 0.00% |
| Juncos | 0.86% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Lajas | 1.68% | 0.00% | 0.50% | 2.10% | 14.60% | 18.93% | 0.00% |
| Lares | 1.99% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Las Marias | 1.50% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Las Piedras | 1.10% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Loiza | 0.03% | 4.04% | 5.47% | 6.45% | 1.82% | 0.00% | 0.00% |
| Luquillo | 0.65% | 2.02% | 2.04% | 1.18% | 0.00% | 0.00% | 0.00% |
| Manati | 1.33% | 4.04% | 2.54% | 0.00% | 0.00% | 0.00% | 0.00% |
| Maricao | 1.18% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Maunabo | 0.63% | 0.00% | 0.19% | 0.95% | 0.00% | 0.00% | 0.00% |
| Mayaguez | 2.31% | 5.41% | 1.05% | 2.85% | 0.00% | 0.00% | 0.00% |
| Moca | 1.63% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Morovis | 1.26% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Naguabo | 1.37% | 6.48% | 1.65% | 1.49% | 8.85% | 0.00% | 0.00% |
| Naranjito | 0.90% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |

| | | | | | | |
|---------------|-------|-------|-------|--------|--------|--------|
| Orocovis | 2.06% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Patillas | 1.42% | 0.50% | 1.07% | 0.87% | 0.00% | 0.00% |
| Penuelas | 1.31% | 0.00% | 1.50% | 0.65% | 2.00% | 0.00% |
| Ponce | 3.26% | 2.02% | 2.69% | 6.63% | 8.00% | 0.00% |
| Quebradillas | 0.69% | 0.00% | 0.64% | 0.56% | 0.00% | 0.00% |
| Rincon | 0.35% | 0.00% | 1.17% | 1.02% | 0.00% | 0.00% |
| Rio Grande | 1.51% | 2.02% | 5.56% | 1.95% | 0.70% | 9.49% |
| Sabana Grande | 1.16% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Salinas | 1.91% | 0.00% | 1.33% | 2.43% | 10.62% | 38.46% |
| San German | 1.76% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| San Juan | 1.15% | 6.17% | 5.99% | 0.81% | 0.00% | 0.00% |
| San Lorenzo | 1.72% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| San Sebastian | 2.30% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Santa Isabel | 0.89% | 0.00% | 1.54% | 2.42% | 3.76% | 1.95% |
| Toa Alta | 0.89% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Toa Baja | 0.48% | 3.83% | 2.94% | 2.04% | 0.00% | 0.00% |
| Trujillo Alto | 0.69% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Utuado | 3.72% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Vega Alta | 0.87% | 0.17% | 0.21% | 0.44% | 0.00% | 0.00% |
| Vega Baja | 1.27% | 7.85% | 2.12% | 1.23% | 0.00% | 0.00% |
| Vieques | 0.81% | 5.58% | 7.35% | 11.05% | 0.03% | 0.00% |
| Villalba | 1.20% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Yabucoa | 1.62% | 2.02% | 2.30% | 0.34% | 0.00% | 0.00% |
| Yauco | 2.21% | 0.00% | 0.01% | 0.37% | 0.00% | 0.00% |

Table 31: Category 3 Storm Surge Hazard Scores and Ranks by Municipio

| Municipio | Hurricane Category 3 Storm Surge Hazard Score (Log Multiplied) | | |
|--------------|--|--------------------------|----------------------|
| | Total Score | Standardized Score (0-1) | Rank of Score (1-78) |
| Salinas | 10751.3595 | 1.0000 | 1 |
| Ceiba | 7490.0536 | 0.6967 | 2 |
| Lajas | 5941.8171 | 0.5527 | 3 |
| Rio Grande | 2541.5848 | 0.2364 | 4 |
| Fajardo | 1497.0050 | 0.1392 | 5 |
| Humacao | 791.7419 | 0.0736 | 6 |
| Santa Isabel | 788.0859 | 0.0733 | 7 |
| Naguabo | 622.8731 | 0.0579 | 8 |
| Guayama | 614.4716 | 0.0572 | 9 |
| Ponce | 611.5413 | 0.0569 | 10 |
| Cabo Rojo | 379.3554 | 0.0353 | 11 |
| Guanica | 208.8471 | 0.0194 | 12 |
| Canovanas | 206.0455 | 0.0192 | 13 |

| | | | |
|--------------|----------|--------|----|
| Bayamon | 199.8185 | 0.0186 | 14 |
| Loiza | 190.4136 | 0.0177 | 15 |
| Aguadilla | 172.5707 | 0.0161 | 16 |
| Juana Diaz | 154.3210 | 0.0144 | 17 |
| Penuelas | 144.9914 | 0.0135 | 18 |
| Vieques | 111.6481 | 0.0104 | 19 |
| Guayanilla | 85.5961 | 0.008 | 20 |
| Aguada | 53.0239 | 0.0049 | 21 |
| Carolina | 51.0750 | 0.0048 | 22 |
| Culebra | 38.5943 | 0.0036 | 23 |
| Arecibo | 34.7651 | 0.0032 | 24 |
| Mayaguez | 27.7639 | 0.0026 | 25 |
| Catano | 22.3714 | 0.0021 | 26 |
| Toa Baja | 22.6181 | 0.0021 | 26 |
| San Juan | 15.6241 | 0.0015 | 28 |
| Vega Baja | 14.7693 | 0.0014 | 29 |
| Dorado | 13.8890 | 0.0013 | 30 |
| Luquillo | 13.4820 | 0.0013 | 30 |
| Isabela | 11.7550 | 0.0011 | 32 |
| Rincon | 10.7056 | 0.001 | 33 |
| Patillas | 9.2597 | 0.0009 | 34 |
| Maunabo | 8.8204 | 0.0008 | 35 |
| Yabucoa | 6.2551 | 0.0006 | 36 |
| Camuy | 5.8149 | 0.0005 | 37 |
| Quebradillas | 5.8619 | 0.0005 | 37 |
| Anasco | 4.5698 | 0.0004 | 39 |
| Barceloneta | 4.7710 | 0.0004 | 39 |
| Vega Alta | 4.2834 | 0.0004 | 39 |
| Manati | 3.6938 | 0.0003 | 42 |
| Yauco | 3.3771 | 0.0003 | 42 |
| Guaynabo | 2.6529 | 0.0002 | 44 |
| Hatillo | 2.2266 | 0.0002 | 44 |
| Arroyo | 1.5302 | 0.0001 | 46 |
| Adjuntas | 0.0000 | 0.0000 | 47 |
| Aguas Buenas | 0.0000 | 0.0000 | 47 |
| Aibonito | 0.0000 | 0.0000 | 47 |
| Barranquitas | 0.0000 | 0.0000 | 47 |
| Caguas | 0.0000 | 0.0000 | 47 |
| Cayey | 0.0000 | 0.0000 | 47 |
| Ciales | 0.0000 | 0.0000 | 47 |
| Cidra | 0.0000 | 0.0000 | 47 |
| Coamo | 0.0000 | 0.0000 | 47 |

| | | | |
|---------------|--------|--------|----|
| Comerio | 0.0000 | 0.0000 | 47 |
| Corozal | 0.0000 | 0.0000 | 47 |
| Florida | 0.0000 | 0.0000 | 47 |
| Gurabo | 0.0000 | 0.0000 | 47 |
| Hormigueros | 0.0000 | 0.0000 | 47 |
| Jayuya | 0.0000 | 0.0000 | 47 |
| Juncos | 0.0000 | 0.0000 | 47 |
| Lares | 0.0000 | 0.0000 | 47 |
| Las Marias | 0.0000 | 0.0000 | 47 |
| Las Piedras | 0.0000 | 0.0000 | 47 |
| Maricao | 0.0000 | 0.0000 | 47 |
| Moca | 0.0000 | 0.0000 | 47 |
| Morovis | 0.0000 | 0.0000 | 47 |
| Naranjito | 0.0000 | 0.0000 | 47 |
| Orocovis | 0.0000 | 0.0000 | 47 |
| Sabana Grande | 0.0000 | 0.0000 | 47 |
| San German | 0.0000 | 0.0000 | 47 |
| San Lorenzo | 0.0000 | 0.0000 | 47 |
| San Sebastian | 0.0000 | 0.0000 | 47 |
| Toa Alta | 0.0000 | 0.0000 | 47 |
| Trujillo Alto | 0.0000 | 0.0000 | 47 |
| Utado | 0.0000 | 0.0000 | 47 |
| Villalba | 0.0000 | 0.0000 | 47 |

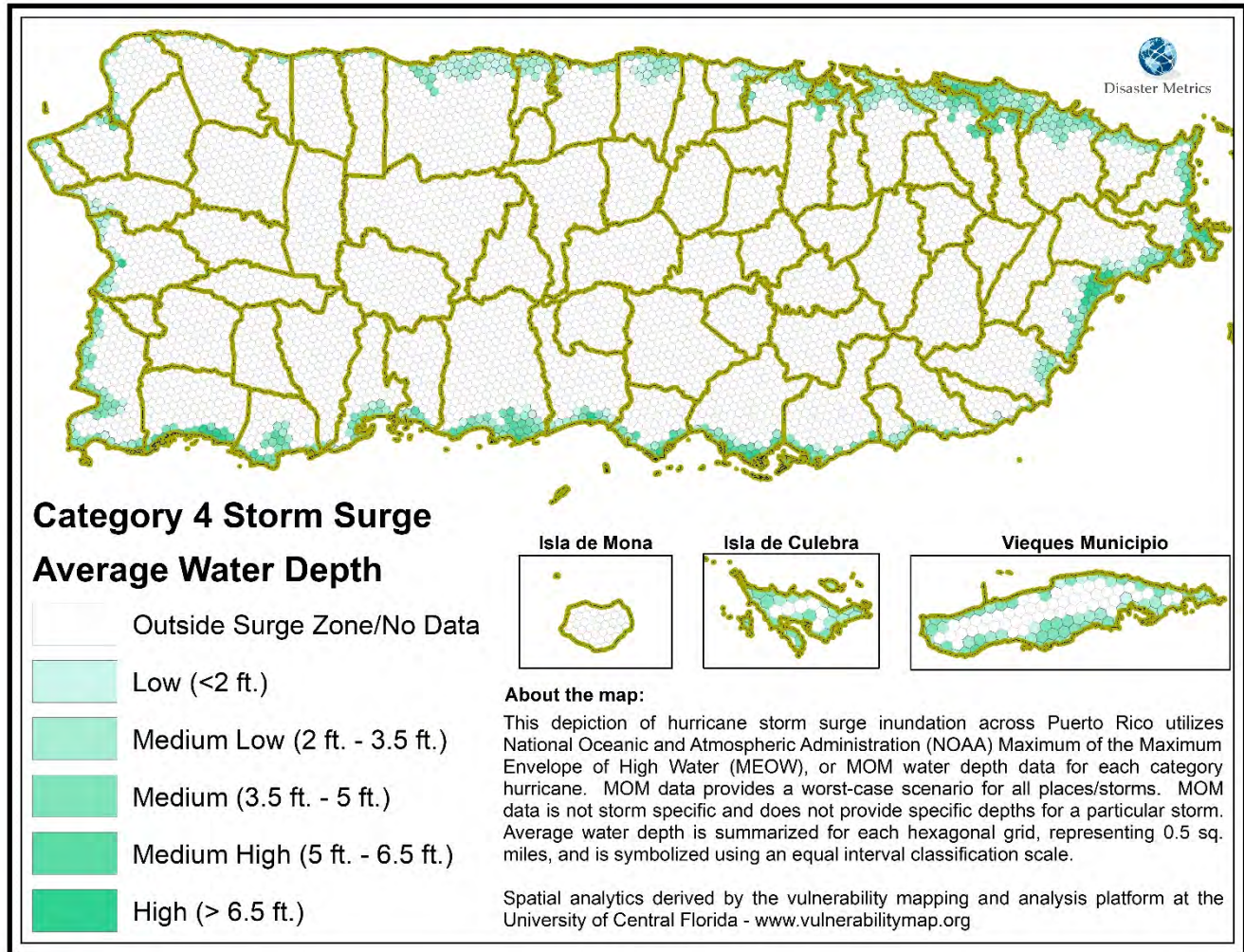


Figure 13: Hurricane Category 4 Storm Surge Hazard Areas

Table 32: Hurricane Category 4 Storm Surge Hazard by Municipio and Areal Extent

| Municipio | HEX GRID Area by Category 4 Storm Surge Water Depth (Sq. miles) | | | | | |
|--------------|---|---------------|--------------------------|----------------------|---------------------------|------------------|
| | None | Low (< 2 ft.) | Medium Low (2 - 3.5 ft.) | Medium (3.5 - 5 ft.) | Medium High (5 - 6.5 ft.) | High (> 6.5 ft.) |
| Adjuntas | 67.10 | | | | | |
| Aguada | 26.92 | 0.66 | 2.10 | 0.56 | 0.69 | |
| Aguadilla | 30.83 | 0.31 | 3.45 | 1.20 | 0.81 | |
| Aguas Buenas | 30.10 | | | | | |
| Aibonito | 31.34 | | | | | |
| Anasco | 35.24 | 2.89 | 1.05 | 0.37 | | |
| Arecibo | 106.19 | 10.29 | 7.87 | 2.63 | | |
| Arroyo | 11.53 | 0.98 | 2.49 | 0.04 | | |
| Barceloneta | 11.41 | 1.43 | 5.92 | | | |
| Barranquitas | 34.28 | | | | | |
| Bayamon | 41.72 | 0.49 | 0.86 | 0.95 | 0.50 | |
| Cabo Rojo | 48.40 | 2.73 | 8.16 | 12.42 | 0.86 | 0.54 |

| | | | | | | |
|-------------|-------|------|------|------|------|------|
| Caguas | 59.07 | | | | | |
| Camuy | 44.49 | | 1.88 | | | |
| Canovanas | 27.75 | | 1.44 | 0.50 | 3.31 | |
| Carolina | 30.86 | 2.51 | 5.99 | 2.55 | 4.98 | 0.41 |
| Catano | 0.25 | | 2.56 | 1.25 | 1.02 | |
| Cayey | 51.96 | | | | | |
| Ceiba | 18.79 | 0.50 | 2.89 | 2.71 | 4.03 | 1.45 |
| Ciales | 66.71 | | | | | |
| Cidra | 36.46 | | | | | |
| Coamo | 78.03 | | | | | |
| Comerio | 28.52 | | | | | |
| Corozal | 42.58 | | | | | |
| Culebra | 3.30 | 0.00 | 5.62 | 4.39 | | |
| Dorado | 16.91 | 1.39 | 4.21 | 0.90 | | |
| Fajardo | 21.46 | | 1.91 | 4.40 | 2.01 | 0.73 |
| Florida | 15.22 | | | | | |
| Guanica | 27.76 | | 2.67 | 5.96 | 2.62 | 0.00 |
| Guayama | 57.00 | 0.50 | 0.25 | 4.76 | 2.70 | 0.65 |
| Guayanilla | 34.39 | 1.31 | 1.96 | 4.83 | 0.50 | |
| Guaynabo | 25.17 | 1.38 | 0.90 | 0.30 | | |
| Gurabo | 28.31 | | | | | |
| Hatillo | 39.62 | | 2.22 | | | |
| Hormigueros | 11.34 | | | | | |
| Humacao | 30.70 | 1.50 | 3.50 | 4.53 | 1.66 | 3.22 |
| Isabela | 51.21 | 1.17 | 2.68 | 0.34 | | |
| Jayuya | 44.53 | | | | | |
| Juana Diaz | 53.56 | 2.00 | 1.56 | 2.66 | 0.27 | 0.68 |
| Juncos | 26.62 | | | | | |
| Lajas | 52.12 | | 0.45 | 1.82 | 3.39 | 3.57 |
| Lares | 61.64 | | | | | |
| Las Marias | 46.51 | | | | | |
| Las Piedras | 33.89 | | | | | |
| Loiza | 0.35 | 2.02 | 5.73 | 7.20 | 4.65 | 0.59 |
| Luquillo | 19.02 | 1.08 | 3.58 | 2.18 | | |
| Manati | 41.00 | 1.68 | 4.14 | | | |
| Maricao | 36.63 | | | | | |
| Maunabo | 18.64 | 1.05 | 0.95 | 0.44 | | |
| Mayaguez | 68.51 | 3.71 | 3.99 | 1.26 | | 0.50 |
| Moca | 50.37 | | | | | |
| Morovis | 38.93 | | | | | |
| Naguabo | 39.97 | 3.00 | 3.07 | 2.15 | 2.10 | 1.59 |
| Naranjito | 27.75 | | | | | |

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|---------------|---------|-------|--------|--------|-------|-------|
| Orocovis | 63.78 | | | | | |
| Patillas | 43.52 | 0.51 | 1.78 | 1.40 | | |
| Penuelas | 40.47 | | 2.02 | 1.54 | 0.67 | 0.05 |
| Ponce | 98.97 | 1.50 | 4.35 | 5.92 | 5.82 | 0.43 |
| Quebradillas | 21.27 | | 1.72 | 0.16 | | |
| Rincon | 10.60 | | 2.26 | 1.53 | | |
| Rio Grande | 44.99 | 1.25 | 10.29 | 3.55 | 0.73 | |
| Sabana Grande | 35.84 | | | | | |
| Salinas | 58.15 | 1.50 | 1.53 | 3.15 | 2.83 | 2.91 |
| San German | 54.51 | | | | | |
| San Juan | 35.51 | 3.21 | 9.51 | 1.29 | | |
| San Lorenzo | 53.21 | | | | | |
| San Sebastian | 71.22 | | | | | |
| Santa Isabel | 26.97 | | 2.31 | 2.38 | 1.91 | 1.01 |
| Toa Alta | 27.56 | | | | | |
| Toa Baja | 14.89 | 1.71 | 4.86 | 2.35 | | |
| Trujillo Alto | 21.38 | | | | | |
| Utua | 115.07 | | | | | |
| Vega Alta | 26.79 | 0.04 | 0.72 | 0.19 | | |
| Vega Baja | 35.24 | 5.45 | 4.87 | 1.09 | | |
| Vieques | 24.52 | 1.90 | 12.69 | 13.73 | 0.34 | |
| Villalba | 37.04 | | | | | |
| Yabucoa | 48.12 | 2.00 | 4.16 | 1.12 | | |
| Yauco | 68.14 | | 0.25 | 0.43 | | |
| Grand Total | 3060.73 | 63.68 | 159.33 | 113.15 | 48.40 | 18.34 |

Table 33: Percent of (Municipio) Hexagonal Area by Hurricane Category 4 Storm Surge Hazard per Municipio

| Municipio | Category 4 Storm Surge Water Depth Percent Area by Total (Municipio) Land Area | | | | | |
|--------------|--|------------------|-----------------------------|-------------------------|------------------------------|---------------------|
| | None | Low (< 2 ft.) | Medium Low (2 - 3.5 ft.) | Medium (3.5 - 5 ft.) | Medium High (5 - 6.5 ft.) | High (> 6.5 ft.) |
| Adjuntas | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Aguada | 87.04% | 2.15% | 6.78% | 1.82% | 2.22% | 0.00% |
| Aguadilla | 84.21% | 0.86% | 9.43% | 3.29% | 2.22% | 0.00% |
| Aguas Buenas | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Aibonito | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Anasco | 89.09% | 7.31% | 2.66% | 0.94% | 0.00% | 0.00% |
| Arecibo | 83.63% | 8.10% | 6.20% | 2.07% | 0.00% | 0.00% |
| Arroyo | 76.64% | 6.51% | 16.55% | 0.29% | 0.00% | 0.00% |
| Barceloneta | 60.83% | 7.61% | 31.56% | 0.00% | 0.00% | 0.00% |
| Barranquitas | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Bayamon | 93.72% | 1.09% | 1.93% | 2.13% | 1.12% | 0.00% |
| Cabo Rojo | 66.20% | 3.74% | 11.17% | 16.99% | 1.18% | 0.73% |

| | | | | | | |
|-------------|---------|-------|--------|--------|--------|-------|
| Caguas | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Camuy | 95.95% | 0.00% | 4.05% | 0.00% | 0.00% | 0.00% |
| Canovanas | 84.09% | 0.00% | 4.37% | 1.51% | 10.03% | 0.00% |
| Carolina | 65.25% | 5.31% | 12.66% | 5.40% | 10.53% | 0.86% |
| Catano | 4.97% | 0.00% | 50.30% | 24.64% | 20.09% | 0.00% |
| Cayey | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Ceiba | 61.88% | 1.65% | 9.51% | 8.92% | 13.25% | 4.79% |
| Ciales | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Cidra | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Coamo | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Comerio | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Corozal | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Culebra | 24.79% | 0.01% | 42.21% | 32.99% | 0.00% | 0.00% |
| Dorado | 72.23% | 5.95% | 17.97% | 3.85% | 0.00% | 0.00% |
| Fajardo | 70.35% | 0.00% | 6.25% | 14.41% | 6.59% | 2.40% |
| Florida | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Guanica | 71.17% | 0.00% | 6.83% | 15.28% | 6.72% | 0.00% |
| Guayama | 86.54% | 0.76% | 0.37% | 7.23% | 4.11% | 0.99% |
| Guayanilla | 80.00% | 3.06% | 4.56% | 11.23% | 1.15% | 0.00% |
| Guaynabo | 90.67% | 4.98% | 3.26% | 1.09% | 0.00% | 0.00% |
| Gurabo | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Hatillo | 94.70% | 0.00% | 5.30% | 0.00% | 0.00% | 0.00% |
| Hormigueros | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Humacao | 68.06% | 3.33% | 7.76% | 10.04% | 3.67% | 7.14% |
| Isabela | 92.43% | 2.12% | 4.83% | 0.62% | 0.00% | 0.00% |
| Jayuya | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Juana Diaz | 88.20% | 3.29% | 2.57% | 4.37% | 0.45% | 1.12% |
| Juncos | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Lajas | 84.94% | 0.00% | 0.74% | 2.97% | 5.53% | 5.82% |
| Lares | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Las Marias | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Las Piedras | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Loiza | 1.70% | 9.83% | 27.89% | 35.04% | 22.66% | 2.89% |
| Luquillo | 73.56% | 4.19% | 13.83% | 8.43% | 0.00% | 0.00% |
| Manati | 87.56% | 3.60% | 8.84% | 0.00% | 0.00% | 0.00% |
| Maricao | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Maunabo | 88.41% | 5.00% | 4.51% | 2.08% | 0.00% | 0.00% |
| Mayaguez | 87.87% | 4.76% | 5.12% | 1.61% | 0.00% | 0.64% |
| Moca | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Morovis | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Naguabo | 77.04% | 5.78% | 5.92% | 4.14% | 4.04% | 3.07% |
| Naranjito | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |

| | | | | | | |
|---------------|---------|--------|--------|--------|-------|-------|
| Orocovis | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Patillas | 92.18% | 1.09% | 3.76% | 2.96% | 0.00% | 0.00% |
| Penuelas | 90.43% | 0.00% | 4.52% | 3.45% | 1.49% | 0.12% |
| Ponce | 84.60% | 1.28% | 3.71% | 5.06% | 4.98% | 0.36% |
| Quebradillas | 91.90% | 0.00% | 7.42% | 0.68% | 0.00% | 0.00% |
| Rincon | 73.65% | 0.00% | 15.70% | 10.65% | 0.00% | 0.00% |
| Rio Grande | 73.98% | 2.06% | 16.92% | 5.84% | 1.21% | 0.00% |
| Sabana Grande | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Salinas | 83.00% | 2.14% | 2.18% | 4.49% | 4.03% | 4.15% |
| San German | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| San Juan | 71.71% | 6.48% | 19.21% | 2.61% | 0.00% | 0.00% |
| San Lorenzo | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| San Sebastian | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Santa Isabel | 78.00% | 0.00% | 6.68% | 6.88% | 5.51% | 2.93% |
| Toa Alta | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Toa Baja | 62.54% | 7.20% | 20.40% | 9.87% | 0.00% | 0.00% |
| Trujillo Alto | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Utuado | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Vega Alta | 96.57% | 0.15% | 2.58% | 0.70% | 0.00% | 0.00% |
| Vega Baja | 75.55% | 11.68% | 10.44% | 2.33% | 0.00% | 0.00% |
| Vieques | 46.10% | 3.58% | 23.87% | 25.82% | 0.63% | 0.00% |
| Villalba | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Yabucoa | 86.85% | 3.61% | 7.51% | 2.02% | 0.00% | 0.00% |
| Yauco | 99.01% | 0.00% | 0.36% | 0.63% | 0.00% | 0.00% |

Table 34: Percent of (Island) Hexagonal Area by Hurricane Category 4 Storm Surge Hazard per Municipio

| Municipio | Category 4 Storm Surge Water Depth Percent Area by Total (Island) Land Area | | | | | |
|--------------|---|-------------------|------------------------------|--------------------------|-------------------------------|----------------------|
| | None | Low (< 2 ft.) | Medium Low (2 - 3.5 ft.) | Medium (3.5 - 5 ft.) | Medium High (5 - 6.5 ft.) | High (> 6.5 ft.) |
| Adjuntas | 2.19% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Aguada | 0.88% | 1.04% | 1.32% | 0.50% | 1.42% | 0.00% |
| Aguadilla | 1.01% | 0.49% | 2.17% | 1.06% | 1.68% | 0.00% |
| Aguas Buenas | 0.98% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Aibonito | 1.02% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Anasco | 1.15% | 4.54% | 0.66% | 0.33% | 0.00% | 0.00% |
| Arecibo | 3.47% | 16.15% | 4.94% | 2.33% | 0.00% | 0.00% |
| Arroyo | 0.38% | 1.54% | 1.56% | 0.04% | 0.00% | 0.00% |
| Barceloneta | 0.37% | 2.24% | 3.72% | 0.00% | 0.00% | 0.00% |
| Barranquitas | 1.12% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Bayamon | 1.36% | 0.76% | 0.54% | 0.84% | 1.03% | 0.00% |
| Cabo Rojo | 1.58% | 4.29% | 5.12% | 10.98% | 1.78% | 2.93% |
| Caguas | 1.93% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |

| | | | | | | |
|-------------|-------|-------|-------|-------|--------|--------|
| Camuy | 1.45% | 0.00% | 1.18% | 0.00% | 0.00% | 0.00% |
| Canovanas | 0.91% | 0.00% | 0.90% | 0.44% | 6.84% | 0.00% |
| Carolina | 1.01% | 3.94% | 3.76% | 2.26% | 10.29% | 2.22% |
| Catano | 0.01% | 0.00% | 1.60% | 1.11% | 2.11% | 0.00% |
| Cayey | 1.70% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Ceiba | 0.61% | 0.79% | 1.81% | 2.40% | 8.32% | 7.93% |
| Ciales | 2.18% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Cidra | 1.19% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Coamo | 2.55% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Comerio | 0.93% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Corozal | 1.39% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Culebra | 0.11% | 0.00% | 3.53% | 3.88% | 0.00% | 0.00% |
| Dorado | 0.55% | 2.19% | 2.64% | 0.80% | 0.00% | 0.00% |
| Fajardo | 0.70% | 0.00% | 1.20% | 3.89% | 4.15% | 4.00% |
| Florida | 0.50% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Guanica | 0.91% | 0.00% | 1.67% | 5.27% | 5.42% | 0.00% |
| Guayama | 1.86% | 0.79% | 0.15% | 4.21% | 5.59% | 3.55% |
| Guayanilla | 1.12% | 2.06% | 1.23% | 4.27% | 1.03% | 0.00% |
| Guaynabo | 0.82% | 2.17% | 0.57% | 0.27% | 0.00% | 0.00% |
| Gurabo | 0.93% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Hatillo | 1.29% | 0.00% | 1.39% | 0.00% | 0.00% | 0.00% |
| Hormigueros | 0.37% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Humacao | 1.00% | 2.36% | 2.20% | 4.00% | 3.42% | 17.55% |
| Isabela | 1.67% | 1.84% | 1.68% | 0.30% | 0.00% | 0.00% |
| Jayuya | 1.46% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Juana Diaz | 1.75% | 3.14% | 0.98% | 2.35% | 0.56% | 3.70% |
| Juncos | 0.87% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Lajas | 1.70% | 0.00% | 0.29% | 1.61% | 7.01% | 19.48% |
| Lares | 2.01% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Las Marias | 1.52% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Las Piedras | 1.11% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Loiza | 0.01% | 3.17% | 3.59% | 6.36% | 9.61% | 3.24% |
| Luquillo | 0.62% | 1.70% | 2.24% | 1.93% | 0.00% | 0.00% |
| Manati | 1.34% | 2.64% | 2.60% | 0.00% | 0.00% | 0.00% |
| Maricao | 1.20% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Maunabo | 0.61% | 1.66% | 0.60% | 0.39% | 0.00% | 0.00% |
| Mayaguez | 2.24% | 5.83% | 2.50% | 1.11% | 0.00% | 2.73% |
| Moca | 1.65% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Morovis | 1.27% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Naguabo | 1.31% | 4.71% | 1.93% | 1.90% | 4.33% | 8.69% |
| Naranjito | 0.91% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Orocovis | 2.08% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |

| | | | | | | |
|---------------|-------|-------|-------|--------|--------|--------|
| Patillas | 1.42% | 0.81% | 1.12% | 1.24% | 0.00% | 0.00% |
| Penuelas | 1.32% | 0.00% | 1.27% | 1.36% | 1.37% | 0.29% |
| Ponce | 3.23% | 2.36% | 2.73% | 5.23% | 12.03% | 2.32% |
| Quebradillas | 0.69% | 0.00% | 1.08% | 0.14% | 0.00% | 0.00% |
| Rincon | 0.35% | 0.00% | 1.42% | 1.35% | 0.00% | 0.00% |
| Rio Grande | 1.47% | 1.96% | 6.46% | 3.14% | 1.52% | 0.00% |
| Sabana Grande | 1.17% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Salinas | 1.90% | 2.36% | 0.96% | 2.78% | 5.84% | 15.87% |
| San German | 1.78% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| San Juan | 1.16% | 5.04% | 5.97% | 1.14% | 0.00% | 0.00% |
| San Lorenzo | 1.74% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| San Sebastian | 2.33% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Santa Isabel | 0.88% | 0.00% | 1.45% | 2.10% | 3.94% | 5.52% |
| Toa Alta | 0.90% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Toa Baja | 0.49% | 2.69% | 3.05% | 2.08% | 0.00% | 0.00% |
| Trujillo Alto | 0.70% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Utua | 3.76% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Vega Alta | 0.88% | 0.06% | 0.45% | 0.17% | 0.00% | 0.00% |
| Vega Baja | 1.15% | 8.55% | 3.06% | 0.96% | 0.00% | 0.00% |
| Vieques | 0.80% | 2.99% | 7.97% | 12.14% | 0.70% | 0.00% |
| Villalba | 1.21% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Yabucoa | 1.57% | 3.14% | 2.61% | 0.99% | 0.00% | 0.00% |
| Yauco | 2.23% | 0.00% | 0.15% | 0.38% | 0.00% | 0.00% |

Table 35: Category 4 Storm Surge Hazard Scores and Ranks by Municipio

| Municipio | Hurricane Category 4 Storm Surge Hazard Score (Log Multiplied) | | |
|--------------|--|--------------------------|----------------------|
| | Total Score | Standardized Score (0-1) | Rank of Score (1-78) |
| Lajas | 10596.3214 | 1.0000 | 1 |
| Humacao | 9331.2624 | 0.8806 | 2 |
| Salinas | 8655.4331 | 0.8168 | 3 |
| Naguabo | 4839.4604 | 0.4567 | 4 |
| Ceiba | 4784.8214 | 0.4516 | 5 |
| Santa Isabel | 3178.1529 | 0.2999 | 6 |
| Loiza | 2517.5095 | 0.2376 | 7 |
| Fajardo | 2430.6567 | 0.2294 | 8 |
| Guayama | 2323.8240 | 0.2193 | 9 |
| Ponce | 2237.8924 | 0.2112 | 10 |
| Carolina | 2016.3969 | 0.1903 | 11 |
| Juana Diaz | 1966.5684 | 0.1856 | 12 |
| Cabo Rojo | 1748.4441 | 0.165 | 13 |
| Mayaguez | 1412.3602 | 0.1333 | 14 |

| | | | |
|--------------|----------|--------|----|
| Canovanas | 573.3036 | 0.0541 | 15 |
| Guanica | 496.5264 | 0.0469 | 16 |
| Penuelas | 273.4937 | 0.0258 | 17 |
| Catano | 186.5175 | 0.0176 | 18 |
| Vieques | 168.1433 | 0.0159 | 19 |
| Rio Grande | 160.0585 | 0.0151 | 20 |
| Aguadilla | 151.0817 | 0.0143 | 21 |
| Aguada | 123.7794 | 0.0117 | 22 |
| Guayanilla | 122.0075 | 0.0115 | 23 |
| Bayamon | 93.4898 | 0.0088 | 24 |
| Culebra | 36.3921 | 0.0034 | 25 |
| Arecibo | 26.3630 | 0.0025 | 26 |
| Toa Baja | 21.0936 | 0.002 | 27 |
| Luquillo | 18.7889 | 0.0018 | 28 |
| San Juan | 17.2050 | 0.0016 | 29 |
| Rincon | 12.9390 | 0.0012 | 30 |
| Vega Baja | 12.2929 | 0.0012 | 30 |
| Patillas | 11.6424 | 0.0011 | 32 |
| Yabucoa | 11.6340 | 0.0011 | 32 |
| Dorado | 10.0193 | 0.0009 | 34 |
| Barceloneta | 4.8024 | 0.0005 | 35 |
| Anasco | 3.8244 | 0.0004 | 36 |
| Isabela | 4.7262 | 0.0004 | 36 |
| Maunabo | 4.0413 | 0.0004 | 36 |
| Guaynabo | 3.0573 | 0.0003 | 39 |
| Manati | 3.4247 | 0.0003 | 39 |
| Yauco | 3.3540 | 0.0003 | 39 |
| Arroyo | 2.3789 | 0.0002 | 42 |
| Hatillo | 1.7474 | 0.0002 | 42 |
| Quebradillas | 2.4904 | 0.0002 | 42 |
| Vega Alta | 1.9817 | 0.0002 | 42 |
| Camuy | 1.4789 | 0.0001 | 46 |
| Adjuntas | 0.0000 | 0.0000 | 47 |
| Aguas Buenas | 0.0000 | 0.0000 | 47 |
| Aibonito | 0.0000 | 0.0000 | 47 |
| Barranquitas | 0.0000 | 0.0000 | 47 |
| Caguas | 0.0000 | 0.0000 | 47 |
| Cayey | 0.0000 | 0.0000 | 47 |
| Ciales | 0.0000 | 0.0000 | 47 |
| Cidra | 0.0000 | 0.0000 | 47 |
| Coamo | 0.0000 | 0.0000 | 47 |
| Comerio | 0.0000 | 0.0000 | 47 |

| | | | |
|---------------|--------|--------|----|
| Corozal | 0.0000 | 0.0000 | 47 |
| Florida | 0.0000 | 0.0000 | 47 |
| Gurabo | 0.0000 | 0.0000 | 47 |
| Hormigueros | 0.0000 | 0.0000 | 47 |
| Jayuya | 0.0000 | 0.0000 | 47 |
| Juncos | 0.0000 | 0.0000 | 47 |
| Lares | 0.0000 | 0.0000 | 47 |
| Las Marias | 0.0000 | 0.0000 | 47 |
| Las Piedras | 0.0000 | 0.0000 | 47 |
| Maricao | 0.0000 | 0.0000 | 47 |
| Moca | 0.0000 | 0.0000 | 47 |
| Morovis | 0.0000 | 0.0000 | 47 |
| Naranjito | 0.0000 | 0.0000 | 47 |
| Orocovis | 0.0000 | 0.0000 | 47 |
| Sabana Grande | 0.0000 | 0.0000 | 47 |
| San German | 0.0000 | 0.0000 | 47 |
| San Lorenzo | 0.0000 | 0.0000 | 47 |
| San Sebastian | 0.0000 | 0.0000 | 47 |
| Toa Alta | 0.0000 | 0.0000 | 47 |
| Trujillo Alto | 0.0000 | 0.0000 | 47 |
| Utado | 0.0000 | 0.0000 | 47 |
| Villalba | 0.0000 | 0.0000 | 47 |

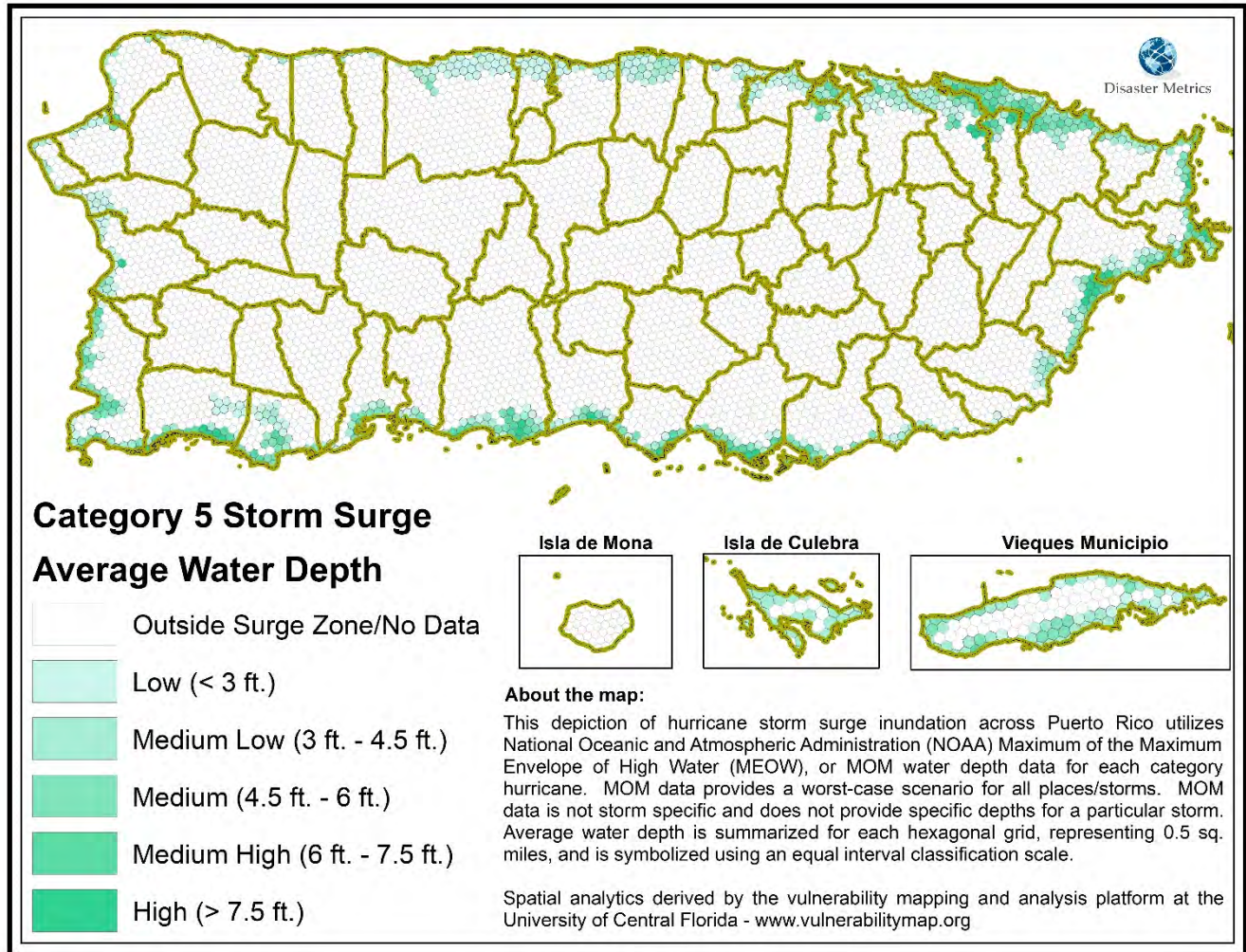


Figure 14: Hurricane Category 5 Storm Surge Hazard Areas

Table 36: Hurricane Category 5 Storm Surge Hazard by Municipio and Areal Extent

| Municipio | HEX GRID Area by Category 5 Storm Surge Water Depth (Sq. miles) | | | | | |
|--------------|---|---------------|--------------------------|----------------------|---------------------------|------------------|
| | None | Low (< 3 ft.) | Medium Low (3 - 4.5 ft.) | Medium (4.5 - 6 ft.) | Medium High (6 - 7.5 ft.) | High (> 7.5 ft.) |
| Adjuntas | 67.10 | | | | | |
| Aguada | 25.92 | 3.19 | 0.66 | 0.96 | 0.20 | |
| Aguadilla | 30.83 | 1.63 | 2.99 | 0.35 | 0.80 | |
| Aguas Buenas | 30.10 | | | | | |
| Aibonito | 31.34 | | | | | |
| Anasco | 32.75 | 5.83 | 0.98 | | | |
| Arecibo | 106.69 | 16.18 | 3.46 | 0.64 | | |
| Arroyo | 11.53 | 2.28 | 1.24 | | | |
| Barceloneta | 10.91 | 7.28 | 0.56 | | | |
| Barranquitas | 34.28 | | | | | |
| Bayamon | 40.47 | 0.99 | 1.13 | 1.17 | 0.75 | |
| Cabo Rojo | 46.90 | 4.64 | 6.85 | 10.54 | 3.64 | 0.54 |

| | | | | | | |
|-------------|-------|------|------|------|------|------|
| Caguas | 59.07 | | | | | |
| Camuy | 44.49 | 0.58 | 1.30 | | | |
| Canovanas | 26.24 | 1.39 | 0.91 | 1.48 | 0.84 | 2.15 |
| Carolina | 28.38 | 4.54 | 5.41 | 4.15 | 1.53 | 3.29 |
| Catano | | 0.55 | 1.91 | 1.35 | 1.27 | |
| Cayey | 51.96 | | | | | |
| Ceiba | 17.35 | 2.17 | 3.00 | 2.90 | 3.38 | 1.58 |
| Ciales | 66.71 | | | | | |
| Cidra | 36.46 | | | | | |
| Coamo | 78.03 | | | | | |
| Comerio | 28.52 | | | | | |
| Corozal | 42.58 | | | | | |
| Culebra | 3.30 | 0.25 | 9.49 | 0.27 | | |
| Dorado | 15.92 | 5.00 | 2.18 | 0.32 | | |
| Fajardo | 21.41 | 0.73 | 1.29 | 5.30 | 0.78 | 1.01 |
| Florida | 15.22 | | | | | |
| Guanica | 22.46 | 5.30 | 3.22 | 5.40 | 2.62 | 0.00 |
| Guayama | 56.50 | 1.18 | 0.77 | 4.56 | 1.87 | 0.98 |
| Guayanilla | 34.39 | 1.31 | 2.26 | 4.09 | 0.65 | 0.30 |
| Guaynabo | 25.53 | 0.98 | 0.96 | 0.30 | | |
| Gurabo | 28.31 | | | | | |
| Hatillo | 39.62 | 0.51 | 1.71 | | | |
| Hormigueros | 11.34 | | | | | |
| Humacao | 30.20 | 2.50 | 3.10 | 4.43 | 1.66 | 3.22 |
| Isabela | 51.21 | 2.84 | 1.35 | | | |
| Jayuya | 44.53 | | | | | |
| Juana Diaz | 53.06 | 3.00 | 1.13 | 2.15 | 0.71 | 0.68 |
| Juncos | 26.62 | | | | | |
| Lajas | 46.92 | 5.20 | 1.45 | 0.82 | 3.15 | 3.81 |
| Lares | 61.64 | | | | | |
| Las Marias | 46.51 | | | | | |
| Las Piedras | 33.89 | | | | | |
| Loiza | 0.35 | 2.23 | 2.45 | 5.61 | 7.35 | 2.55 |
| Luquillo | 19.02 | 1.08 | 4.61 | 1.15 | | |
| Manati | 38.63 | 6.83 | 1.37 | | | |
| Maricao | 36.63 | | | | | |
| Maunabo | 18.64 | 1.81 | 0.62 | 0.01 | | |
| Mayaguez | 68.00 | 6.88 | 2.16 | 0.43 | | 0.50 |
| Moca | 50.37 | | | | | |
| Morovis | 38.93 | | | | | |
| Naguabo | 38.97 | 5.32 | 1.75 | 2.29 | 1.96 | 1.59 |
| Naranjito | 27.75 | | | | | |

| | | | | | | | |
|---------------|---------|--------|--------|-------|-------|-------|--|
| Orocovis | 63.78 | | | | | | |
| Patillas | 43.52 | 0.67 | 2.82 | 0.20 | | | |
| Penuelas | 40.47 | 0.50 | 2.02 | 1.54 | 0.11 | 0.11 | |
| Ponce | 98.97 | 2.50 | 5.00 | 4.15 | 4.71 | 1.66 | |
| Quebradillas | 21.27 | 1.03 | 0.84 | | | | |
| Rincon | 10.60 | 1.06 | 2.73 | | | | |
| Rio Grande | 44.99 | 1.59 | 4.69 | 6.16 | 3.39 | | |
| Sabana Grande | 35.84 | | | | | | |
| Salinas | 57.65 | 2.50 | 1.11 | 2.66 | 2.64 | 3.50 | |
| San German | 54.51 | | | | | | |
| San Juan | 34.16 | 7.42 | 6.47 | 0.98 | 0.50 | | |
| San Lorenzo | 53.21 | | | | | | |
| San Sebastian | 71.22 | | | | | | |
| Santa Isabel | 26.47 | 0.99 | 1.35 | 3.34 | 1.23 | 1.19 | |
| Toa Alta | 27.56 | | | | | | |
| Toa Baja | 12.39 | 7.60 | 3.28 | 0.54 | | | |
| Trujillo Alto | 21.38 | | | | | | |
| Utuado | 115.07 | | | | | | |
| Vega Alta | 26.29 | 1.45 | | | | | |
| Vega Baja | 32.11 | 7.76 | 6.36 | 0.41 | | | |
| Vieques | 23.02 | 6.59 | 15.62 | 7.62 | 0.34 | | |
| Villalba | 37.04 | | | | | | |
| Yabucoa | 47.62 | 3.47 | 3.40 | 0.91 | | | |
| Yauco | 68.14 | | 0.68 | | | | |
| Grand Total | 3021.73 | 149.32 | 128.66 | 89.16 | 46.08 | 28.68 | |

Table 37: Percent of (Municipio) Hexagonal Area by Hurricane Category 5 Storm Surge Hazard per Municipio

| Municipio | Category 5 Storm Surge Water Depth Percent Area by Total (Municipio) Land Area | | | | | |
|--------------|--|------------------|-----------------------------|-------------------------|------------------------------|---------------------|
| | None | Low (< 3 ft.) | Medium Low (3 - 4.5 ft.) | Medium (4.5 - 6 ft.) | Medium High (6 - 7.5 ft.) | High (> 7.5 ft.) |
| Adjuntas | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Aguada | 83.80% | 10.31% | 2.15% | 3.10% | 0.64% | 0.00% |
| Aguadilla | 84.21% | 4.47% | 8.18% | 0.96% | 2.19% | 0.00% |
| Aguas Buenas | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Aibonito | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Anasco | 82.80% | 14.73% | 2.48% | 0.00% | 0.00% | 0.00% |
| Arecibo | 84.02% | 12.74% | 2.73% | 0.50% | 0.00% | 0.00% |
| Arroyo | 76.64% | 15.13% | 8.23% | 0.00% | 0.00% | 0.00% |
| Barceloneta | 58.17% | 38.83% | 3.00% | 0.00% | 0.00% | 0.00% |
| Barranquitas | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Bayamon | 90.92% | 2.21% | 2.55% | 2.64% | 1.68% | 0.00% |
| Cabo Rojo | 64.15% | 6.35% | 9.37% | 14.42% | 4.98% | 0.73% |

| | | | | | | |
|-------------|---------|--------|--------|--------|--------|--------|
| Caguas | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Camuy | 95.95% | 1.25% | 2.80% | 0.00% | 0.00% | 0.00% |
| Canovanas | 79.51% | 4.20% | 2.74% | 4.47% | 2.56% | 6.52% |
| Carolina | 59.99% | 9.60% | 11.44% | 8.76% | 3.24% | 6.96% |
| Catano | 0.00% | 10.88% | 37.48% | 26.58% | 25.06% | 0.00% |
| Cayey | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Ceiba | 57.13% | 7.13% | 9.88% | 9.53% | 11.12% | 5.20% |
| Ciales | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Cidra | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Coamo | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Comerio | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Corozal | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Culebra | 24.79% | 1.90% | 71.30% | 2.02% | 0.00% | 0.00% |
| Dorado | 67.97% | 21.35% | 9.32% | 1.36% | 0.00% | 0.00% |
| Fajardo | 70.16% | 2.39% | 4.22% | 17.36% | 2.55% | 3.32% |
| Florida | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Guanica | 57.58% | 13.58% | 8.26% | 13.85% | 6.72% | 0.00% |
| Guayama | 85.78% | 1.78% | 1.18% | 6.92% | 2.84% | 1.49% |
| Guayanilla | 80.00% | 3.06% | 5.25% | 9.50% | 1.50% | 0.69% |
| Guaynabo | 91.95% | 3.52% | 3.44% | 1.09% | 0.00% | 0.00% |
| Gurabo | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Hatillo | 94.70% | 1.22% | 4.09% | 0.00% | 0.00% | 0.00% |
| Hormigueros | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Humacao | 66.95% | 5.54% | 6.88% | 9.82% | 3.67% | 7.14% |
| Isabela | 92.43% | 5.13% | 2.44% | 0.00% | 0.00% | 0.00% |
| Jayuya | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Juana Diaz | 87.38% | 4.94% | 1.86% | 3.54% | 1.17% | 1.12% |
| Juncos | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Lajas | 76.46% | 8.48% | 2.37% | 1.34% | 5.14% | 6.22% |
| Lares | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Las Marias | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Las Piedras | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Loiza | 1.70% | 10.84% | 11.91% | 27.33% | 35.78% | 12.44% |
| Luquillo | 73.56% | 4.19% | 17.82% | 4.43% | 0.00% | 0.00% |
| Manati | 82.50% | 14.58% | 2.92% | 0.00% | 0.00% | 0.00% |
| Maricao | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Maunabo | 88.41% | 8.60% | 2.93% | 0.07% | 0.00% | 0.00% |
| Mayaguez | 87.22% | 8.82% | 2.77% | 0.55% | 0.00% | 0.64% |
| Moca | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Morovis | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Naguabo | 75.11% | 10.26% | 3.37% | 4.40% | 3.78% | 3.07% |
| Naranjito | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |

| | | | | | | |
|---------------|---------|--------|--------|--------|-------|-------|
| Orocovis | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Patillas | 92.18% | 1.42% | 5.97% | 0.42% | 0.00% | 0.00% |
| Penuelas | 90.43% | 1.12% | 4.52% | 3.45% | 0.24% | 0.25% |
| Ponce | 84.60% | 2.14% | 4.27% | 3.54% | 4.02% | 1.42% |
| Quebradillas | 91.90% | 4.47% | 3.63% | 0.00% | 0.00% | 0.00% |
| Rincon | 73.65% | 7.35% | 19.00% | 0.00% | 0.00% | 0.00% |
| Rio Grande | 73.98% | 2.61% | 7.71% | 10.12% | 5.58% | 0.00% |
| Sabana Grande | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Salinas | 82.28% | 3.57% | 1.58% | 3.80% | 3.77% | 5.00% |
| San German | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| San Juan | 68.97% | 14.98% | 13.06% | 1.97% | 1.01% | 0.00% |
| San Lorenzo | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| San Sebastian | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Santa Isabel | 76.55% | 2.87% | 3.91% | 9.67% | 3.57% | 3.43% |
| Toa Alta | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Toa Baja | 52.04% | 31.91% | 13.80% | 2.26% | 0.00% | 0.00% |
| Trujillo Alto | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Utuado | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Vega Alta | 94.77% | 5.23% | 0.00% | 0.00% | 0.00% | 0.00% |
| Vega Baja | 68.85% | 16.64% | 13.63% | 0.89% | 0.00% | 0.00% |
| Vieques | 43.28% | 12.38% | 29.38% | 14.33% | 0.63% | 0.00% |
| Villalba | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Yabucoa | 85.95% | 6.27% | 6.13% | 1.65% | 0.00% | 0.00% |
| Yauco | 99.01% | 0.00% | 0.99% | 0.00% | 0.00% | 0.00% |

Table 38: Percent of (Island) Hexagonal Area by Hurricane Category 5 Storm Surge Hazard per Municipio

| Municipio | Category 5 Storm Surge Water Depth Percent Area by Total (Island) Land Area | | | | | |
|--------------|---|------------------|-----------------------------|-------------------------|------------------------------|---------------------|
| | None | Low (< 3 ft.) | Medium Low (3 - 4.5 ft.) | Medium (4.5 - 6 ft.) | Medium High (6 - 7.5 ft.) | High (> 7.5 ft.) |
| Adjuntas | 2.22% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Aguada | 0.86% | 2.13% | 0.52% | 1.07% | 0.43% | 0.00% |
| Aguadilla | 1.02% | 1.09% | 2.33% | 0.39% | 1.74% | 0.00% |
| Aguas Buenas | 1.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Aibonito | 1.04% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Anasco | 1.08% | 3.90% | 0.76% | 0.00% | 0.00% | 0.00% |
| Arecibo | 3.53% | 10.84% | 2.69% | 0.72% | 0.00% | 0.00% |
| Arroyo | 0.38% | 1.52% | 0.96% | 0.00% | 0.00% | 0.00% |
| Barceloneta | 0.36% | 4.88% | 0.44% | 0.00% | 0.00% | 0.00% |
| Barranquitas | 1.13% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Bayamon | 1.34% | 0.66% | 0.88% | 1.32% | 1.62% | 0.00% |
| Cabo Rojo | 1.55% | 3.11% | 5.33% | 11.82% | 7.90% | 1.87% |
| Caguas | 1.95% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |

| | | | | | | |
|-------------|-------|-------|-------|-------|--------|--------|
| Camuy | 1.47% | 0.39% | 1.01% | 0.00% | 0.00% | 0.00% |
| Canovanas | 0.87% | 0.93% | 0.70% | 1.66% | 1.83% | 7.50% |
| Carolina | 0.94% | 3.04% | 4.21% | 4.65% | 3.33% | 11.48% |
| Catano | 0.00% | 0.37% | 1.48% | 1.52% | 2.77% | 0.00% |
| Cayey | 1.72% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Ceiba | 0.57% | 1.45% | 2.33% | 3.25% | 7.33% | 5.51% |
| Ciales | 2.21% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Cidra | 1.21% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Coamo | 2.58% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Comerio | 0.94% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Corozal | 1.41% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Culebra | 0.11% | 0.17% | 7.37% | 0.30% | 0.00% | 0.00% |
| Dorado | 0.53% | 3.35% | 1.70% | 0.36% | 0.00% | 0.00% |
| Fajardo | 0.71% | 0.49% | 1.00% | 5.94% | 1.69% | 3.53% |
| Florida | 0.50% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Guanica | 0.74% | 3.55% | 2.50% | 6.06% | 5.69% | 0.00% |
| Guayama | 1.87% | 0.79% | 0.60% | 5.11% | 4.06% | 3.43% |
| Guayanilla | 1.14% | 0.88% | 1.76% | 4.58% | 1.40% | 1.04% |
| Guaynabo | 0.84% | 0.65% | 0.74% | 0.34% | 0.00% | 0.00% |
| Gurabo | 0.94% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Hatillo | 1.31% | 0.34% | 1.33% | 0.00% | 0.00% | 0.00% |
| Hormigueros | 0.38% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Humacao | 1.00% | 1.67% | 2.41% | 4.97% | 3.59% | 11.22% |
| Isabela | 1.69% | 1.90% | 1.05% | 0.00% | 0.00% | 0.00% |
| Jayuya | 1.47% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Juana Diaz | 1.76% | 2.01% | 0.88% | 2.41% | 1.54% | 2.37% |
| Juncos | 0.88% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Lajas | 1.55% | 3.48% | 1.13% | 0.92% | 6.84% | 13.30% |
| Lares | 2.04% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Las Marias | 1.54% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Las Piedras | 1.12% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Loiza | 0.01% | 1.49% | 1.90% | 6.29% | 15.94% | 8.91% |
| Luquillo | 0.63% | 0.73% | 3.58% | 1.28% | 0.00% | 0.00% |
| Manati | 1.28% | 4.57% | 1.06% | 0.00% | 0.00% | 0.00% |
| Maricao | 1.21% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Maunabo | 0.62% | 1.21% | 0.48% | 0.02% | 0.00% | 0.00% |
| Mayaguez | 2.25% | 4.61% | 1.68% | 0.48% | 0.00% | 1.74% |
| Moca | 1.67% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Morovis | 1.29% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Naguabo | 1.29% | 3.57% | 1.36% | 2.56% | 4.26% | 5.56% |
| Naranjito | 0.92% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Orocovis | 2.11% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |

| | | | | | | |
|---------------|-------|-------|--------|-------|--------|--------|
| Patillas | 1.44% | 0.45% | 2.19% | 0.22% | 0.00% | 0.00% |
| Penuelas | 1.34% | 0.33% | 1.57% | 1.73% | 0.23% | 0.39% |
| Ponce | 3.28% | 1.67% | 3.88% | 4.65% | 10.21% | 5.80% |
| Quebradillas | 0.70% | 0.69% | 0.65% | 0.00% | 0.00% | 0.00% |
| Rincon | 0.35% | 0.71% | 2.13% | 0.00% | 0.00% | 0.00% |
| Rio Grande | 1.49% | 1.06% | 3.64% | 6.90% | 7.36% | 0.00% |
| Sabana Grande | 1.19% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Salinas | 1.91% | 1.67% | 0.86% | 2.98% | 5.73% | 12.21% |
| San German | 1.80% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| San Juan | 1.13% | 4.97% | 5.03% | 1.09% | 1.09% | 0.00% |
| San Lorenzo | 1.76% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| San Sebastian | 2.36% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Santa Isabel | 0.88% | 0.66% | 1.05% | 3.75% | 2.68% | 4.14% |
| Toa Alta | 0.91% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Toa Baja | 0.41% | 5.09% | 2.55% | 0.60% | 0.00% | 0.00% |
| Trujillo Alto | 0.71% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Utua | 3.81% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Vega Alta | 0.87% | 0.97% | 0.00% | 0.00% | 0.00% | 0.00% |
| Vega Baja | 1.06% | 5.20% | 4.94% | 0.46% | 0.00% | 0.00% |
| Vieques | 0.76% | 4.41% | 12.14% | 8.55% | 0.73% | 0.00% |
| Villalba | 1.23% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Yabucoa | 1.58% | 2.32% | 2.64% | 1.02% | 0.00% | 0.00% |
| Yauco | 2.25% | 0.00% | 0.53% | 0.00% | 0.00% | 0.00% |

Table 39: Category 5 Storm Surge Hazard Scores and Ranks by Municipio

| Municipio | Hurricane Category 5 Storm Surge Hazard Score (Log Multiplied) | | |
|--------------|--|--------------------------|----------------------|
| | Total Score | Standardized Score (0-1) | Rank of Score (1-78) |
| Lajas | 10438.0640 | 1.0000 | 1 |
| Salinas | 9569.7114 | 0.9168 | 2 |
| Carolina | 8885.3158 | 0.8512 | 3 |
| Humacao | 8709.2810 | 0.8344 | 4 |
| Loiza | 7753.2376 | 0.7428 | 5 |
| Canovanas | 5772.8938 | 0.5531 | 6 |
| Ponce | 5044.5718 | 0.4833 | 7 |
| Ceiba | 4632.9955 | 0.4439 | 8 |
| Naguabo | 4468.3742 | 0.4281 | 9 |
| Santa Isabel | 3310.1225 | 0.3171 | 10 |
| Guayama | 2877.0056 | 0.2756 | 11 |
| Fajardo | 2814.5156 | 0.2696 | 12 |
| Cabo Rojo | 2008.4657 | 0.1924 | 13 |
| Juana Diaz | 1896.7247 | 0.1817 | 14 |

| | | | |
|--------------|-----------|--------|----|
| Mayaguez | 1316.7920 | 0.1262 | 15 |
| Guayanilla | 907.4509 | 0.0869 | 16 |
| Rio Grande | 523.3309 | 0.0501 | 17 |
| Guanica | 411.3057 | 0.0394 | 18 |
| Penuelas | 322.8076 | 0.0309 | 19 |
| Catano | 187.5036 | 0.018 | 20 |
| Vieques | 128.6291 | 0.0123 | 21 |
| Aguadilla | 114.3571 | 0.011 | 22 |
| Bayamon | 113.6448 | 0.0109 | 23 |
| San Juan | 81.9124 | 0.0078 | 24 |
| Aguada | 36.7976 | 0.0035 | 25 |
| Luquillo | 13.8820 | 0.0013 | 26 |
| Yabucoa | 11.0548 | 0.0011 | 27 |
| Arecibo | 9.2919 | 0.0009 | 28 |
| Culebra | 8.6345 | 0.0008 | 29 |
| Vega Baja | 8.4675 | 0.0008 | 29 |
| Toa Baja | 7.6673 | 0.0007 | 31 |
| Dorado | 4.7245 | 0.0005 | 32 |
| Patillas | 3.7351 | 0.0004 | 33 |
| Guaynabo | 3.5516 | 0.0003 | 34 |
| Rincon | 1.8156 | 0.0002 | 35 |
| Anasco | 0.9875 | 0.0001 | 36 |
| Arroyo | 0.9330 | 0.0001 | 36 |
| Barceloneta | 0.8107 | 0.0001 | 36 |
| Camuy | 0.8672 | 0.0001 | 36 |
| Hatillo | 1.1256 | 0.0001 | 36 |
| Isabela | 1.0409 | 0.0001 | 36 |
| Manati | 1.2963 | 0.0001 | 36 |
| Maunabo | 0.6432 | 0.0001 | 36 |
| Quebradillas | 0.6010 | 0.0001 | 36 |
| Adjuntas | 0.0000 | 0.0000 | 45 |
| Aguas Buenas | 0.0000 | 0.0000 | 45 |
| Aibonito | 0.0000 | 0.0000 | 45 |
| Barranquitas | 0.0000 | 0.0000 | 45 |
| Caguas | 0.0000 | 0.0000 | 45 |
| Cayey | 0.0000 | 0.0000 | 45 |
| Ciales | 0.0000 | 0.0000 | 45 |
| Cidra | 0.0000 | 0.0000 | 45 |
| Coamo | 0.0000 | 0.0000 | 45 |
| Comerio | 0.0000 | 0.0000 | 45 |
| Corozal | 0.0000 | 0.0000 | 45 |
| Florida | 0.0000 | 0.0000 | 45 |

| | | | |
|---------------|--------|--------|----|
| Gurabo | 0.0000 | 0.0000 | 45 |
| Hormigueros | 0.0000 | 0.0000 | 45 |
| Jayuya | 0.0000 | 0.0000 | 45 |
| Juncos | 0.0000 | 0.0000 | 45 |
| Lares | 0.0000 | 0.0000 | 45 |
| Las Marias | 0.0000 | 0.0000 | 45 |
| Las Piedras | 0.0000 | 0.0000 | 45 |
| Maricao | 0.0000 | 0.0000 | 45 |
| Moca | 0.0000 | 0.0000 | 45 |
| Morovis | 0.0000 | 0.0000 | 45 |
| Naranjito | 0.0000 | 0.0000 | 45 |
| Orocovis | 0.0000 | 0.0000 | 45 |
| Sabana Grande | 0.0000 | 0.0000 | 45 |
| San German | 0.0000 | 0.0000 | 45 |
| San Lorenzo | 0.0000 | 0.0000 | 45 |
| San Sebastian | 0.0000 | 0.0000 | 45 |
| Toa Alta | 0.0000 | 0.0000 | 45 |
| Trujillo Alto | 0.0000 | 0.0000 | 45 |
| Utuado | 0.0000 | 0.0000 | 45 |
| Vega Alta | 0.0897 | 0.0000 | 45 |
| Villalba | 0.0000 | 0.0000 | 45 |
| Yauco | 0.4349 | 0.0000 | 45 |

Earthquakes

Hazard Overview

As most of the Caribbean, Puerto Rico is subject to significant threat from earthquakes. Earthquakes represent a particularly severe threat due to irregular time intervals between these events, lack of adequate forecasts and the catastrophic damage that can occur as a result of a significant event of this nature.

An earthquake is caused by the release of stored energy within or along the edge of the tectonic plates of the Earth. They are characterized by a sudden shaking of the earth. The severity of an earthquake depends on its place of origin (epicenter) and the amount of energy released. Upon the occurrence of the earthquake, seismic waves radiate from the earthquake source, causing the shaking of the earth. The severity of the tremor increases as energy is released, and decreases according to its distance from the epicenter. The tremors can be felt hundreds of miles from its epicenter. The intensity of shaking is the result of several factors, such as: the extent and type of earthquake, the distance from this, the area's soil conditions, and the relative orientation of the site with respect to the seismic event.

Among the damages earthquakes can cause are liquefaction, landslides, and significant damage to buildings and infrastructure. Liquefaction is a phenomenon that causes unconsolidated soils to lose their strength and act like a viscous fluid (like quicksand) when these soils are subject to tremors due to an earthquake. The frequency and intensity of liquefaction that can occur during an earthquake is due to several factors including: the geological conditions of the area, groundwater depth, the tremor severity, and magnitude of the earthquake.

Earthquakes can cause landslides and other types of soil failures. Landslides are sudden movements of materials that emerge from the hills or mountains, free fall, sliding or rolling down. Landslides caused by earthquakes can occur on natural slopes, cut slopes on the ground, eroded rocks, or filled slopes. They are common in areas where they are abruptly cut off the slopes, on plain soils or fractured eroded rock. The frequency and intensity of landslides that may occur during an earthquake is due to several factors, including: geological materials contained in the area, the steepness of the slope, the water content of the material that slides, trembling land and the magnitude of the earthquake.

Data and Methods

The United States Geological Survey (USGS), charged with overseeing all geophysical hazard activity in the United State and its protectorates, has completed several studies of earthquake risk for Puerto Rico. Among the most recent is a 2003 study of U.S. Seismic Hazard Maps – Puerto Rico and the U.S.

Virgin Islands, Samoa and the Pacific Islands, and Guam and Northern Mariana Islands.²⁰ This study provides gridded seismic hazard curve data, gridded ground motion data, and mapped gridded ground motion values for the Puerto Rico region. In this case, as in many probabilistic seismic hazard analysis (PSHA), the greater than 2% probability of peak ground acceleration (PGA) has become the defacto measure for estimating seismic activity.²¹ Although considerable discussion in seismology, engineering, and emergency management is beginning to shift away from PSHA and PGA as a measure of risk^{22, 23} (eg. hazard X vulnerability) it still proves to be useful for understanding the occurrence frequency of ground shaking. For the purposes of this hazard assessment, the > 2% exceedance of Peak Ground Acceleration provides a useful tool for understanding where the hazard is likely to occur, but not which buildings or communities are likely to be adversely impacted. In this assessment, average PGA values were calculated for each hexagonal grid and mapped using standard deviations showing us a clear pattern of increased hazard across the island.

Hazard Frequency Analysis Results

Figure 15 shows that earthquake threat generally decreases from southwest to northeast across Puerto Rico. Four municipios, Cabo Rojo, Lajas, Guanica, and Yauco have greater than 10 sq. miles of land area in the highest PGA zones, and 36 municipios have greater than 10 sq. miles in the second highest hazard category (Table 40). Thirty-three municipios have 100% of their land area in a high or medium high earthquake hazard zone as defined by PGA of 40 or greater (Table 41). Table 42 provides a breakdown of municipio/hazard threat category as a ratio of total island area, highlighting the highest hazard threat across the island in a numerically comparable way. Finally, Table 43, summarizes across all earthquake hazard zones and ranks each municipio based on earthquake hazard threat.

²⁰ https://www.usgs.gov/natural-hazards/earthquake-hazards/science/us-seismic-hazard-maps-puerto-rico-and-us-virgin-islands?qt-science_center_objects=0#qt-science_center_objects

²¹ http://www.opensha.org/sites/opensha.org/files/PSHA_Primer_v2_0.pdf

²² https://www.iitk.ac.in/nicee/wcee/article/14_S27-001.PDF

²³ <https://www.sciencedirect.com/science/article/pii/S0031920116303016>

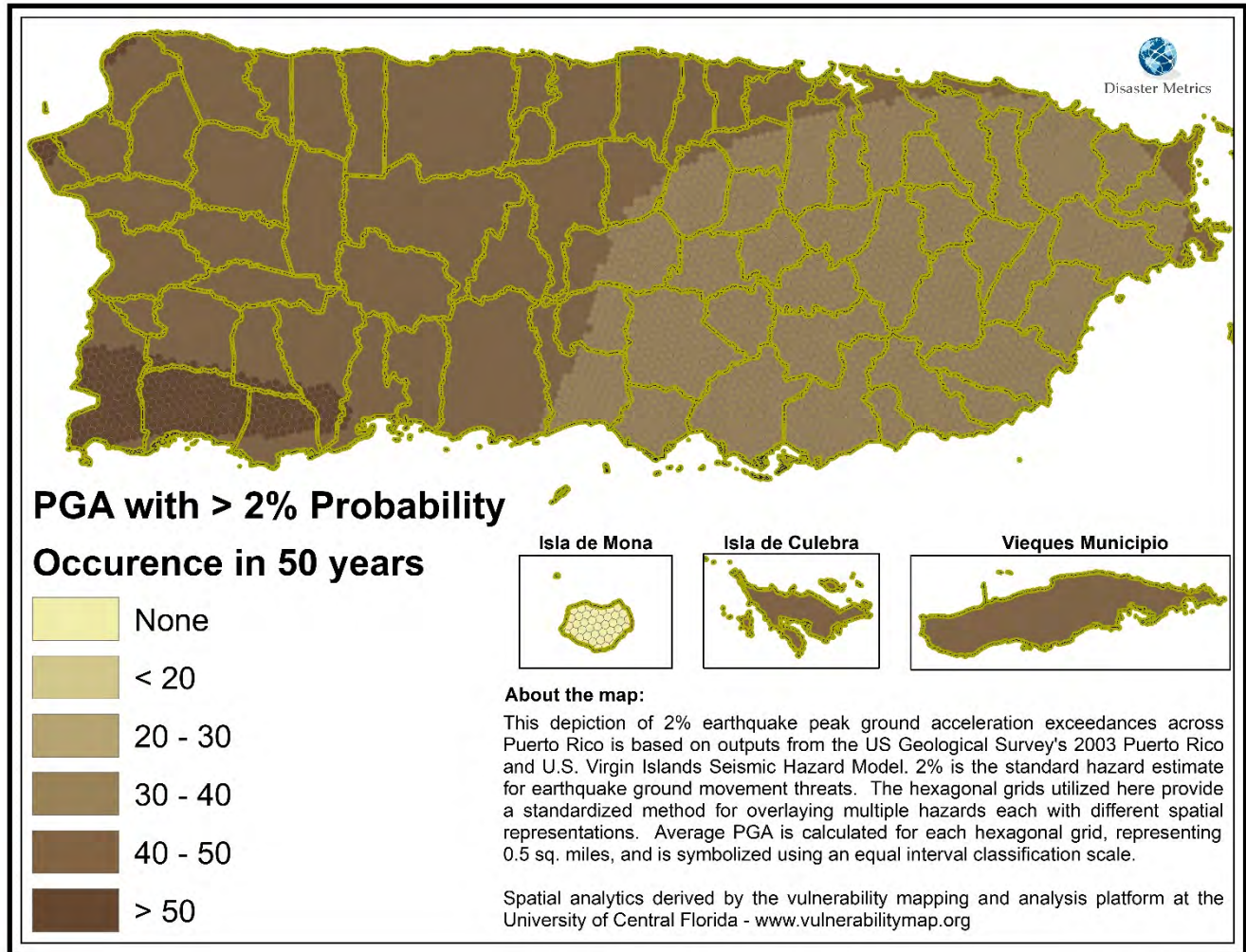


Figure 15: Earthquake Hazard Areas

Table 40: Earthquake Hazard by Municipio and Areal Extent

| Municipio | HEX GRID Area by >2% Probability of Earthquake Peak Ground Acceleration (Sq. miles) | | | | | |
|--------------|---|-------------------|-----------------------------|-------------------------|------------------------------|----------------------|
| | None | Low (PGA < 20) | Medium Low (PGA 20 - 30) | Medium (PGA 30 - 40) | Medium High (PGA 40 - 50) | High (> PGA > 50) |
| Adjuntas | | | | | 67.10 | |
| Aguada | | | | | 29.84 | 1.09 |
| Aguadilla | | | | | 32.54 | 4.06 |
| Aguas Buenas | | | | 30.10 | | |
| Aibonito | | | | 31.34 | | |
| Anasco | | | | | 39.56 | |
| Arecibo | | | | | 126.97 | |
| Arroyo | | | | 15.05 | | |
| Barceloneta | | | | | 18.76 | |
| Barranquitas | | | | 34.28 | | |
| Bayamon | | | | 38.87 | 5.64 | |
| Cabo Rojo | | | | | 20.41 | 52.70 |

| | | | | | |
|-------------|-------|--|-------|-------|-------|
| Caguas | | | 59.07 | | |
| Camuy | | | | 46.37 | |
| Canovanas | | | 33.01 | | |
| Carolina | | | 42.29 | 5.02 | |
| Catano | | | | 5.08 | |
| Cayey | | | 51.96 | | |
| Ceiba | | | 20.67 | 9.70 | |
| Ciales | | | | 66.71 | |
| Cidra | | | 36.46 | | |
| Coamo | | | 78.03 | | |
| Comerio | | | 28.52 | | |
| Corozal | | | 37.65 | 4.93 | |
| Culebra | | | | 13.31 | |
| Dorado | | | | 23.42 | |
| Fajardo | | | 16.45 | 14.06 | |
| Florida | | | | 15.22 | |
| Guanica | | | | 15.50 | 23.51 |
| Guayama | | | 65.87 | | |
| Guayanilla | | | | 40.64 | 2.35 |
| Guaynabo | | | 25.53 | 2.24 | |
| Gurabo | | | 28.31 | | |
| Hatillo | | | | 41.84 | |
| Hormigueros | | | | 11.34 | |
| Humacao | | | 45.10 | | |
| Isabela | | | | 55.41 | |
| Jayuya | | | | 44.53 | |
| Juana Diaz | | | 41.29 | 19.44 | |
| Juncos | | | 26.62 | | |
| Lajas | 0.00 | | | 3.75 | 57.61 |
| Lares | | | | 61.64 | |
| Las Marias | | | | 46.51 | |
| Las Piedras | | | 33.89 | | |
| Loiza | | | 12.02 | 8.52 | |
| Luquillo | | | 23.66 | 2.20 | |
| Manati | | | | 46.82 | |
| Maricao | | | | 36.63 | |
| Maunabo | | | 21.09 | | |
| Mayaguez | 22.18 | | | 55.20 | 0.59 |
| Moca | | | | 50.37 | |
| Morovis | | | 6.94 | 31.98 | |
| Naguabo | | | 51.88 | | |
| Naranjito | | | 27.75 | | |

| | | | | | | |
|--------------------|--------------|---------------|---------------|----------------|----------------|---------------|
| Orocovis | | | | 42.84 | 20.93 | |
| Patillas | | | | 47.21 | 0.00 | |
| Penuelas | | | | | 44.76 | |
| Ponce | | | | 2.88 | 114.10 | |
| Quebradillas | | | | | 23.14 | |
| Rincon | | | | | 8.82 | 5.57 |
| Rio Grande | | | | 60.77 | 0.04 | |
| Sabana Grande | | | | | 28.90 | 6.94 |
| Salinas | | | | 70.06 | | |
| San German | | | | | 48.68 | 5.82 |
| San Juan | 0.00 | | | 39.00 | 10.53 | |
| San Lorenzo | | | | 53.21 | | |
| San Sebastian | | | | | 71.22 | |
| Santa Isabel | | | | 34.57 | | |
| Toa Alta | | | | 19.05 | 8.51 | |
| Toa Baja | | | | 0.29 | 23.51 | |
| Trujillo Alto | | | | 21.38 | | |
| Utuado | | | | | 115.07 | |
| Vega Alta | | | | 0.07 | 27.67 | |
| Vega Baja | | | | | 46.65 | |
| Vieques | 0.00 | | | | 53.18 | |
| Villalba | | | | 21.98 | 15.05 | |
| Yabucoa | | | | 55.28 | 0.12 | |
| Yauco | | | | | 56.34 | 12.48 |
| Grand Total | 22.19 | 149.32 | 128.66 | 1432.29 | 1836.43 | 172.73 |

Table 41: Percent of (Municipio) Hexagonal Area by Earthquake Hazard per Municipio

| Municipio | HEX GRID Area by >2% Probability of Earthquake Peak Ground Acceleration (Sq. miles) | | | | | |
|--------------|---|-------------------|-----------------------------|-------------------------|------------------------------|----------------------|
| | None | Low (PGA < 20) | Medium Low (PGA 20 - 30) | Medium (PGA 30 - 40) | Medium High (PGA 40 - 50) | High (> PGA > 50) |
| Adjuntas | 0.00% | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Aguada | 0.00% | 0.00% | 0.00% | 0.00% | 96.48% | 3.52% |
| Aguadilla | 0.00% | 0.00% | 0.00% | 0.00% | 88.91% | 11.09% |
| Aguas Buenas | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% | 0.00% |
| Aibonito | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% | 0.00% |
| Anasco | 0.00% | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Arecibo | 0.00% | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Arroyo | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% | 0.00% |
| Barceloneta | 0.00% | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Barranquitas | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% | 0.00% |
| Bayamon | 0.00% | 0.00% | 0.00% | 87.33% | 12.67% | 0.00% |
| Cabo Rojo | 0.00% | 0.00% | 0.00% | 0.00% | 27.92% | 72.08% |

| | | | | | | |
|-------------|--------|-------|-------|---------|---------|--------|
| Caguas | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% | 0.00% |
| Camuy | 0.00% | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Canovanas | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% | 0.00% |
| Carolina | 0.00% | 0.00% | 0.00% | 89.39% | 10.61% | 0.00% |
| Catano | 0.00% | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Cayey | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% | 0.00% |
| Ceiba | 0.00% | 0.00% | 0.00% | 68.06% | 31.94% | 0.00% |
| Ciales | 0.00% | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Cidra | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% | 0.00% |
| Coamo | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% | 0.00% |
| Comerio | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% | 0.00% |
| Corozal | 0.00% | 0.00% | 0.00% | 88.42% | 11.58% | 0.00% |
| Culebra | 0.00% | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Dorado | 0.00% | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Fajardo | 0.00% | 0.00% | 0.00% | 53.91% | 46.09% | 0.00% |
| Florida | 0.00% | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Guanica | 0.00% | 0.00% | 0.00% | 0.00% | 39.74% | 60.26% |
| Guayama | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% | 0.00% |
| Guayanilla | 0.00% | 0.00% | 0.00% | 0.00% | 94.52% | 5.48% |
| Guaynabo | 0.00% | 0.00% | 0.00% | 91.95% | 8.05% | 0.00% |
| Gurabo | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% | 0.00% |
| Hatillo | 0.00% | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Hormigueros | 0.00% | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Humacao | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% | 0.00% |
| Isabela | 0.00% | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Jayuya | 0.00% | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Juana Diaz | 0.00% | 0.00% | 0.00% | 67.98% | 32.02% | 0.00% |
| Juncos | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% | 0.00% |
| Lajas | 0.00% | 0.00% | 0.00% | 0.00% | 6.11% | 93.89% |
| Lares | 0.00% | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Las Marias | 0.00% | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Las Piedras | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% | 0.00% |
| Loiza | 0.00% | 0.00% | 0.00% | 58.53% | 41.47% | 0.00% |
| Luquillo | 0.00% | 0.00% | 0.00% | 91.51% | 8.49% | 0.00% |
| Manati | 0.00% | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Maricao | 0.00% | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Maunabo | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% | 0.00% |
| Mayaguez | 28.45% | 0.00% | 0.00% | 0.00% | 70.80% | 0.75% |
| Moca | 0.00% | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Morovis | 0.00% | 0.00% | 0.00% | 17.83% | 82.17% | 0.00% |
| Naguabo | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% | 0.00% |
| Naranjito | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% | 0.00% |

| | | | | | | |
|---------------|-------|--------|--------|---------|---------|--------|
| Orocovis | 0.00% | 0.00% | 0.00% | 67.18% | 32.82% | 0.00% |
| Patillas | 0.00% | 0.00% | 0.00% | 99.99% | 0.01% | 0.00% |
| Penuelas | 0.00% | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Ponce | 0.00% | 0.00% | 0.00% | 2.46% | 97.54% | 0.00% |
| Quebradillas | 0.00% | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Rincon | 0.00% | 0.00% | 0.00% | 0.00% | 61.33% | 38.67% |
| Rio Grande | 0.00% | 0.00% | 0.00% | 99.93% | 0.07% | 0.00% |
| Sabana Grande | 0.00% | 0.00% | 0.00% | 0.00% | 80.64% | 19.36% |
| Salinas | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% | 0.00% |
| San German | 0.00% | 0.00% | 0.00% | 0.00% | 89.31% | 10.69% |
| San Juan | 0.00% | 0.00% | 0.00% | 78.74% | 21.26% | 0.00% |
| San Lorenzo | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% | 0.00% |
| San Sebastian | 0.00% | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Santa Isabel | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% | 0.00% |
| Toa Alta | 0.00% | 0.00% | 0.00% | 69.12% | 30.88% | 0.00% |
| Toa Baja | 0.00% | 0.00% | 0.00% | 1.22% | 98.78% | 0.00% |
| Trujillo Alto | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% | 0.00% |
| Utuado | 0.00% | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Vega Alta | 0.00% | 0.00% | 0.00% | 0.26% | 99.74% | 0.00% |
| Vega Baja | 0.00% | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Vieques | 0.00% | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Villalba | 0.00% | 0.00% | 0.00% | 59.36% | 40.64% | 0.00% |
| Yabucoa | 0.00% | 0.00% | 0.00% | 99.78% | 0.22% | 0.00% |
| Yauco | 0.00% | 0.00% | 0.00% | 0.00% | 81.87% | 18.13% |
| Grand Total | 22.19 | 149.32 | 128.66 | 1432.29 | 1836.43 | 172.73 |

Table 42: Percent of (Island) Hexagonal Area by Earthquake Hazard per Municipio

| Municipio | >2% Probability of Earthquake Peak Ground Acceleration Percent Area by Total (Island) Land Area | | | | | |
|--------------|---|----------------|--------------------------|----------------------|---------------------------|-------------------|
| | None | Low (PGA < 20) | Medium Low (PGA 20 - 30) | Medium (PGA 30 - 40) | Medium High (PGA 40 - 50) | High (> PGA > 50) |
| Adjuntas | 0.00% | 0.00% | 0.00% | 0.00% | 3.65% | 0.00% |
| Aguada | 0.00% | 0.00% | 0.00% | 0.00% | 1.62% | 0.63% |
| Aguadilla | 0.00% | 0.00% | 0.00% | 0.00% | 1.77% | 2.35% |
| Aguas Buenas | 0.00% | 0.00% | 0.00% | 2.10% | 0.00% | 0.00% |
| Aibonito | 0.00% | 0.00% | 0.00% | 2.19% | 0.00% | 0.00% |
| Anasco | 0.00% | 0.00% | 0.00% | 0.00% | 2.15% | 0.00% |
| Arecibo | 0.00% | 0.00% | 0.00% | 0.00% | 6.91% | 0.00% |
| Arroyo | 0.00% | 0.00% | 0.00% | 1.05% | 0.00% | 0.00% |
| Barceloneta | 0.00% | 0.00% | 0.00% | 0.00% | 1.02% | 0.00% |
| Barranquitas | 0.00% | 0.00% | 0.00% | 2.39% | 0.00% | 0.00% |
| Bayamon | 0.00% | 0.00% | 0.00% | 2.71% | 0.31% | 0.00% |

| | | | | | | |
|-------------|--------|-------|-------|-------|-------|--------|
| Cabo Rojo | 0.00% | 0.00% | 0.00% | 0.00% | 1.11% | 30.51% |
| Caguas | 0.00% | 0.00% | 0.00% | 4.12% | 0.00% | 0.00% |
| Camuy | 0.00% | 0.00% | 0.00% | 0.00% | 2.53% | 0.00% |
| Canovanas | 0.00% | 0.00% | 0.00% | 2.30% | 0.00% | 0.00% |
| Carolina | 0.00% | 0.00% | 0.00% | 2.95% | 0.27% | 0.00% |
| Catano | 0.00% | 0.00% | 0.00% | 0.00% | 0.28% | 0.00% |
| Cayey | 0.00% | 0.00% | 0.00% | 3.63% | 0.00% | 0.00% |
| Ceiba | 0.00% | 0.00% | 0.00% | 1.44% | 0.53% | 0.00% |
| Ciales | 0.00% | 0.00% | 0.00% | 0.00% | 3.63% | 0.00% |
| Cidra | 0.00% | 0.00% | 0.00% | 2.55% | 0.00% | 0.00% |
| Coamo | 0.00% | 0.00% | 0.00% | 5.45% | 0.00% | 0.00% |
| Comerio | 0.00% | 0.00% | 0.00% | 1.99% | 0.00% | 0.00% |
| Corozal | 0.00% | 0.00% | 0.00% | 2.63% | 0.27% | 0.00% |
| Culebra | 0.00% | 0.00% | 0.00% | 0.00% | 0.72% | 0.00% |
| Dorado | 0.00% | 0.00% | 0.00% | 0.00% | 1.28% | 0.00% |
| Fajardo | 0.00% | 0.00% | 0.00% | 1.15% | 0.77% | 0.00% |
| Florida | 0.00% | 0.00% | 0.00% | 0.00% | 0.83% | 0.00% |
| Guanica | 0.00% | 0.00% | 0.00% | 0.00% | 0.84% | 13.61% |
| Guayama | 0.00% | 0.00% | 0.00% | 4.60% | 0.00% | 0.00% |
| Guayanilla | 0.00% | 0.00% | 0.00% | 0.00% | 2.21% | 1.36% |
| Guaynabo | 0.00% | 0.00% | 0.00% | 1.78% | 0.12% | 0.00% |
| Gurabo | 0.00% | 0.00% | 0.00% | 1.98% | 0.00% | 0.00% |
| Hatillo | 0.00% | 0.00% | 0.00% | 0.00% | 2.28% | 0.00% |
| Hormigueros | 0.00% | 0.00% | 0.00% | 0.00% | 0.62% | 0.00% |
| Humacao | 0.00% | 0.00% | 0.00% | 3.15% | 0.00% | 0.00% |
| Isabela | 0.00% | 0.00% | 0.00% | 0.00% | 3.02% | 0.00% |
| Jayuya | 0.00% | 0.00% | 0.00% | 0.00% | 2.43% | 0.00% |
| Juana Diaz | 0.00% | 0.00% | 0.00% | 2.88% | 1.06% | 0.00% |
| Juncos | 0.00% | 0.00% | 0.00% | 1.86% | 0.00% | 0.00% |
| Lajas | 0.01% | 0.00% | 0.00% | 0.00% | 0.20% | 33.36% |
| Lares | 0.00% | 0.00% | 0.00% | 0.00% | 3.36% | 0.00% |
| Las Marias | 0.00% | 0.00% | 0.00% | 0.00% | 2.53% | 0.00% |
| Las Piedras | 0.00% | 0.00% | 0.00% | 2.37% | 0.00% | 0.00% |
| Loiza | 0.00% | 0.00% | 0.00% | 0.84% | 0.46% | 0.00% |
| Luquillo | 0.00% | 0.00% | 0.00% | 1.65% | 0.12% | 0.00% |
| Manati | 0.00% | 0.00% | 0.00% | 0.00% | 2.55% | 0.00% |
| Maricao | 0.00% | 0.00% | 0.00% | 0.00% | 1.99% | 0.00% |
| Maunabo | 0.00% | 0.00% | 0.00% | 1.47% | 0.00% | 0.00% |
| Mayaguez | 99.98% | 0.00% | 0.00% | 0.00% | 3.01% | 0.34% |
| Moca | 0.00% | 0.00% | 0.00% | 0.00% | 2.74% | 0.00% |
| Morovis | 0.00% | 0.00% | 0.00% | 0.48% | 1.74% | 0.00% |
| Naguabo | 0.00% | 0.00% | 0.00% | 3.62% | 0.00% | 0.00% |

| | | | | | | |
|---------------|-------|-------|-------|-------|-------|-------|
| Naranjito | 0.00% | 0.00% | 0.00% | 1.94% | 0.00% | 0.00% |
| Orocovis | 0.00% | 0.00% | 0.00% | 2.99% | 1.14% | 0.00% |
| Patillas | 0.00% | 0.00% | 0.00% | 3.30% | 0.00% | 0.00% |
| Penuelas | 0.00% | 0.00% | 0.00% | 0.00% | 2.44% | 0.00% |
| Ponce | 0.00% | 0.00% | 0.00% | 0.20% | 6.21% | 0.00% |
| Quebradillas | 0.00% | 0.00% | 0.00% | 0.00% | 1.26% | 0.00% |
| Rincon | 0.00% | 0.00% | 0.00% | 0.00% | 0.48% | 3.22% |
| Rio Grande | 0.00% | 0.00% | 0.00% | 4.24% | 0.00% | 0.00% |
| Sabana Grande | 0.00% | 0.00% | 0.00% | 0.00% | 1.57% | 4.02% |
| Salinas | 0.00% | 0.00% | 0.00% | 4.89% | 0.00% | 0.00% |
| San German | 0.00% | 0.00% | 0.00% | 0.00% | 2.65% | 3.37% |
| San Juan | 0.01% | 0.00% | 0.00% | 2.72% | 0.57% | 0.00% |
| San Lorenzo | 0.00% | 0.00% | 0.00% | 3.71% | 0.00% | 0.00% |
| San Sebastian | 0.00% | 0.00% | 0.00% | 0.00% | 3.88% | 0.00% |
| Santa Isabel | 0.00% | 0.00% | 0.00% | 2.41% | 0.00% | 0.00% |
| Toa Alta | 0.00% | 0.00% | 0.00% | 1.33% | 0.46% | 0.00% |
| Toa Baja | 0.00% | 0.00% | 0.00% | 0.02% | 1.28% | 0.00% |
| Trujillo Alto | 0.00% | 0.00% | 0.00% | 1.49% | 0.00% | 0.00% |
| Utua | 0.00% | 0.00% | 0.00% | 0.00% | 6.27% | 0.00% |
| Vega Alta | 0.00% | 0.00% | 0.00% | 0.00% | 1.51% | 0.00% |
| Vega Baja | 0.00% | 0.00% | 0.00% | 0.00% | 2.54% | 0.00% |
| Vieques | 0.01% | 0.00% | 0.00% | 0.00% | 2.90% | 0.00% |
| Villalba | 0.00% | 0.00% | 0.00% | 1.53% | 0.82% | 0.00% |
| Yabucoa | 0.00% | 0.00% | 0.00% | 3.86% | 0.01% | 0.00% |
| Yauco | 0.00% | 0.00% | 0.00% | 0.00% | 3.07% | 7.23% |

Table 43: Earthquake Hazard Scores and Ranks by Municipio

| Municipio | Earthquake Hazard Score (Log Multiplied) | | |
|---------------|--|--------------------------|----------------------|
| | Total Score | Standardized Score (0-1) | Rank of Score (1-78) |
| Lajas | 10029.5216 | 1 | 1 |
| Cabo Rojo | 9308.5181 | 0.928 | 2 |
| Guanica | 4202.6147 | 0.4179 | 3 |
| Yauco | 2609.7743 | 0.2588 | 4 |
| Sabana Grande | 1431.8902 | 0.1411 | 5 |
| San German | 1394.4018 | 0.1374 | 6 |
| Rincon | 1035.4309 | 0.1015 | 7 |
| Arecibo | 1000.0000 | 0.098 | 8 |
| Aguadilla | 961.2002 | 0.0941 | 9 |
| Utua | 906.2384 | 0.0886 | 10 |
| Ponce | 902.2966 | 0.0882 | 11 |

| | | | |
|---------------|----------|--------|----|
| Guayanilla | 728.5981 | 0.0709 | 12 |
| San Sebastian | 560.8899 | 0.0541 | 13 |
| Mayaguez | 536.9325 | 0.0517 | 14 |
| Adjuntas | 528.4201 | 0.0509 | 15 |
| Ciales | 525.3555 | 0.0506 | 16 |
| Lares | 485.4330 | 0.0466 | 17 |
| Isabela | 436.3739 | 0.0417 | 18 |
| Aguada | 423.8025 | 0.0404 | 19 |
| Vieques | 418.8334 | 0.0399 | 20 |
| Moca | 396.6589 | 0.0377 | 21 |
| Manati | 368.7413 | 0.0349 | 22 |
| Vega Baja | 367.3796 | 0.0348 | 23 |
| Las Marias | 366.2568 | 0.0347 | 24 |
| Camuy | 365.2022 | 0.0346 | 25 |
| Penuelas | 352.4840 | 0.0333 | 26 |
| Jayuya | 350.7355 | 0.0331 | 27 |
| Hatillo | 329.5046 | 0.031 | 28 |
| Anasco | 311.5538 | 0.0292 | 29 |
| Maricao | 288.4623 | 0.0269 | 30 |
| Morovis | 260.7905 | 0.0241 | 31 |
| Orocovis | 219.7516 | 0.02 | 32 |
| Vega Alta | 218.0046 | 0.0199 | 33 |
| Juana Diaz | 206.0491 | 0.0187 | 34 |
| Toa Baja | 185.5580 | 0.0166 | 35 |
| Dorado | 184.4249 | 0.0165 | 36 |
| Quebradillas | 182.2401 | 0.0163 | 37 |
| Barceloneta | 147.7382 | 0.0128 | 38 |
| Villalba | 146.7126 | 0.0127 | 39 |
| San Juan | 132.9075 | 0.0114 | 40 |
| Fajardo | 131.8226 | 0.0112 | 41 |
| Florida | 119.8846 | 0.01 | 42 |
| Culebra | 104.8017 | 0.0085 | 43 |
| Ceiba | 102.8938 | 0.0084 | 44 |
| Coamo | 100.0000 | 0.0081 | 45 |
| Bayamon | 94.2540 | 0.0075 | 46 |
| Carolina | 93.7068 | 0.0074 | 47 |
| Toa Alta | 91.4398 | 0.0072 | 48 |
| Hormigueros | 89.3423 | 0.007 | 49 |
| Salinas | 89.7869 | 0.007 | 49 |
| Corozal | 87.0774 | 0.0068 | 51 |
| Guayama | 84.4157 | 0.0065 | 52 |
| Loiza | 82.4649 | 0.0063 | 53 |

| | | | |
|---------------|---------|--------|----|
| Rio Grande | 78.2051 | 0.0059 | 54 |
| Caguas | 75.7008 | 0.0056 | 55 |
| Yabucoa | 71.8283 | 0.0052 | 56 |
| San Lorenzo | 68.1895 | 0.0049 | 57 |
| Cayey | 66.5934 | 0.0047 | 58 |
| Naguabo | 66.4907 | 0.0047 | 58 |
| Patillas | 60.5348 | 0.0041 | 60 |
| Humacao | 57.8050 | 0.0038 | 61 |
| Guaynabo | 50.3297 | 0.0031 | 62 |
| Luquillo | 47.6235 | 0.0028 | 63 |
| Cidra | 46.7209 | 0.0027 | 64 |
| Barranquitas | 43.9367 | 0.0025 | 65 |
| Santa Isabel | 44.3102 | 0.0025 | 65 |
| Las Piedras | 43.4364 | 0.0024 | 67 |
| Canovanas | 42.3003 | 0.0023 | 68 |
| Aibonito | 40.1634 | 0.0021 | 69 |
| Catano | 40.0417 | 0.0021 | 69 |
| Aguas Buenas | 38.5708 | 0.0019 | 71 |
| Comerio | 36.5564 | 0.0017 | 72 |
| Gurabo | 36.2859 | 0.0017 | 72 |
| Naranjito | 35.5621 | 0.0016 | 74 |
| Juncos | 34.1101 | 0.0015 | 75 |
| Maunabo | 27.0275 | 0.0008 | 76 |
| Trujillo Alto | 27.4030 | 0.0008 | 76 |
| Arroyo | 19.2846 | 0.0000 | 78 |

Tsunami

Hazard Overview

A tsunami is a series of waves caused generally by a vertical displacement on the bottom (bed) of the sea caused by an earthquake under the seabed. Tsunamis can also be caused by underwater landslides or volcanic eruptions. Tsunami characteristics are different in deep and surface water events. In deep water, waves travel at speeds up to 500 mph but the visual indication of deep water tsunami's is typically a low wave under one foot in height. However, as these deep water waves approach coastal areas they greatly decrease in speed and dramatically increase in height. Near shore tsunami waves, sometimes reaching heights of more than 30 meters (98 feet), can cause great impacts to lives, property and livelihoods when they impact the coast.²⁴

Data and Methods

Puerto Rico's Seismic Network (PRSN), part of the Department of Geology of the University of Puerto Rico in Mayagüez, has a mission to detect, process and investigate the seismic activity in the region of Puerto Rico to aid in public security, education, engineering and scientific research. In 2012, PRSN completed a tsunami inundation model considering an 8.5 magnitude catastrophic event on the north of Puerto Rico.²⁵ Results of this model include geospatial data files displaying flood inundation areas across Puerto Rico. Like flood hazard, these polygonal representations of tsunami hazard were spatially intersected with Puerto Rico's 0.5-mile hexagonal grid to produce a spatial representation of tsunami inundation hazard across the island.

Hazard Frequency Analysis Results

Tsunamis are mainly a coastal hazard yet potential impacts are uneven across the coastline (Figure 16). Municipios on the north shore of Puerto Rico appear to have more land area in tsunami hazard zones in comparison to other parts of the island. These results are dependent on many factors, but could be related to the fact that the 2012 model was based on an event in the north of Puerto Rico. Additionally, municipios along Puerto Rico's western shore have land areas in high tsunami hazard zones. Thirty-seven municipios have land in high tsunami impact areas (Table 44) with Loiza topping the list in terms of total land area in high tsunami hazard zone (Figure 16). Table 47 provides a standardized score and rank for each municipio in terms of its tsunami hazard threat.

²⁴ <https://recovery.pr/en/document-library>

²⁵ <http://redsismica.uprm.edu/English/tsunami/tsunamiiprogram/prc/gisdataenglish.php>

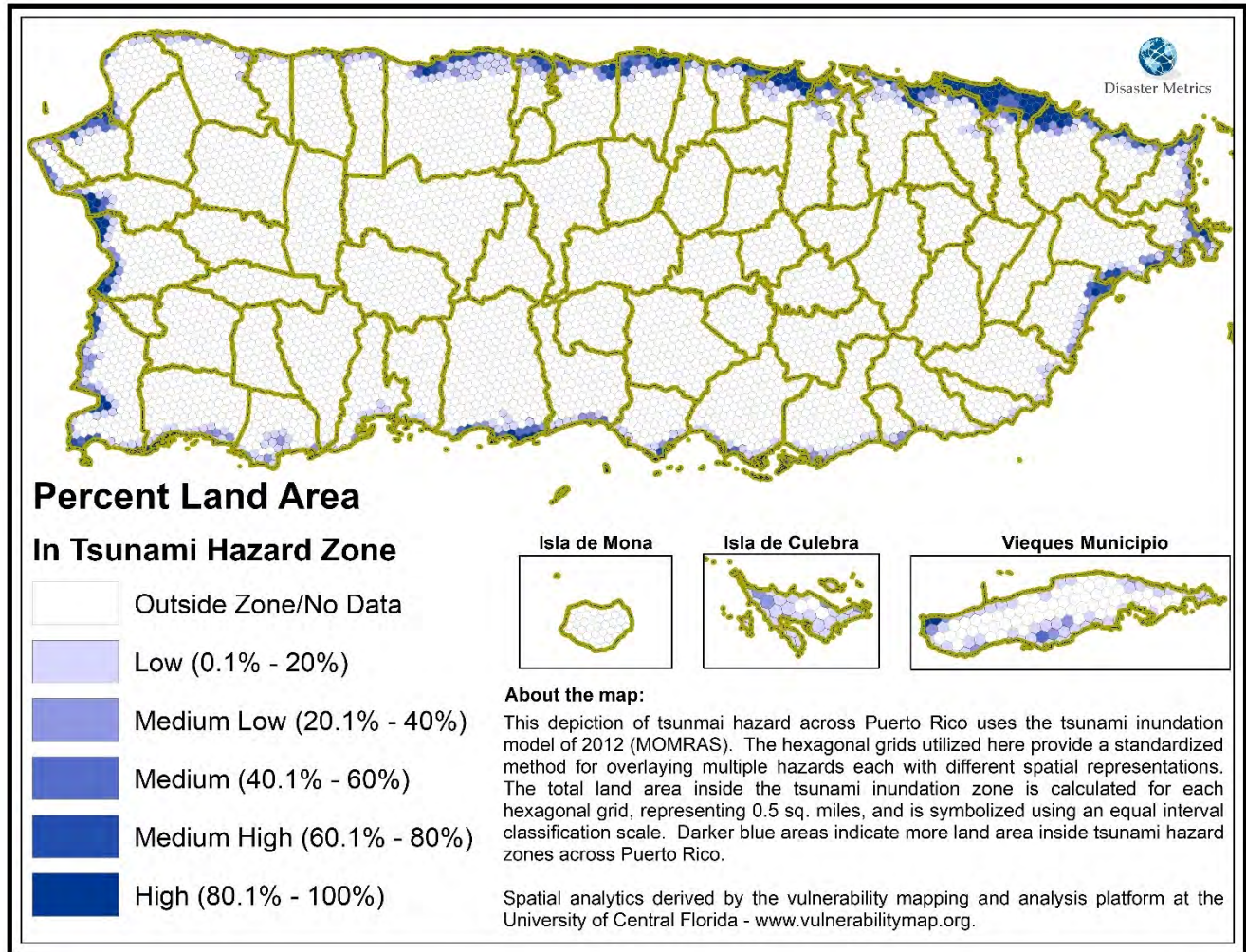


Figure 16: Tsunami Hazard Areas

Table 44: Tsunami Hazard by Municipio and Areal Extent

| Municipio | HEX GRID Area by Tsunami Inundation (Sq. miles) | | | | | |
|--------------|---|---------------------|-----------------------------|-------------------------|------------------------------|----------------|
| | None | Low (0.1% – 20%) | Medium Low (20.1% - 40%) | Medium (40.1% - 60%) | Medium High (60.1% - 80%) | High (>80%) |
| Adjuntas | 67.10 | | | | | |
| Aguada | 22.44 | 2.20 | 1.80 | 1.50 | 1.40 | 1.59 |
| Aguadilla | 29.82 | 4.23 | 0.94 | 0.59 | 0.43 | 0.59 |
| Aguas Buenas | 30.10 | | | | | |
| Aibonito | 31.34 | | | | | |
| Anasco | 32.13 | 3.33 | 0.54 | 1.00 | | 2.57 |
| Arecibo | 105.93 | 13.09 | 1.59 | 1.83 | 3.28 | 1.25 |
| Arroyo | 12.03 | 1.40 | 1.21 | 0.29 | | 0.11 |
| Barceloneta | 11.52 | 2.97 | 1.69 | 0.79 | 1.36 | 0.43 |
| Barranquitas | 34.28 | | | | | |
| Bayamon | 41.13 | 2.71 | 0.45 | | | 0.23 |
| Cabo Rojo | 47.64 | 11.57 | 4.95 | 2.78 | 3.75 | 2.43 |

| | | | | | | | |
|-------------|-------|-------|------|------|------|-------|--|
| Caguas | 59.07 | | | | | | |
| Camuy | 43.99 | 1.35 | 0.43 | | 0.51 | 0.08 | |
| Canovanas | 28.16 | 2.80 | 1.13 | 0.03 | 0.52 | 0.37 | |
| Carolina | 33.86 | 5.71 | 0.95 | 1.64 | 0.94 | 4.20 | |
| Catano | 0.99 | 0.25 | 1.53 | 0.49 | 0.72 | 1.10 | |
| Cayey | 51.96 | | | | | | |
| Ceiba | 17.93 | 6.30 | 1.54 | 1.93 | 1.16 | 1.52 | |
| Ciales | 66.71 | | | | | | |
| Cidra | 36.46 | | | | | | |
| Coamo | 78.03 | | | | | | |
| Comerio | 28.52 | | | | | | |
| Corozal | 42.58 | | | | | | |
| Culebra | 1.69 | 10.05 | 1.56 | | | | |
| Dorado | 16.04 | 2.60 | 0.46 | 1.38 | 0.51 | 2.42 | |
| Fajardo | 19.95 | 5.77 | 1.41 | 0.89 | 1.83 | 0.67 | |
| Florida | 15.22 | | | | | | |
| Guanica | 28.76 | 8.31 | 1.82 | 0.01 | 0.11 | | |
| Guayama | 56.51 | 6.03 | 1.66 | 0.33 | 1.00 | 0.33 | |
| Guayanilla | 37.06 | 5.37 | 0.56 | | | | |
| Guaynabo | 26.37 | 1.01 | 0.39 | | | | |
| Gurabo | 28.31 | | | | | | |
| Hatillo | 36.97 | 2.38 | 1.47 | 0.26 | 0.61 | 0.15 | |
| Hormigueros | 11.14 | 0.21 | | | | | |
| Humacao | 34.61 | 4.15 | 2.08 | 2.30 | 1.20 | 0.76 | |
| Isabela | 47.55 | 4.81 | 2.07 | 0.50 | | 0.47 | |
| Jayuya | 44.53 | | | | | | |
| Juana Diaz | 55.52 | 2.56 | 1.27 | 0.61 | 0.39 | 0.39 | |
| Juncos | 26.62 | | | | | | |
| Lajas | 52.28 | 6.20 | 2.01 | | 0.53 | 0.34 | |
| Lares | 61.64 | | | | | | |
| Las Marias | 46.51 | | | | | | |
| Las Piedras | 33.89 | | | | | | |
| Loiza | 0.62 | 0.70 | 0.37 | 2.66 | 1.95 | 14.24 | |
| Luquillo | 19.06 | 2.54 | 1.89 | 0.69 | 0.53 | 1.15 | |
| Manati | 38.10 | 2.84 | 2.21 | 1.14 | 1.60 | 0.94 | |
| Maricao | 36.63 | | | | | | |
| Maunabo | 18.64 | 2.45 | | | | | |
| Mayaguez | 65.89 | 3.76 | 1.97 | 0.88 | 0.26 | 5.21 | |
| Moca | 50.37 | | | | | | |
| Morovis | 38.93 | | | | | | |
| Naguabo | 43.10 | 3.46 | 2.41 | 0.41 | 2.25 | 0.24 | |
| Naranjito | 27.75 | | | | | | |

| | | | | | | | |
|---------------|---------|--------|-------|-------|-------|-------|--|
| Orocovis | 63.78 | | | | | | |
| Patillas | 43.53 | 3.11 | 0.37 | 0.21 | | | |
| Penuelas | 41.47 | 2.59 | 0.02 | 0.47 | 0.08 | 0.13 | |
| Ponce | 104.44 | 4.63 | 1.60 | 2.68 | 1.24 | 2.39 | |
| Quebradillas | 20.02 | 2.96 | 0.16 | | | | |
| Rincon | 8.77 | 2.64 | 1.52 | 0.93 | 0.31 | 0.22 | |
| Rio Grande | 47.74 | 2.50 | 2.06 | 0.76 | 1.81 | 5.95 | |
| Sabana Grande | 35.84 | | | | | | |
| Salinas | 61.65 | 5.14 | 0.60 | 0.58 | 1.14 | 0.96 | |
| San German | 54.51 | | | | | | |
| San Juan | 38.16 | 6.80 | 1.65 | 0.39 | 1.45 | 1.07 | |
| San Lorenzo | 53.21 | | | | | | |
| San Sebastian | 71.22 | | | | | | |
| Santa Isabel | 27.45 | 4.46 | 0.65 | 0.69 | 1.02 | 0.30 | |
| Toa Alta | 27.56 | | | | | | |
| Toa Baja | 11.35 | 4.02 | 1.71 | 0.01 | 0.54 | 6.17 | |
| Trujillo Alto | 21.38 | | | | | | |
| Utuado | 115.07 | | | | | | |
| Vega Alta | 25.22 | 1.07 | 0.63 | | 0.62 | 0.19 | |
| Vega Baja | 34.55 | 2.57 | 2.47 | 1.86 | 2.43 | 2.78 | |
| Vieques | 29.53 | 19.53 | 2.53 | 0.70 | 0.18 | 0.71 | |
| Villalba | 37.04 | | | | | | |
| Yabucoa | 51.14 | 4.16 | | 0.01 | 0.10 | | |
| Yauco | 68.14 | 0.68 | | | | | |
| Grand Total | 3066.71 | 199.97 | 60.31 | 34.23 | 37.77 | 64.64 | |

Table 45: Percent of (Municipio) Hexagonal Area by Tsunami Hazard per Municipio

| Municipio | Tsunami Inundation Percent Area by Total (Municipio) Land Area | | | | | |
|--------------|--|---------------------|-----------------------------|-------------------------|------------------------------|----------------|
| | None | Low (0.1% – 20%) | Medium Low (20.1% - 40%) | Medium (40.1% - 60%) | Medium High (60.1% - 80%) | High (>80%) |
| Adjuntas | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Aguada | 72.57% | 7.11% | 5.82% | 4.85% | 4.52% | 5.13% |
| Aguadilla | 81.46% | 11.57% | 2.58% | 1.61% | 1.18% | 1.60% |
| Aguas Buenas | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Aibonito | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Anasco | 81.21% | 8.41% | 1.36% | 2.53% | 0.00% | 6.49% |
| Arecibo | 83.43% | 10.31% | 1.26% | 1.44% | 2.58% | 0.98% |
| Arroyo | 79.97% | 9.31% | 8.06% | 1.94% | 0.00% | 0.72% |
| Barceloneta | 61.39% | 15.85% | 9.01% | 4.20% | 7.27% | 2.28% |
| Barranquitas | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Bayamon | 92.39% | 6.09% | 1.01% | 0.00% | 0.00% | 0.51% |
| Cabo Rojo | 65.16% | 15.82% | 6.77% | 3.80% | 5.13% | 3.33% |

| | | | | | | |
|-------------|---------|--------|--------|--------|--------|--------|
| Caguas | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Camuy | 94.87% | 2.92% | 0.93% | 0.00% | 1.11% | 0.17% |
| Canovanas | 85.32% | 8.48% | 3.42% | 0.10% | 1.57% | 1.12% |
| Carolina | 71.58% | 12.07% | 2.01% | 3.47% | 1.98% | 8.89% |
| Catano | 19.48% | 4.97% | 30.04% | 9.57% | 14.23% | 21.71% |
| Cayey | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Ceiba | 59.03% | 20.73% | 5.08% | 6.34% | 3.83% | 4.99% |
| Ciales | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Cidra | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Coamo | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Comerio | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Corozal | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Culebra | 12.73% | 75.54% | 11.72% | 0.00% | 0.00% | 0.00% |
| Dorado | 68.51% | 11.10% | 1.98% | 5.88% | 2.19% | 10.35% |
| Fajardo | 65.37% | 18.92% | 4.61% | 2.91% | 5.98% | 2.20% |
| Florida | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Guanica | 73.73% | 21.30% | 4.67% | 0.01% | 0.29% | 0.00% |
| Guayama | 85.80% | 9.15% | 2.52% | 0.50% | 1.52% | 0.51% |
| Guayanilla | 86.21% | 12.49% | 1.30% | 0.00% | 0.00% | 0.00% |
| Guaynabo | 94.96% | 3.65% | 1.39% | 0.00% | 0.00% | 0.00% |
| Gurabo | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Hatillo | 88.37% | 5.68% | 3.51% | 0.62% | 1.45% | 0.36% |
| Hormigueros | 98.18% | 1.82% | 0.00% | 0.00% | 0.00% | 0.00% |
| Humacao | 76.73% | 9.21% | 4.61% | 5.11% | 2.66% | 1.68% |
| Isabela | 85.82% | 8.68% | 3.73% | 0.91% | 0.00% | 0.85% |
| Jayuya | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Juana Diaz | 91.42% | 4.21% | 2.09% | 1.01% | 0.64% | 0.64% |
| Juncos | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Lajas | 85.20% | 10.11% | 3.27% | 0.00% | 0.87% | 0.56% |
| Lares | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Las Marias | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Las Piedras | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Loiza | 3.01% | 3.39% | 1.81% | 12.96% | 9.48% | 69.34% |
| Luquillo | 73.70% | 9.82% | 7.29% | 2.67% | 2.06% | 4.46% |
| Manati | 81.37% | 6.06% | 4.73% | 2.43% | 3.41% | 2.01% |
| Maricao | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Maunabo | 88.38% | 11.62% | 0.00% | 0.00% | 0.00% | 0.00% |
| Mayaguez | 84.51% | 4.82% | 2.52% | 1.13% | 0.34% | 6.68% |
| Moca | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Morovis | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Naguabo | 83.08% | 6.67% | 4.65% | 0.79% | 4.35% | 0.47% |
| Naranjito | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |

| | | | | | | |
|---------------|---------|--------|--------|-------|-------|--------|
| Orocovis | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Patillas | 92.19% | 6.58% | 0.78% | 0.45% | 0.00% | 0.00% |
| Penuelas | 92.66% | 5.78% | 0.03% | 1.04% | 0.19% | 0.29% |
| Ponce | 89.28% | 3.96% | 1.37% | 2.29% | 1.06% | 2.04% |
| Quebradillas | 86.53% | 12.79% | 0.68% | 0.00% | 0.00% | 0.00% |
| Rincon | 60.96% | 18.34% | 10.56% | 6.46% | 2.15% | 1.54% |
| Rio Grande | 78.50% | 4.11% | 3.38% | 1.25% | 2.97% | 9.78% |
| Sabana Grande | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Salinas | 87.99% | 7.33% | 0.85% | 0.83% | 1.62% | 1.37% |
| San German | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| San Juan | 77.06% | 13.73% | 3.34% | 0.79% | 2.93% | 2.15% |
| San Lorenzo | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| San Sebastian | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Santa Isabel | 79.40% | 12.90% | 1.89% | 1.99% | 2.96% | 0.86% |
| Toa Alta | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Toa Baja | 47.68% | 16.88% | 7.20% | 0.06% | 2.26% | 25.92% |
| Trujillo Alto | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Utuado | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Vega Alta | 90.91% | 3.86% | 2.29% | 0.00% | 2.24% | 0.70% |
| Vega Baja | 74.06% | 5.51% | 5.29% | 3.98% | 5.22% | 5.96% |
| Vieques | 55.53% | 36.72% | 4.76% | 1.31% | 0.33% | 1.34% |
| Villalba | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Yabucoa | 92.30% | 7.50% | 0.00% | 0.02% | 0.17% | 0.00% |
| Yauco | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |

Table 46: Percent of (Island) Hexagonal Area by Tsunami Hazard per Municipio

| Municipio | Tsunami Inundation Percent Area by Total (Island) Land Area | | | | | |
|--------------|---|---------------------|-----------------------------|-------------------------|------------------------------|----------------|
| | None | Low (0.1% – 20%) | Medium Low (20.1% - 40%) | Medium (40.1% - 60%) | Medium High (60.1% - 80%) | High (>80%) |
| Adjuntas | 2.19% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Aguada | 0.73% | 1.10% | 2.98% | 4.38% | 3.70% | 2.46% |
| Aguadilla | 0.97% | 2.12% | 1.57% | 1.73% | 1.15% | 0.91% |
| Aguas Buenas | 0.98% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Aibonito | 1.02% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Anasco | 1.05% | 1.66% | 0.89% | 2.92% | 0.00% | 3.97% |
| Arecibo | 3.45% | 6.55% | 2.64% | 5.35% | 8.69% | 1.93% |
| Arroyo | 0.39% | 0.70% | 2.01% | 0.85% | 0.00% | 0.17% |
| Barceloneta | 0.38% | 1.49% | 2.80% | 2.30% | 3.61% | 0.66% |
| Barranquitas | 1.12% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Bayamon | 1.34% | 1.36% | 0.75% | 0.00% | 0.00% | 0.35% |
| Cabo Rojo | 1.55% | 5.79% | 8.20% | 8.11% | 9.93% | 3.76% |
| Caguas | 1.93% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |

| | | | | | | |
|-------------|-------|-------|-------|-------|-------|--------|
| Camuy | 1.43% | 0.68% | 0.72% | 0.00% | 1.36% | 0.12% |
| Canovanas | 0.92% | 1.40% | 1.87% | 0.10% | 1.37% | 0.57% |
| Carolina | 1.10% | 2.86% | 1.57% | 4.79% | 2.48% | 6.51% |
| Catano | 0.03% | 0.13% | 2.53% | 1.42% | 1.92% | 1.71% |
| Cayey | 1.69% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Ceiba | 0.58% | 3.15% | 2.56% | 5.63% | 3.08% | 2.34% |
| Ciales | 2.18% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Cidra | 1.19% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Coamo | 2.54% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Comerio | 0.93% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Corozal | 1.39% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Culebra | 0.06% | 5.03% | 2.59% | 0.00% | 0.00% | 0.00% |
| Dorado | 0.52% | 1.30% | 0.77% | 4.02% | 1.36% | 3.75% |
| Fajardo | 0.65% | 2.89% | 2.33% | 2.60% | 4.83% | 1.04% |
| Florida | 0.50% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Guanica | 0.94% | 4.16% | 3.02% | 0.02% | 0.30% | 0.00% |
| Guayama | 1.84% | 3.01% | 2.75% | 0.97% | 2.66% | 0.52% |
| Guayanilla | 1.21% | 2.69% | 0.93% | 0.00% | 0.00% | 0.00% |
| Guaynabo | 0.86% | 0.51% | 0.64% | 0.00% | 0.00% | 0.00% |
| Gurabo | 0.92% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Hatillo | 1.21% | 1.19% | 2.44% | 0.76% | 1.61% | 0.24% |
| Hormigueros | 0.36% | 0.10% | 0.00% | 0.00% | 0.00% | 0.00% |
| Humacao | 1.13% | 2.08% | 3.45% | 6.73% | 3.17% | 1.17% |
| Isabela | 1.55% | 2.41% | 3.43% | 1.47% | 0.00% | 0.73% |
| Jayuya | 1.45% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Juana Diaz | 1.81% | 1.28% | 2.10% | 1.79% | 1.02% | 0.60% |
| Juncos | 0.87% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Lajas | 1.70% | 3.10% | 3.33% | 0.00% | 1.41% | 0.53% |
| Lares | 2.01% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Las Marias | 1.52% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Las Piedras | 1.11% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Loiza | 0.02% | 0.35% | 0.62% | 7.78% | 5.15% | 22.03% |
| Luquillo | 0.62% | 1.27% | 3.13% | 2.02% | 1.41% | 1.78% |
| Manati | 1.24% | 1.42% | 3.67% | 3.32% | 4.22% | 1.45% |
| Maricao | 1.19% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Maunabo | 0.61% | 1.23% | 0.00% | 0.00% | 0.00% | 0.00% |
| Mayaguez | 2.15% | 1.88% | 3.26% | 2.58% | 0.70% | 8.06% |
| Moca | 1.64% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Morovis | 1.27% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Naguabo | 1.41% | 1.73% | 4.00% | 1.20% | 5.97% | 0.38% |
| Naranjito | 0.90% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Orocovis | 2.08% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |

| | | | | | | |
|---------------|-------|-------|-------|-------|-------|-------|
| Patillas | 1.42% | 1.55% | 0.61% | 0.62% | 0.00% | 0.00% |
| Penuelas | 1.35% | 1.29% | 0.02% | 1.36% | 0.22% | 0.20% |
| Ponce | 3.41% | 2.32% | 2.65% | 7.83% | 3.28% | 3.70% |
| Quebradillas | 0.65% | 1.48% | 0.26% | 0.00% | 0.00% | 0.00% |
| Rincon | 0.29% | 1.32% | 2.52% | 2.72% | 0.82% | 0.34% |
| Rio Grande | 1.56% | 1.25% | 3.41% | 2.22% | 4.79% | 9.20% |
| Sabana Grande | 1.17% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Salinas | 2.01% | 2.57% | 0.99% | 1.70% | 3.01% | 1.48% |
| San German | 1.78% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| San Juan | 1.24% | 3.40% | 2.74% | 1.15% | 3.84% | 1.65% |
| San Lorenzo | 1.73% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| San Sebastian | 2.32% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Santa Isabel | 0.90% | 2.23% | 1.08% | 2.01% | 2.71% | 0.46% |
| Toa Alta | 0.90% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Toa Baja | 0.37% | 2.01% | 2.84% | 0.04% | 1.42% | 9.54% |
| Trujillo Alto | 0.70% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Utua | 3.75% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Vega Alta | 0.82% | 0.54% | 1.05% | 0.00% | 1.65% | 0.30% |
| Vega Baja | 1.13% | 1.28% | 4.09% | 5.42% | 6.44% | 4.30% |
| Vieques | 0.96% | 9.77% | 4.20% | 2.04% | 0.47% | 1.10% |
| Villalba | 1.21% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Yabucoa | 1.67% | 2.08% | 0.00% | 0.04% | 0.25% | 0.00% |
| Yauco | 2.22% | 0.34% | 0.00% | 0.00% | 0.00% | 0.00% |

Table 47: Tsunami Hazard Scores and Ranks by Municipio

| Municipio | Tsunami Hazard Score (Log Multiplied) | | |
|------------|---------------------------------------|--------------------------|----------------------|
| | Total Score | Standardized Score (0-1) | Rank of Score (1-78) |
| Loiza | 10615.7743 | 1 | 1 |
| Rio Grande | 4690.4402 | 0.4418 | 2 |
| Toa Baja | 4480.2465 | 0.422 | 3 |
| Mayaguez | 3762.7659 | 0.3545 | 4 |
| Carolina | 3263.9850 | 0.3075 | 5 |
| Cabo Rojo | 2818.2217 | 0.2655 | 6 |
| Vega Baja | 2672.2557 | 0.2517 | 7 |
| Ponce | 2110.3040 | 0.1988 | 8 |
| Dorado | 1889.4124 | 0.178 | 9 |
| Anasco | 1839.6819 | 0.1733 | 10 |
| Arecibo | 1819.8641 | 0.1714 | 11 |
| Aguada | 1545.0843 | 0.1455 | 12 |
| Ceiba | 1447.8828 | 0.1364 | 13 |
| San Juan | 1153.1737 | 0.1086 | 14 |

| | | | |
|--------------|-----------|--------|----|
| Manati | 1130.6196 | 0.1065 | 15 |
| Salinas | 998.7860 | 0.0941 | 16 |
| Fajardo | 994.4713 | 0.0937 | 17 |
| Catano | 988.7064 | 0.0931 | 18 |
| Luquillo | 980.8060 | 0.0924 | 19 |
| Humacao | 939.1662 | 0.0885 | 20 |
| Naguabo | 791.5192 | 0.0746 | 21 |
| Barceloneta | 695.6450 | 0.0655 | 22 |
| Vieques | 579.5953 | 0.0546 | 23 |
| Aguadilla | 550.5881 | 0.0519 | 24 |
| Guayama | 517.3711 | 0.0487 | 25 |
| Santa Isabel | 507.9129 | 0.0478 | 26 |
| Canovanas | 401.1996 | 0.0378 | 27 |
| Juana Diaz | 398.6350 | 0.0376 | 28 |
| Lajas | 388.0023 | 0.0365 | 29 |
| Isabela | 353.5118 | 0.0333 | 30 |
| Vega Alta | 303.6024 | 0.0286 | 31 |
| Hatillo | 281.3682 | 0.0265 | 32 |
| Rincon | 274.5131 | 0.0259 | 33 |
| Camuy | 194.6023 | 0.0183 | 34 |
| Bayamon | 159.2441 | 0.015 | 35 |
| Penuelas | 129.7541 | 0.0122 | 36 |
| Arroyo | 89.2676 | 0.0084 | 37 |
| Guanica | 34.6589 | 0.0033 | 38 |
| Yabucoa | 26.1885 | 0.0025 | 39 |
| Patillas | 8.5053 | 0.0008 | 40 |
| Culebra | 3.6677 | 0.0003 | 41 |
| Guayanilla | 1.4064 | 0.0001 | 42 |
| Guaynabo | 0.8305 | 0.0001 | 42 |
| Adjuntas | 0.0000 | 0.0000 | 44 |
| Aguas Buenas | 0.0000 | 0.0000 | 44 |
| Aibonito | 0.0000 | 0.0000 | 44 |
| Barranquitas | 0.0000 | 0.0000 | 44 |
| Caguas | 0.0000 | 0.0000 | 44 |
| Cayey | 0.0000 | 0.0000 | 44 |
| Ciales | 0.0000 | 0.0000 | 44 |
| Cidra | 0.0000 | 0.0000 | 44 |
| Coamo | 0.0000 | 0.0000 | 44 |
| Comerio | 0.0000 | 0.0000 | 44 |
| Corozal | 0.0000 | 0.0000 | 44 |
| Florida | 0.0000 | 0.0000 | 44 |
| Gurabo | 0.0000 | 0.0000 | 44 |

| | | | |
|---------------|--------|--------|----|
| Hormigueros | 0.0106 | 0.0000 | 44 |
| Jayuya | 0.0000 | 0.0000 | 44 |
| Juncos | 0.0000 | 0.0000 | 44 |
| Lares | 0.0000 | 0.0000 | 44 |
| Las Marias | 0.0000 | 0.0000 | 44 |
| Las Piedras | 0.0000 | 0.0000 | 44 |
| Maricao | 0.0000 | 0.0000 | 44 |
| Maunabo | 0.1254 | 0.0000 | 44 |
| Moca | 0.0000 | 0.0000 | 44 |
| Morovis | 0.0000 | 0.0000 | 44 |
| Naranjito | 0.0000 | 0.0000 | 44 |
| Orocovis | 0.0000 | 0.0000 | 44 |
| Quebradillas | 0.4673 | 0.0000 | 44 |
| Sabana Grande | 0.0000 | 0.0000 | 44 |
| San German | 0.0000 | 0.0000 | 44 |
| San Lorenzo | 0.0000 | 0.0000 | 44 |
| San Sebastian | 0.0000 | 0.0000 | 44 |
| Toa Alta | 0.0000 | 0.0000 | 44 |
| Trujillo Alto | 0.0000 | 0.0000 | 44 |
| Utua | 0.0000 | 0.0000 | 44 |
| Villalba | 0.0000 | 0.0000 | 44 |
| Yauco | 0.0348 | 0.0000 | 44 |

Drought

Hazard Overview

Drought is described as "long periods of abnormal weather enough for water shortages to cause serious hydrological imbalances in the affected area". In simpler terms, a drought is a period of unusually persistent dry weather that persists long enough to cause serious problems such as damage to agriculture and rationing in the provision of potable water to the population. The severity of a drought depends on the degree of impairment in humidity levels, duration and size of the affected area.

There are four main approaches that can define a drought.

1. Meteorological Focus: a measure of deviation from normal precipitation levels. Due to climatic differences, which can be considered a drought in one country may not necessarily be a drought elsewhere.
2. Agricultural Focus: refers to the situation where the amount of moisture in the soil does not meet the needs of a particular crop.
3. Hydrological Focus: occurs when surface water sources and groundwater are below normal.
4. Socioeconomic Focus: refers to the situation that occurs when physical shortages in water supplies begin to affect people.

The main cause of any drought is lack of rain or precipitation – a phenomenon called meteorological drought. Persistent meteorological drought leads to a hydrological drought characterized by a disparity between the natural availability of water and natural water demands. In extreme cases you can get to drought. The lack of precipitation for an extended period of time can have disastrous consequences for agriculture and metropolitan areas. In some areas of the country, it does not take long as several weeks without rain to cause damage to crops. These areas must take measures on consumption savings, such as rationing.

Data and Methods

Produced jointly by the National Drought Mitigation Center (NDMC) at the University of Nebraska-Lincoln, the National Oceanic and Atmospheric Administration (NOAA), and the U.S. Department of Agriculture (USDA), the United States Drought Monitor (USDM) provides geospatial representations of drought hazard areas for the entire US and outlying areas. The NDMC hosts the web site of the drought monitor and the associated data, and provides the map and data to NOAA, USDA and other agencies.²⁶ Polygons produced by the USDM represent areas that have had drought conditions from 2000-2019 across Puerto Rico. Each hexagonal grid was populated with the number of instances (weeks) of drought and categorized using an equal interval classification.

²⁶ <https://droughtmonitor.unl.edu/>

Hazard Frequency Analysis Results

Drought hazard is most prevalent in the south central and central island areas and radiates out along the southern coast and into the central and north central portions of the island (Figure 17). Salinas municipio, with 58 square miles) has 83% of its land area in the highest drought frequency category (Table 48, Table 49) and more than 63% of all the high drought areas across the island are also located here (Table 50). Several surrounding municipios have a majority (if not all) of their individual land area in the medium-high drought category (Table 49) and when ranking each municipio across all hazard categories by area one can easily see the most threatened areas in terms of drought (Table 51).

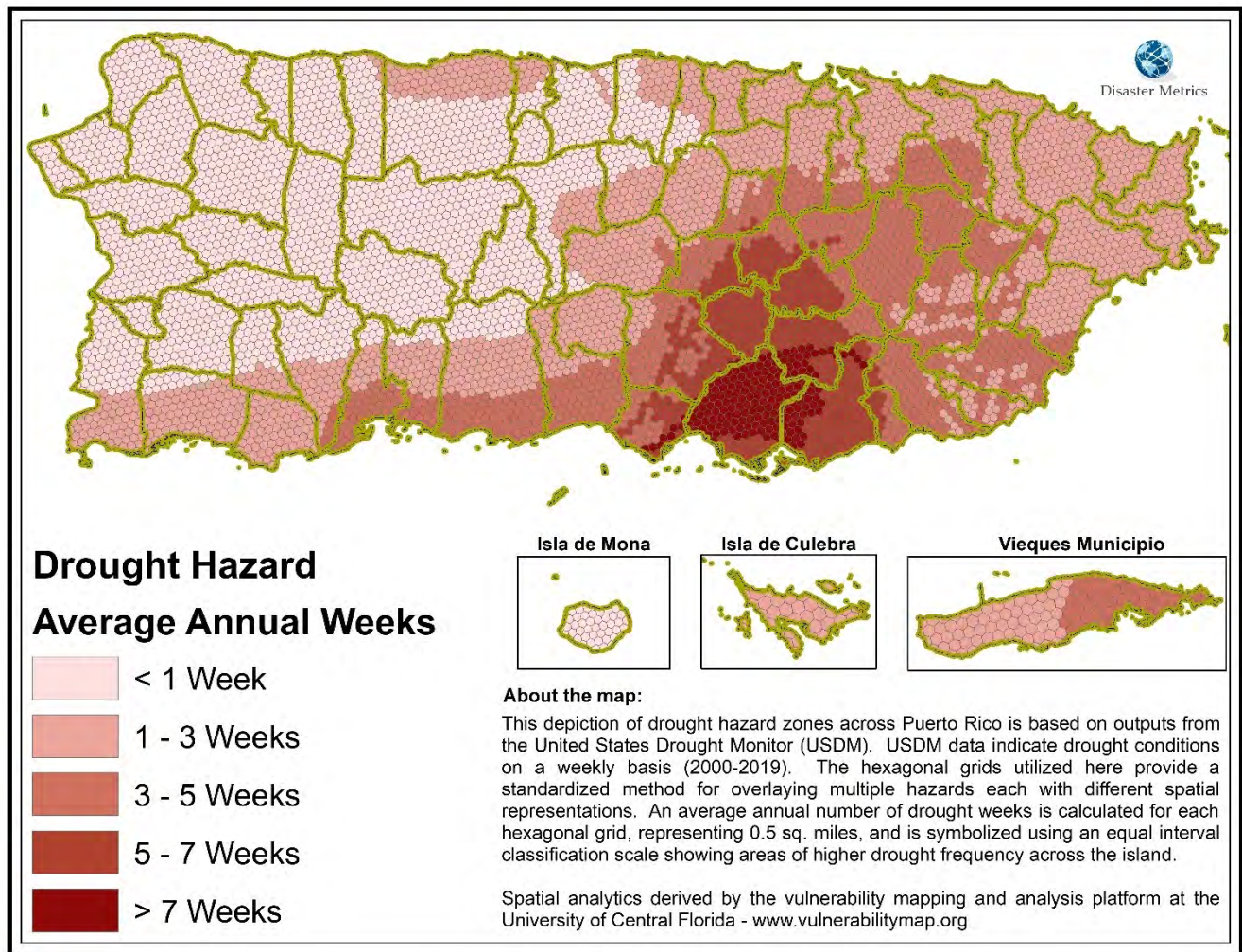


Figure 17: Drought Hazard Areas

Table 48: Drought Hazard by Municipio and Areal Extent

| Municipio | HEX GRID Area by Drought Frequency (Sq. miles) | | | | |
|-----------|--|-----------------------------|-------------------------|------------------------------|---------------------|
| | Low (< 1 Week) | Medium Low (1 – 3 Weeks) | Medium (3 – 5 Weeks) | Medium High (5 – 7 Weeks) | High (> 7 Weeks) |
| Adjuntas | 67.10 | | | | |

| | | | | | |
|--------------|-------|-------|-------|-------|-------|
| Aguada | 30.92 | | | | |
| Aguadilla | 36.61 | | | | |
| Aguas Buenas | | | 28.60 | 1.50 | |
| Aibonito | | | 0.36 | 30.64 | 0.34 |
| Anasco | 39.56 | | | | |
| Arecibo | 83.00 | 43.98 | | | |
| Arroyo | | | 9.61 | 5.44 | |
| Barceloneta | 9.58 | 9.18 | | | |
| Barranquitas | | 1.76 | 19.65 | 12.88 | |
| Bayamon | | 27.40 | 17.11 | | |
| Cabo Rojo | 41.43 | 31.69 | | | |
| Caguas | | 2.70 | 56.36 | | |
| Camuy | 46.37 | | | | |
| Canovanas | | 30.86 | 2.15 | | |
| Cantano | | 29.91 | 17.39 | | |
| Carolina | 0.02 | 5.06 | | | |
| Cayey | | | 11.57 | 28.96 | 11.43 |
| Ceiba | 0.00 | 30.37 | | | |
| Ciales | 47.74 | 18.96 | | | |
| Cidra | | | 9.52 | 26.93 | |
| Coamo | | 10.57 | 38.38 | 27.62 | 1.47 |
| Comerio | | | 10.12 | 18.41 | |
| Corozal | 1.49 | 40.06 | 1.03 | | |
| Culebra | 0.06 | 13.25 | | | |
| Dorado | 0.04 | 23.38 | | | |
| Fajardo | 0.35 | 30.16 | | | |
| Florida | 15.22 | | | | |
| Guanica | 0.02 | 38.97 | 0.02 | | |
| Guayama | 0.13 | | 2.30 | 46.49 | 16.95 |
| Guayanilla | 6.71 | 12.99 | 23.29 | | |
| Guaynabo | | 16.11 | 11.66 | | |
| Gurabo | | 0.48 | 27.83 | | |
| Hatillo | 39.17 | 2.67 | | | |
| Hormigueros | 11.34 | | | | |
| Humacao | 0.01 | 36.22 | 8.87 | | |
| Isabela | 55.41 | | | | |
| Jayuya | 44.53 | | | | |
| Juana Diaz | 0.71 | 20.47 | 39.56 | | |
| Juncos | | 6.74 | 19.87 | | |
| Lajas | 11.55 | 49.81 | | | |
| Lares | 61.64 | | | | |
| Las Marias | 46.51 | | | | |

| | | | | | |
|--------------------|----------------|----------------|---------------|---------------|--------------|
| Las Piedras | | 19.75 | 14.14 | | |
| Loiza | | 20.53 | | | |
| Luquillo | 0.02 | 25.84 | | | |
| Manati | 43.30 | 3.52 | | | |
| Maricao | 36.63 | | | | |
| Maunabo | 0.07 | 13.32 | 7.70 | | |
| Mayaguez | 77.97 | | | | |
| Moca | 50.37 | | | | |
| Morovis | 13.52 | 25.40 | | | |
| Naguabo | 0.01 | 51.63 | 0.24 | | |
| Naranjito | | 8.50 | 17.82 | 1.42 | |
| Orocovis | 5.36 | 52.75 | 5.66 | | |
| Patillas | 0.00 | 6.48 | 37.57 | 3.16 | |
| Penuelas | 9.13 | 24.23 | 11.40 | | |
| Ponce | 28.82 | 46.52 | 41.64 | | |
| Quebradillas | 23.14 | | | | |
| Rio Grande | 14.39 | | | | |
| Rincon | | 60.81 | | | |
| Sabana Grande | 23.76 | 12.08 | | | |
| Salinas | 0.36 | | | 11.41 | 58.29 |
| San German | 54.48 | 0.03 | | | |
| San Juan | 0.00 | 43.83 | 5.70 | | |
| San Lorenzo | | 20.48 | 32.73 | | |
| San Sebastian | 71.22 | | | | |
| Santa Isabel | 0.11 | | 16.30 | 14.01 | 4.15 |
| Toa Alta | 1.22 | 25.45 | 0.89 | | |
| Toa Baja | | 23.80 | | | |
| Trujillo Alto | | 2.49 | 18.89 | | |
| Utua | 115.07 | | | | |
| Vega Alta | 11.47 | 16.27 | | | |
| Vega Baja | 29.57 | 17.08 | | | |
| Vieques | 0.03 | 30.46 | 22.69 | | |
| Villalba | 0.16 | 36.69 | 0.19 | | |
| Yabucoa | | 14.58 | 40.83 | | |
| Yauco | 39.32 | 24.22 | 5.28 | | |
| Grand Total | 1346.72 | 1160.50 | 634.92 | 228.85 | 92.63 |

Table 49: Percent of (Municipio) Hexagonal Area by Drought Hazard per Municipio

| Municipio | Drought Percent Area by Total (Municipio) Land Area | | | | |
|-----------|---|------------------------------|--------------------------|-------------------------------|----------------------|
| | Low (< 1 Week) | Medium Low (1 – 3 Weeks) | Medium (3 – 5 Weeks) | Medium High (5 – 7 Weeks) | High (> 7 Weeks) |

| | | | | | |
|--------------|---------|--------|--------|--------|--------|
| Adjuntas | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Aguada | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Aguadilla | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Aguas Buenas | 0.00% | 0.00% | 95.02% | 4.98% | 0.00% |
| Aibonito | 0.00% | 0.00% | 1.15% | 97.77% | 1.08% |
| Anasco | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Arecibo | 65.36% | 34.64% | 0.00% | 0.00% | 0.00% |
| Arroyo | 0.00% | 0.00% | 63.87% | 36.13% | 0.00% |
| Barceloneta | 51.05% | 48.95% | 0.00% | 0.00% | 0.00% |
| Barranquitas | 0.00% | 5.13% | 57.31% | 37.56% | 0.00% |
| Bayamon | 0.00% | 61.56% | 38.44% | 0.00% | 0.00% |
| Cabo Rojo | 56.66% | 43.34% | 0.00% | 0.00% | 0.00% |
| Caguas | 0.00% | 4.58% | 95.42% | 0.00% | 0.00% |
| Camuy | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Canovanas | 0.00% | 93.49% | 6.51% | 0.00% | 0.00% |
| Cantano | 0.00% | 63.24% | 36.76% | 0.00% | 0.00% |
| Carolina | 0.42% | 99.58% | 0.00% | 0.00% | 0.00% |
| Cayey | 0.00% | 0.00% | 22.27% | 55.73% | 22.00% |
| Ceiba | 0.02% | 99.98% | 0.00% | 0.00% | 0.00% |
| Ciales | 71.57% | 28.43% | 0.00% | 0.00% | 0.00% |
| Cidra | 0.00% | 0.00% | 26.12% | 73.88% | 0.00% |
| Coamo | 0.00% | 13.55% | 49.18% | 35.39% | 1.88% |
| Comerio | 0.00% | 0.00% | 35.47% | 64.53% | 0.00% |
| Corozal | 3.49% | 94.09% | 2.42% | 0.00% | 0.00% |
| Culebra | 0.44% | 99.56% | 0.00% | 0.00% | 0.00% |
| Dorado | 0.18% | 99.82% | 0.00% | 0.00% | 0.00% |
| Fajardo | 1.14% | 98.86% | 0.00% | 0.00% | 0.00% |
| Florida | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Guanica | 0.06% | 99.90% | 0.04% | 0.00% | 0.00% |
| Guayama | 0.19% | 0.00% | 3.48% | 70.58% | 25.74% |
| Guayanilla | 15.61% | 30.21% | 54.18% | 0.00% | 0.00% |
| Guaynabo | 0.00% | 58.02% | 41.98% | 0.00% | 0.00% |
| Gurabo | 0.00% | 1.70% | 98.30% | 0.00% | 0.00% |
| Hatillo | 93.62% | 6.38% | 0.00% | 0.00% | 0.00% |
| Hormigueros | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Humacao | 0.02% | 80.31% | 19.66% | 0.00% | 0.00% |
| Isabela | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Jayuya | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Juana Diaz | 1.17% | 33.70% | 65.13% | 0.00% | 0.00% |
| Juncos | 0.00% | 25.33% | 74.67% | 0.00% | 0.00% |
| Lajas | 18.83% | 81.17% | 0.00% | 0.00% | 0.00% |
| Lares | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |

| | | | | | |
|---------------|---------|---------|--------|--------|--------|
| Las Marias | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Las Piedras | 0.00% | 58.28% | 41.72% | 0.00% | 0.00% |
| Loiza | 0.00% | 100.00% | 0.00% | 0.00% | 0.00% |
| Luquillo | 0.09% | 99.91% | 0.00% | 0.00% | 0.00% |
| Manati | 92.49% | 7.51% | 0.00% | 0.00% | 0.00% |
| Maricao | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Maunabo | 0.33% | 63.16% | 36.51% | 0.00% | 0.00% |
| Mayaguez | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Moca | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Morovis | 34.74% | 65.26% | 0.00% | 0.00% | 0.00% |
| Naguabo | 0.02% | 99.51% | 0.47% | 0.00% | 0.00% |
| Naranjito | 0.00% | 30.65% | 64.23% | 5.12% | 0.00% |
| Orocovis | 8.41% | 82.71% | 8.88% | 0.00% | 0.00% |
| Patillas | 0.01% | 13.73% | 79.58% | 6.69% | 0.00% |
| Penuelas | 20.41% | 54.13% | 25.47% | 0.00% | 0.00% |
| Ponce | 24.64% | 39.77% | 35.59% | 0.00% | 0.00% |
| Quebradillas | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Rio Grande | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Rincon | 0.00% | 100.00% | 0.00% | 0.00% | 0.00% |
| Sabana Grande | 66.30% | 33.70% | 0.00% | 0.00% | 0.00% |
| Salinas | 0.51% | 0.00% | 0.00% | 16.28% | 83.21% |
| San German | 99.94% | 0.06% | 0.00% | 0.00% | 0.00% |
| San Juan | 0.00% | 88.49% | 11.51% | 0.00% | 0.00% |
| San Lorenzo | 0.00% | 38.49% | 61.51% | 0.00% | 0.00% |
| San Sebastian | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Santa Isabel | 0.32% | 0.00% | 47.15% | 40.53% | 12.00% |
| Toa Alta | 4.43% | 92.34% | 3.23% | 0.00% | 0.00% |
| Toa Baja | 0.00% | 100.00% | 0.00% | 0.00% | 0.00% |
| Trujillo Alto | 0.00% | 11.65% | 88.35% | 0.00% | 0.00% |
| Utuado | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Vega Alta | 41.36% | 58.64% | 0.00% | 0.00% | 0.00% |
| Vega Baja | 63.40% | 36.60% | 0.00% | 0.00% | 0.00% |
| Vieques | 0.06% | 57.28% | 42.66% | 0.00% | 0.00% |
| Villalba | 0.42% | 99.06% | 0.52% | 0.00% | 0.00% |
| Yabucoa | 0.00% | 26.31% | 73.69% | 0.00% | 0.00% |
| Yauco | 57.13% | 35.19% | 7.68% | 0.00% | 0.00% |

Table 50: Percent of (Island) Hexagonal Area by Drought Hazard per Municipio

| Municipio | Drought Percent Area by Total (Island) Land Area | | | | |
|-----------|--|-----------------------------|-------------------------|------------------------------|---------------------|
| | Low (< 1 Week) | Medium Low (1 – 3 Weeks) | Medium (3 – 5 Weeks) | Medium High (5 – 7 Weeks) | High (> 7 Weeks) |
| Adjuntas | 4.98% | 0.00% | 0.00% | 0.00% | 0.00% |

| | | | | | |
|--------------|-------|-------|-------|--------|--------|
| Aguada | 2.30% | 0.00% | 0.00% | 0.00% | 0.00% |
| Aguadilla | 2.72% | 0.00% | 0.00% | 0.00% | 0.00% |
| Aguas Buenas | 0.00% | 0.00% | 4.50% | 0.66% | 0.00% |
| Aibonito | 0.00% | 0.00% | 0.06% | 13.39% | 0.36% |
| Anasco | 2.94% | 0.00% | 0.00% | 0.00% | 0.00% |
| Arecibo | 6.16% | 3.79% | 0.00% | 0.00% | 0.00% |
| Arroyo | 0.00% | 0.00% | 1.51% | 2.38% | 0.00% |
| Barceloneta | 0.71% | 0.79% | 0.00% | 0.00% | 0.00% |
| Barranquitas | 0.00% | 0.15% | 3.09% | 5.63% | 0.00% |
| Bayamon | 0.00% | 2.36% | 2.69% | 0.00% | 0.00% |
| Cabo Rojo | 3.08% | 2.73% | 0.00% | 0.00% | 0.00% |
| Caguas | 0.00% | 0.23% | 8.88% | 0.00% | 0.00% |
| Camuy | 3.44% | 0.00% | 0.00% | 0.00% | 0.00% |
| Canovanas | 0.00% | 2.66% | 0.34% | 0.00% | 0.00% |
| Cantano | 0.00% | 2.58% | 2.74% | 0.00% | 0.00% |
| Carolina | 0.00% | 0.44% | 0.00% | 0.00% | 0.00% |
| Cayey | 0.00% | 0.00% | 1.82% | 12.65% | 12.34% |
| Ceiba | 0.00% | 2.62% | 0.00% | 0.00% | 0.00% |
| Ciales | 3.55% | 1.63% | 0.00% | 0.00% | 0.00% |
| Cidra | 0.00% | 0.00% | 1.50% | 11.77% | 0.00% |
| Coamo | 0.00% | 0.91% | 6.04% | 12.07% | 1.58% |
| Comerio | 0.00% | 0.00% | 1.59% | 8.04% | 0.00% |
| Corozal | 0.11% | 3.45% | 0.16% | 0.00% | 0.00% |
| Culebra | 0.00% | 1.14% | 0.00% | 0.00% | 0.00% |
| Dorado | 0.00% | 2.01% | 0.00% | 0.00% | 0.00% |
| Fajardo | 0.03% | 2.60% | 0.00% | 0.00% | 0.00% |
| Florida | 1.13% | 0.00% | 0.00% | 0.00% | 0.00% |
| Guanica | 0.00% | 3.36% | 0.00% | 0.00% | 0.00% |
| Guayama | 0.01% | 0.00% | 0.36% | 20.31% | 18.30% |
| Guayanilla | 0.50% | 1.12% | 3.67% | 0.00% | 0.00% |
| Guaynabo | 0.00% | 1.39% | 1.84% | 0.00% | 0.00% |
| Gurabo | 0.00% | 0.04% | 4.38% | 0.00% | 0.00% |
| Hatillo | 2.91% | 0.23% | 0.00% | 0.00% | 0.00% |
| Hormigueros | 0.84% | 0.00% | 0.00% | 0.00% | 0.00% |
| Humacao | 0.00% | 3.12% | 1.40% | 0.00% | 0.00% |
| Isabela | 4.11% | 0.00% | 0.00% | 0.00% | 0.00% |
| Jayuya | 3.31% | 0.00% | 0.00% | 0.00% | 0.00% |
| Juana Diaz | 0.05% | 1.76% | 6.23% | 0.00% | 0.00% |
| Juncos | 0.00% | 0.58% | 3.13% | 0.00% | 0.00% |
| Lajas | 0.86% | 4.29% | 0.00% | 0.00% | 0.00% |
| Lares | 4.58% | 0.00% | 0.00% | 0.00% | 0.00% |
| Las Marias | 3.45% | 0.00% | 0.00% | 0.00% | 0.00% |

| | | | | | |
|---------------|-------|-------|-------|-------|--------|
| Las Piedras | 0.00% | 1.70% | 2.23% | 0.00% | 0.00% |
| Loiza | 0.00% | 1.77% | 0.00% | 0.00% | 0.00% |
| Luquillo | 0.00% | 2.23% | 0.00% | 0.00% | 0.00% |
| Manati | 3.22% | 0.30% | 0.00% | 0.00% | 0.00% |
| Maricao | 2.72% | 0.00% | 0.00% | 0.00% | 0.00% |
| Maunabo | 0.01% | 1.15% | 1.21% | 0.00% | 0.00% |
| Mayaguez | 5.79% | 0.00% | 0.00% | 0.00% | 0.00% |
| Moca | 3.74% | 0.00% | 0.00% | 0.00% | 0.00% |
| Morovis | 1.00% | 2.19% | 0.00% | 0.00% | 0.00% |
| Naguabo | 0.00% | 4.45% | 0.04% | 0.00% | 0.00% |
| Naranjito | 0.00% | 0.73% | 2.81% | 0.62% | 0.00% |
| Orocovis | 0.40% | 4.55% | 0.89% | 0.00% | 0.00% |
| Patillas | 0.00% | 0.56% | 5.92% | 1.38% | 0.00% |
| Penuelas | 0.68% | 2.09% | 1.80% | 0.00% | 0.00% |
| Ponce | 2.14% | 4.01% | 6.56% | 0.00% | 0.00% |
| Quebradillas | 1.72% | 0.00% | 0.00% | 0.00% | 0.00% |
| Rio Grande | 1.07% | 0.00% | 0.00% | 0.00% | 0.00% |
| Rincon | 0.00% | 5.24% | 0.00% | 0.00% | 0.00% |
| Sabana Grande | 1.76% | 1.04% | 0.00% | 0.00% | 0.00% |
| Salinas | 0.03% | 0.00% | 0.00% | 4.98% | 62.93% |
| San German | 4.05% | 0.00% | 0.00% | 0.00% | 0.00% |
| San Juan | 0.00% | 3.78% | 0.90% | 0.00% | 0.00% |
| San Lorenzo | 0.00% | 1.76% | 5.15% | 0.00% | 0.00% |
| San Sebastian | 5.29% | 0.00% | 0.00% | 0.00% | 0.00% |
| Santa Isabel | 0.01% | 0.00% | 2.57% | 6.12% | 4.48% |
| Toa Alta | 0.09% | 2.19% | 0.14% | 0.00% | 0.00% |
| Toa Baja | 0.00% | 2.05% | 0.00% | 0.00% | 0.00% |
| Trujillo Alto | 0.00% | 0.21% | 2.98% | 0.00% | 0.00% |
| Utua | 8.54% | 0.00% | 0.00% | 0.00% | 0.00% |
| Vega Alta | 0.85% | 1.40% | 0.00% | 0.00% | 0.00% |
| Vega Baja | 2.20% | 1.47% | 0.00% | 0.00% | 0.00% |
| Vieques | 0.00% | 2.62% | 3.57% | 0.00% | 0.00% |
| Villalba | 0.01% | 3.16% | 0.03% | 0.00% | 0.00% |
| Yabucoa | 0.00% | 1.26% | 6.43% | 0.00% | 0.00% |
| Yauco | 2.92% | 2.09% | 0.83% | 0.00% | 0.00% |

Table 51: Drought Hazard Scores and Ranks by Municipio

| Municipio | Drought Hazard Score (Log Multiplied) | | |
|-----------|---------------------------------------|--------------------------|----------------------|
| | Total Score | Standardized Score (0-1) | Rank of Score (1-78) |
| Salinas | 10,245.3534 | 1 | 1 |
| Guayama | 3,912.6122 | 0.3819 | 2 |

| | | | |
|---------------|------------|--------|----|
| Cayey | 2,604.1302 | 0.2542 | 3 |
| Santa Isabel | 1,042.0473 | 0.1017 | 4 |
| Coamo | 915.3007 | 0.0893 | 5 |
| Aibonito | 717.5077 | 0.07 | 6 |
| Cidra | 596.1961 | 0.0582 | 7 |
| Comerio | 413.8881 | 0.0404 | 8 |
| Barranquitas | 312.1129 | 0.0305 | 9 |
| Patillas | 135.6640 | 0.0132 | 10 |
| Arroyo | 133.9784 | 0.0131 | 11 |
| Caguas | 100.4445 | 0.0098 | 12 |
| Aguas Buenas | 82.9991 | 0.0081 | 13 |
| Ponce | 81.7744 | 0.008 | 14 |
| Yabucoa | 74.8380 | 0.0073 | 15 |
| Juana Diaz | 73.5514 | 0.0072 | 16 |
| Naranjito | 63.6018 | 0.0062 | 17 |
| San Lorenzo | 61.4303 | 0.006 | 18 |
| Gurabo | 49.4566 | 0.0048 | 19 |
| Vieques | 45.2656 | 0.0044 | 20 |
| Guayanilla | 43.5186 | 0.0042 | 21 |
| Carolina | 35.7718 | 0.0035 | 22 |
| Juncos | 36.3701 | 0.0035 | 22 |
| Bayamon | 34.8626 | 0.0034 | 24 |
| Trujillo Alto | 33.9242 | 0.0033 | 25 |
| Las Piedras | 28.3343 | 0.0028 | 26 |
| Penuelas | 24.2849 | 0.0024 | 27 |
| Guaynabo | 23.3302 | 0.0023 | 28 |
| Humacao | 21.6914 | 0.0021 | 29 |
| Orocovis | 18.7653 | 0.0018 | 30 |
| San Juan | 17.3171 | 0.0017 | 31 |
| Maunabo | 15.8500 | 0.0015 | 32 |
| Yauco | 13.7002 | 0.0013 | 33 |
| Rio Grande | 10.0000 | 0.001 | 34 |
| Canovanas | 8.8859 | 0.0009 | 35 |
| Naguabo | 8.9185 | 0.0009 | 35 |
| Arecibo | 7.9530 | 0.0008 | 37 |
| Corozal | 8.4282 | 0.0008 | 37 |
| Lajas | 8.2910 | 0.0008 | 37 |
| Guanica | 6.4373 | 0.0006 | 40 |
| Toa Alta | 5.7747 | 0.0006 | 40 |
| Villalba | 6.3746 | 0.0006 | 40 |
| Cabo Rojo | 5.5715 | 0.0005 | 43 |
| Ceiba | 4.9936 | 0.0005 | 43 |

| | | | |
|---------------|--------|--------|----|
| Fajardo | 4.9628 | 0.0005 | 43 |
| Dorado | 3.8443 | 0.0004 | 46 |
| Luquillo | 4.2487 | 0.0004 | 46 |
| Morovis | 4.2948 | 0.0004 | 46 |
| Toa Baja | 3.9142 | 0.0004 | 46 |
| Ciales | 3.5335 | 0.0003 | 50 |
| Loiza | 3.3766 | 0.0003 | 50 |
| Vega Alta | 2.7746 | 0.0003 | 50 |
| Vega Baja | 3.0648 | 0.0003 | 50 |
| Culebra | 2.1791 | 0.0002 | 54 |
| Sabana Grande | 2.1929 | 0.0002 | 54 |
| Barceloneta | 1.5931 | 0.0001 | 56 |
| Catano | 0.8327 | 0.0001 | 56 |
| Hatillo | 0.7797 | 0.0001 | 56 |
| Manati | 0.9547 | 0.0001 | 56 |
| Mayaguez | 0.6776 | 0.0001 | 56 |
| San Sebastian | 0.6189 | 0.0001 | 56 |
| Utuado | 1.0000 | 0.0001 | 56 |
| Adjuntas | 0.5831 | 0 | 63 |
| Aguada | 0.2687 | 0 | 63 |
| Aguadilla | 0.3181 | 0 | 63 |
| Anasco | 0.3438 | 0 | 63 |
| Camuy | 0.4030 | 0 | 63 |
| Florida | 0.1323 | 0 | 63 |
| Hormigueros | 0.0986 | 0 | 63 |
| Isabela | 0.4815 | 0 | 63 |
| Jayuya | 0.3870 | 0 | 63 |
| Lares | 0.5357 | 0 | 63 |
| Las Marias | 0.4042 | 0 | 63 |
| Maricao | 0.3183 | 0 | 63 |
| Moca | 0.4377 | 0 | 63 |
| Quebradillas | 0.2011 | 0 | 63 |
| Rincon | 0.1251 | 0 | 63 |
| San German | 0.4787 | 0 | 63 |

Wind

Hazard Overview

Wind is “the horizontal motion of the air past a given point”.²⁷ Winds occur when there are differences in air pressure, always moving from a location with high pressure to one with relatively lower pressure. Wind speed depends on two factors: (a) the pressure difference between two areas, and (b) and the distance between those two areas. Stronger winds occur the higher the pressure difference and/or the closer the areas of high/low pressure. Wind speed is usually expressed in miles per hour or knots. The direction from which the wind is blowing is used to describe the wind. For example, “westerly winds” mean winds are blowing from the west. The wind events discussed in this assessment are non-hurricane, and non-tornadic wind events (i.e., mostly thunderstorm winds). Very few wind advisory events, sustained winds of 30-39 miles per hour (mph.) or wind gusts of 46-57 mph. occur in Puerto Rico on an annual basis.

Data and Methods

Puerto Rico has only a limited number of weather stations on the island capable of collecting crucial hourly information about temperature, fog, wind, and other atmospheric conditions. Using insufficient data coverage to determine wind hazard zones could result in both under and over-estimation of hazard areas. Because Puerto Rico’s wind sensor array is less than optimal, this assessment used hourly 10-meter u- and v- wind component data (unit:m/s) (1989-2018) obtained from ERA5 (ECMWF Atmospheric Reanalysis, the fifth generation) data. This satellite derived dataset of wind speeds has a spatial resolution of 0.25-degree latitude-longitude. The hourly windspeed at 10-meter is calculated from u- and v- wind components. As for each hexagon, the daily max hourly wind speed is determined first, then the average annual number of days that daily max hourly wind speed exceeds 30-kt is calculated.

Hazard Frequency Analysis Results

Wind hazard is a lower threat to lives, livelihoods, and infrastructure across Puerto Rico than other hazards. Most non-hurricane related wind events do not reach the threshold to cause damage, however the frequency of 30 knot winds across the island merits review. Figure 18 shows average annual frequency of 30 knot wind events over the 30-year period from 1989-2018 and indicates that areas on the western and eastern portions of the island have slightly greater frequency than the remainder of the island. Table 52 shows the land area of each municipio based on wind hazard class. Coupled with Table 53 and Table 54, we can see that Vieques, Culebra, Ceiba all have land in high wind hazard zones and Cabo Rojo and Rio Grande, Aguadilla, and Isla de Mona all have significant

²⁷ National Weather Service, Glossary, <http://w1.weather.gov/glossary/>

land area in the medium high hazard zone. Table 55 provides a standardized wind hazard score and rank for Puerto Rico’s Municipios.

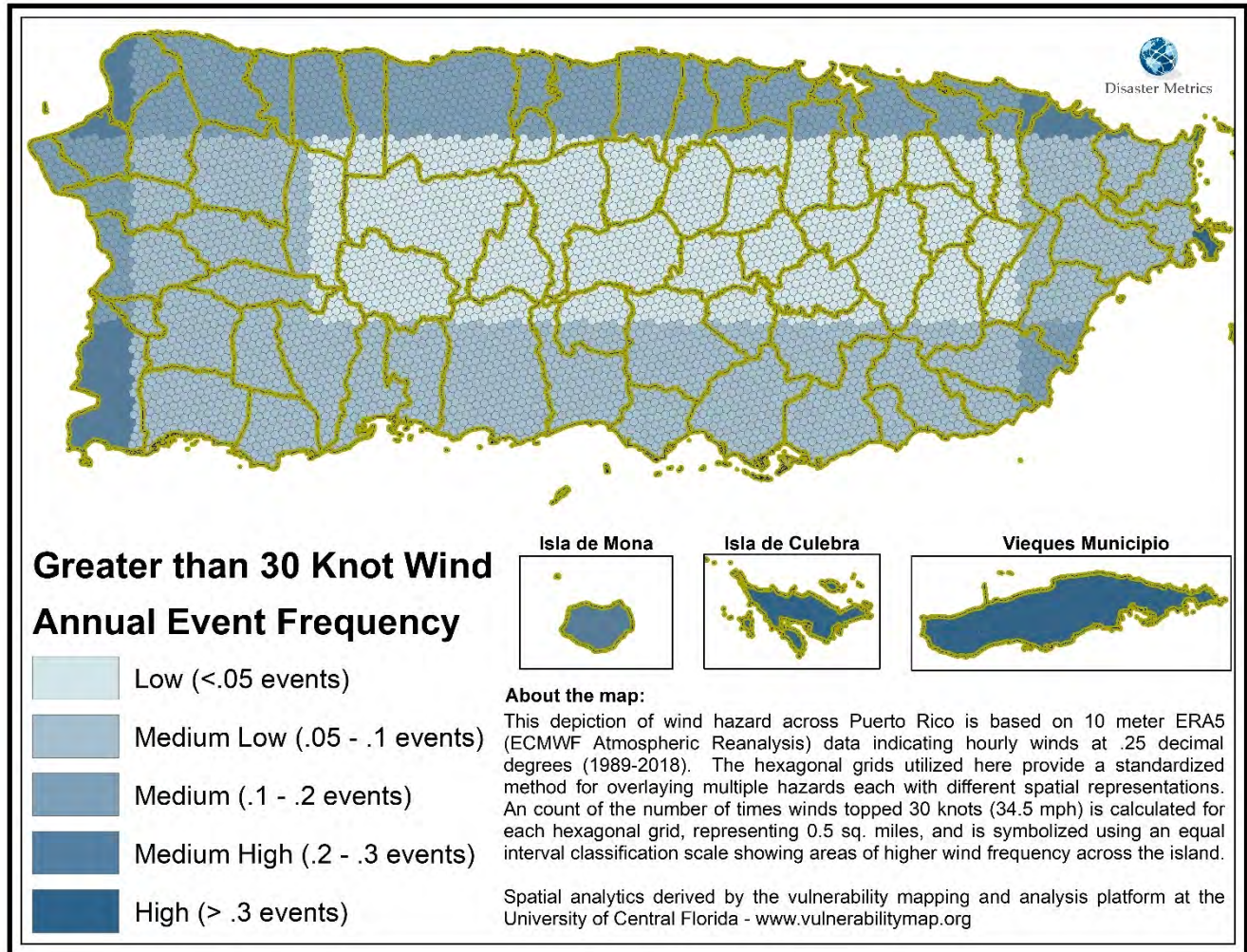


Figure 18: Wind Hazard Areas

Table 52: Wind Hazard by Municipio and Areal Extent

| Municipio | HEX GRID Area by Wind Frequency (Sq. miles) | | | | |
|--------------|---|------------------------------|-------------------------|------------------------------|--------------------|
| | Low (< .05 Events) | Medium Low (.05 - .1 Events) | Medium (.1 - .2 Events) | Medium High (.2 - .3 Events) | High (> .3 events) |
| Adjuntas | 65.57 | 1.53 | | | |
| Aguada | | | 22.09 | 8.83 | |
| Aguadilla | | | 18.95 | 17.65 | |
| Aguas Buenas | 30.10 | | | | |
| Aibonito | 18.83 | 12.51 | | | |
| Anasco | | 22.04 | 17.52 | | |
| Arecibo | 37.77 | | 89.21 | | |
| Arroyo | | 15.05 | | | |
| Barceloneta | | | 18.76 | | |
| Barranquitas | 34.28 | | | | |

| | | | | | |
|-------------|-------|-------|-------|-------|-------|
| Bayamon | 29.06 | | 15.46 | | |
| Cabo Rojo | | 12.74 | 5.38 | 55.00 | |
| Caguas | 57.95 | 1.12 | | | |
| Camuy | 5.92 | 1.27 | 39.18 | | |
| Canovanas | 18.39 | 7.06 | 6.98 | 0.58 | |
| Cantano | 21.93 | | 25.37 | | |
| Carolina | | | 5.08 | | |
| Cayey | 12.82 | 39.14 | | | |
| Ceiba | | 25.41 | | | 4.96 |
| Ciales | 66.69 | | 0.02 | | |
| Cidra | 36.46 | | | | |
| Coamo | 20.88 | 57.15 | | | |
| Comerio | 28.52 | | | | |
| Corozal | 42.58 | | | | |
| Culebra | | | | | 13.31 |
| Dorado | | | 23.42 | | |
| Fajardo | | 28.86 | | 0.25 | 1.40 |
| Florida | 8.01 | | 7.21 | | |
| Guanica | | 39.01 | | | |
| Guayama | | 65.87 | | | |
| Guayanilla | 1.05 | 41.94 | | | |
| Guaynabo | 21.33 | | 6.44 | | |
| Gurabo | 28.31 | | | | |
| Hatillo | 12.50 | | 29.34 | | |
| Hormigueros | | 8.04 | 3.00 | 0.30 | |
| Humacao | | 32.18 | 12.92 | | |
| Isabela | | 0.06 | 55.35 | | |
| Jayuya | 44.53 | | | | |
| Juana Diaz | 4.28 | 56.45 | | | |
| Juncos | 24.29 | 2.32 | | | |
| Lajas | | 61.36 | | | |
| Lares | 37.34 | 24.30 | | | |
| Las Marias | | 46.51 | | | |
| Las Piedras | 13.39 | 20.35 | 0.16 | | |
| Loiza | | | 13.58 | 6.96 | |
| Luquillo | | 24.16 | | 1.70 | |
| Manati | 4.16 | | 42.66 | | |
| Maricao | 4.26 | 32.36 | | | |
| Maunabo | | 19.49 | 1.60 | | |
| Mayaguez | | 33.54 | 21.66 | 22.18 | 0.59 |
| Moca | | 22.46 | 27.40 | 0.51 | |
| Morovis | 38.80 | | 0.12 | | |

| | | | | | |
|---------------|---------|---------|--------|--------|-------|
| Naguabo | | 51.88 | | | |
| Naranjito | 27.75 | | | | |
| Orocovis | 63.78 | | | | |
| Patillas | | 47.21 | 0.00 | | |
| Penuelas | 1.23 | 43.53 | | | |
| Ponce | 18.15 | 98.83 | | | |
| Quebradillas | | 0.44 | 22.70 | | |
| Rio Grande | | | 14.29 | 0.10 | |
| Rincon | 0.15 | 44.77 | | 15.90 | |
| Sabana Grande | | 35.84 | | | |
| Salinas | | 70.06 | | | |
| San German | | 54.51 | | | |
| San Juan | 17.85 | | 31.67 | | |
| San Lorenzo | 35.67 | 17.54 | | | |
| San Sebastian | | 64.76 | 6.46 | | |
| Santa Isabel | | 34.57 | | | |
| Toa Alta | 19.51 | | 8.05 | | |
| Toa Baja | | | 23.80 | | |
| Trujillo Alto | 20.91 | | 0.47 | | |
| Utua | 115.07 | | | | |
| Vega Alta | 5.37 | | 22.37 | | |
| Vega Baja | 3.46 | | 43.19 | | |
| Vieques | | | | | 53.18 |
| Villalba | 19.91 | 17.13 | | | |
| Yabucoa | 0.15 | 35.03 | 20.23 | | |
| Yauco | 9.58 | 59.24 | | | |
| Grand Total | 1128.50 | 1429.63 | 702.10 | 129.96 | 73.44 |

Table 53: Percent of (Municipio) Hexagonal Area by Wind Hazard per Municipio

| Municipio | Wind Percent Area by Total (Municipio) Land Area | | | | |
|--------------|--|---------------------------------|----------------------------|---------------------------------|-----------------------|
| | Low (< .05 Events) | Medium Low (.05 - .1 Events) | Medium (.1 - .2 Events) | Medium High (.2 - .3 Events) | High (> .3 events) |
| Adjuntas | 97.72% | 2.28% | 0.00% | 0.00% | 0.00% |
| Aguada | 0.00% | 0.00% | 71.43% | 28.57% | 0.00% |
| Aguadilla | 0.00% | 0.00% | 51.78% | 48.22% | 0.00% |
| Aguas Buenas | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Aibonito | 60.07% | 39.93% | 0.00% | 0.00% | 0.00% |
| Anasco | 0.00% | 55.72% | 44.28% | 0.00% | 0.00% |
| Arecibo | 29.74% | 0.00% | 70.26% | 0.00% | 0.00% |
| Arroyo | 0.00% | 100.00% | 0.00% | 0.00% | 0.00% |
| Barceloneta | 0.00% | 0.00% | 100.00% | 0.00% | 0.00% |

| | | | | | |
|--------------|---------|---------|---------|--------|---------|
| Barranquitas | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Bayamon | 65.27% | 0.00% | 34.73% | 0.00% | 0.00% |
| Cabo Rojo | 0.00% | 17.42% | 7.36% | 75.22% | 0.00% |
| Caguas | 98.10% | 1.90% | 0.00% | 0.00% | 0.00% |
| Camuy | 12.77% | 2.74% | 84.49% | 0.00% | 0.00% |
| Canovanas | 55.71% | 21.39% | 21.15% | 1.75% | 0.00% |
| Cantano | 46.37% | 0.00% | 53.63% | 0.00% | 0.00% |
| Carolina | 0.00% | 0.00% | 100.00% | 0.00% | 0.00% |
| Cayey | 24.67% | 75.33% | 0.00% | 0.00% | 0.00% |
| Ceiba | 0.00% | 83.67% | 0.00% | 0.00% | 16.33% |
| Ciales | 99.97% | 0.00% | 0.03% | 0.00% | 0.00% |
| Cidra | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Coamo | 26.76% | 73.24% | 0.00% | 0.00% | 0.00% |
| Comerio | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Corozal | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Culebra | 0.00% | 0.00% | 0.00% | 0.00% | 100.00% |
| Dorado | 0.00% | 0.00% | 100.00% | 0.00% | 0.00% |
| Fajardo | 0.00% | 94.60% | 0.00% | 0.81% | 4.59% |
| Florida | 52.62% | 0.00% | 47.38% | 0.00% | 0.00% |
| Guanica | 0.00% | 100.00% | 0.00% | 0.00% | 0.00% |
| Guayama | 0.00% | 100.00% | 0.00% | 0.00% | 0.00% |
| Guayanilla | 2.45% | 97.55% | 0.00% | 0.00% | 0.00% |
| Guaynabo | 76.81% | 0.00% | 23.19% | 0.00% | 0.00% |
| Gurabo | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Hatillo | 29.88% | 0.00% | 70.12% | 0.00% | 0.00% |
| Hormigueros | 0.00% | 70.90% | 26.44% | 2.66% | 0.00% |
| Humacao | 0.00% | 71.36% | 28.64% | 0.00% | 0.00% |
| Isabela | 0.00% | 0.10% | 99.90% | 0.00% | 0.00% |
| Jayuya | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Juana Diaz | 7.05% | 92.95% | 0.00% | 0.00% | 0.00% |
| Juncos | 91.28% | 8.72% | 0.00% | 0.00% | 0.00% |
| Lajas | 0.00% | 100.00% | 0.00% | 0.00% | 0.00% |
| Lares | 60.58% | 39.42% | 0.00% | 0.00% | 0.00% |
| Las Marias | 0.00% | 100.00% | 0.00% | 0.00% | 0.00% |
| Las Piedras | 39.51% | 60.03% | 0.46% | 0.00% | 0.00% |
| Loiza | 0.00% | 0.00% | 66.11% | 33.89% | 0.00% |
| Luquillo | 0.00% | 93.44% | 0.00% | 6.56% | 0.00% |
| Manati | 8.88% | 0.00% | 91.12% | 0.00% | 0.00% |
| Maricao | 11.64% | 88.36% | 0.00% | 0.00% | 0.00% |
| Maunabo | 0.00% | 92.42% | 7.58% | 0.00% | 0.00% |
| Mayaguez | 0.00% | 43.02% | 27.78% | 28.45% | 0.75% |
| Moca | 0.00% | 44.59% | 54.39% | 1.02% | 0.00% |

| | | | | | |
|---------------|---------|---------|---------|--------|---------|
| Morovis | 99.69% | 0.00% | 0.31% | 0.00% | 0.00% |
| Naguabo | 0.00% | 100.00% | 0.00% | 0.00% | 0.00% |
| Naranjito | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Orocovis | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Patillas | 0.00% | 99.99% | 0.01% | 0.00% | 0.00% |
| Penuelas | 2.75% | 97.25% | 0.00% | 0.00% | 0.00% |
| Ponce | 15.51% | 84.49% | 0.00% | 0.00% | 0.00% |
| Quebradillas | 0.00% | 1.89% | 98.11% | 0.00% | 0.00% |
| Rjo Grande | 0.00% | 0.00% | 99.32% | 0.68% | 0.00% |
| Rincon | 0.24% | 73.61% | 0.00% | 26.14% | 0.00% |
| Sabana Grande | 0.00% | 100.00% | 0.00% | 0.00% | 0.00% |
| Salinas | 0.00% | 100.00% | 0.00% | 0.00% | 0.00% |
| San German | 0.00% | 100.00% | 0.00% | 0.00% | 0.00% |
| San Juan | 36.05% | 0.00% | 63.95% | 0.00% | 0.00% |
| San Lorenzo | 67.04% | 32.96% | 0.00% | 0.00% | 0.00% |
| San Sebastian | 0.00% | 90.94% | 9.06% | 0.00% | 0.00% |
| Santa Isabel | 0.00% | 100.00% | 0.00% | 0.00% | 0.00% |
| Toa Alta | 70.78% | 0.00% | 29.22% | 0.00% | 0.00% |
| Toa Baja | 0.00% | 0.00% | 100.00% | 0.00% | 0.00% |
| Trujillo Alto | 97.79% | 0.00% | 2.21% | 0.00% | 0.00% |
| Utuado | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Vega Alta | 19.35% | 0.00% | 80.65% | 0.00% | 0.00% |
| Vega Baja | 7.41% | 0.00% | 92.59% | 0.00% | 0.00% |
| Vieques | 0.00% | 0.00% | 0.00% | 0.00% | 100.00% |
| Villalba | 53.75% | 46.25% | 0.00% | 0.00% | 0.00% |
| Yabucoa | 0.27% | 63.22% | 36.51% | 0.00% | 0.00% |
| Yauco | 13.91% | 86.09% | 0.00% | 0.00% | 0.00% |

Table 54: Percent of (Island) Hexagonal Area by Wind Hazard per Municipio

| Municipio | Wind Percent Area by Total (Island) Land Area | | | | |
|--------------|---|---------------------------------|----------------------------|---------------------------------|-----------------------|
| | Low (< .05 Events) | Medium Low (.05 - .1 Events) | Medium (.1 - .2 Events) | Medium High (.2 - .3 Events) | High (> .3 events) |
| Adjuntas | 4.87% | 0.13% | 0.00% | 0.00% | 0.00% |
| Aguada | 0.00% | 0.00% | 3.48% | 3.86% | 0.00% |
| Aguadilla | 0.00% | 0.00% | 2.99% | 7.71% | 0.00% |
| Aguas Buenas | 2.23% | 0.00% | 0.00% | 0.00% | 0.00% |
| Aibonito | 1.40% | 1.08% | 0.00% | 0.00% | 0.00% |
| Anasco | 0.00% | 1.90% | 2.76% | 0.00% | 0.00% |
| Arecibo | 2.80% | 0.00% | 14.05% | 0.00% | 0.00% |
| Arroyo | 0.00% | 1.30% | 0.00% | 0.00% | 0.00% |
| Barceloneta | 0.00% | 0.00% | 2.95% | 0.00% | 0.00% |
| Barranquitas | 2.55% | 0.00% | 0.00% | 0.00% | 0.00% |

| | | | | | |
|-------------|-------|-------|-------|--------|--------|
| Bayamon | 2.16% | 0.00% | 2.43% | 0.00% | 0.00% |
| Cabo Rojo | 0.00% | 1.10% | 0.85% | 24.03% | 0.00% |
| Caguas | 4.30% | 0.10% | 0.00% | 0.00% | 0.00% |
| Camuy | 0.44% | 0.11% | 6.17% | 0.00% | 0.00% |
| Canovanas | 1.37% | 0.61% | 1.10% | 0.25% | 0.00% |
| Cantano | 1.63% | 0.00% | 4.00% | 0.00% | 0.00% |
| Carolina | 0.00% | 0.00% | 0.80% | 0.00% | 0.00% |
| Cayey | 0.95% | 3.37% | 0.00% | 0.00% | 0.00% |
| Ceiba | 0.00% | 2.19% | 0.00% | 0.00% | 5.36% |
| Ciales | 4.95% | 0.00% | 0.00% | 0.00% | 0.00% |
| Cidra | 2.71% | 0.00% | 0.00% | 0.00% | 0.00% |
| Coamo | 1.55% | 4.92% | 0.00% | 0.00% | 0.00% |
| Comerio | 2.12% | 0.00% | 0.00% | 0.00% | 0.00% |
| Corozal | 3.16% | 0.00% | 0.00% | 0.00% | 0.00% |
| Culebra | 0.00% | 0.00% | 0.00% | 0.00% | 14.37% |
| Dorado | 0.00% | 0.00% | 3.69% | 0.00% | 0.00% |
| Fajardo | 0.00% | 2.49% | 0.00% | 0.11% | 1.51% |
| Florida | 0.59% | 0.00% | 1.14% | 0.00% | 0.00% |
| Guanica | 0.00% | 3.36% | 0.00% | 0.00% | 0.00% |
| Guayama | 0.00% | 5.68% | 0.00% | 0.00% | 0.00% |
| Guayanilla | 0.08% | 3.61% | 0.00% | 0.00% | 0.00% |
| Guaynabo | 1.58% | 0.00% | 1.01% | 0.00% | 0.00% |
| Gurabo | 2.10% | 0.00% | 0.00% | 0.00% | 0.00% |
| Hatillo | 0.93% | 0.00% | 4.62% | 0.00% | 0.00% |
| Hormigueros | 0.00% | 0.69% | 0.47% | 0.13% | 0.00% |
| Humacao | 0.00% | 2.77% | 2.03% | 0.00% | 0.00% |
| Isabela | 0.00% | 0.00% | 8.72% | 0.00% | 0.00% |
| Jayuya | 3.31% | 0.00% | 0.00% | 0.00% | 0.00% |
| Juana Diaz | 0.32% | 4.86% | 0.00% | 0.00% | 0.00% |
| Juncos | 1.80% | 0.20% | 0.00% | 0.00% | 0.00% |
| Lajas | 0.00% | 5.29% | 0.00% | 0.00% | 0.00% |
| Lares | 2.77% | 2.09% | 0.00% | 0.00% | 0.00% |
| Las Marias | 0.00% | 4.01% | 0.00% | 0.00% | 0.00% |
| Las Piedras | 0.99% | 1.75% | 0.02% | 0.00% | 0.00% |
| Loiza | 0.00% | 0.00% | 2.14% | 3.04% | 0.00% |
| Luquillo | 0.00% | 2.08% | 0.00% | 0.74% | 0.00% |
| Manati | 0.31% | 0.00% | 6.72% | 0.00% | 0.00% |
| Maricao | 0.32% | 2.79% | 0.00% | 0.00% | 0.00% |
| Maunabo | 0.00% | 1.68% | 0.25% | 0.00% | 0.00% |
| Mayaguez | 0.00% | 2.89% | 3.41% | 9.69% | 0.64% |
| Moca | 0.00% | 1.94% | 4.31% | 0.22% | 0.00% |
| Morovis | 2.88% | 0.00% | 0.02% | 0.00% | 0.00% |

| | | | | | |
|---------------|-------|-------|-------|-------|--------|
| Naguabo | 0.00% | 4.47% | 0.00% | 0.00% | 0.00% |
| Naranjito | 2.06% | 0.00% | 0.00% | 0.00% | 0.00% |
| Orocovis | 4.74% | 0.00% | 0.00% | 0.00% | 0.00% |
| Patillas | 0.00% | 4.07% | 0.00% | 0.00% | 0.00% |
| Penuelas | 0.09% | 3.75% | 0.00% | 0.00% | 0.00% |
| Ponce | 1.35% | 8.52% | 0.00% | 0.00% | 0.00% |
| Quebradillas | 0.00% | 0.04% | 3.58% | 0.00% | 0.00% |
| Rio Grande | 0.00% | 0.00% | 2.25% | 0.04% | 0.00% |
| Rincon | 0.01% | 3.86% | 0.00% | 6.95% | 0.00% |
| Sabana Grande | 0.00% | 3.09% | 0.00% | 0.00% | 0.00% |
| Salinas | 0.00% | 6.04% | 0.00% | 0.00% | 0.00% |
| San German | 0.00% | 4.70% | 0.00% | 0.00% | 0.00% |
| San Juan | 1.33% | 0.00% | 4.99% | 0.00% | 0.00% |
| San Lorenzo | 2.65% | 1.51% | 0.00% | 0.00% | 0.00% |
| San Sebastian | 0.00% | 5.58% | 1.02% | 0.00% | 0.00% |
| Santa Isabel | 0.00% | 2.98% | 0.00% | 0.00% | 0.00% |
| Toa Alta | 1.45% | 0.00% | 1.27% | 0.00% | 0.00% |
| Toa Baja | 0.00% | 0.00% | 3.75% | 0.00% | 0.00% |
| Trujillo Alto | 1.55% | 0.00% | 0.07% | 0.00% | 0.00% |
| Utua | 8.54% | 0.00% | 0.00% | 0.00% | 0.00% |
| Vega Alta | 0.40% | 0.00% | 3.52% | 0.00% | 0.00% |
| Vega Baja | 0.26% | 0.00% | 6.80% | 0.00% | 0.00% |
| Vieques | 0.00% | 0.00% | 0.00% | 0.00% | 57.41% |
| Villalba | 1.48% | 1.48% | 0.00% | 0.00% | 0.00% |
| Yabucoa | 0.01% | 3.02% | 3.19% | 0.00% | 0.00% |
| Yauco | 0.71% | 5.11% | 0.00% | 0.00% | 0.00% |

Table 55: Wind Hazard Scores and Ranks by Municipio

| Municipio | Wind Hazard Score (Log Multiplied) | | |
|-----------|------------------------------------|--------------------------|----------------------|
| | Total Score | Standardized Score (0-1) | Rank of Score (1-78) |
| Vieques | 10,000.0000 | 1 | 1 |
| Culebra | 2,502.1295 | 0.2502 | 2 |
| Cabo Rojo | 1,007.3185 | 0.1007 | 3 |
| Ceiba | 935.3059 | 0.0935 | 4 |
| Mayaguez | 541.6386 | 0.0541 | 5 |
| Aguadilla | 342.1955 | 0.0342 | 6 |
| Rincon | 293.5972 | 0.0293 | 7 |
| Fajardo | 270.9198 | 0.0271 | 8 |
| Aguada | 185.3915 | 0.0185 | 9 |
| Loiza | 141.7311 | 0.0141 | 10 |
| Arecibo | 100.3282 | 0.01 | 11 |

| | | | |
|---------------|---------|--------|----|
| Isabela | 62.0542 | 0.0062 | 12 |
| Manati | 47.8585 | 0.0048 | 13 |
| Vega Baja | 48.4455 | 0.0048 | 13 |
| Camuy | 44.0988 | 0.0044 | 15 |
| Moca | 42.3054 | 0.0042 | 16 |
| San Juan | 35.6610 | 0.0035 | 17 |
| Hatillo | 32.9946 | 0.0033 | 18 |
| Luquillo | 33.3097 | 0.0033 | 18 |
| Cantano | 28.6312 | 0.0028 | 20 |
| Dorado | 26.2499 | 0.0026 | 21 |
| Toa Baja | 26.6828 | 0.0026 | 21 |
| Yabucoa | 26.2214 | 0.0026 | 21 |
| Quebradillas | 25.4921 | 0.0025 | 24 |
| Vega Alta | 25.1267 | 0.0025 | 24 |
| Anasco | 21.8672 | 0.0022 | 26 |
| Barceloneta | 21.0282 | 0.0021 | 27 |
| Canovanas | 19.2284 | 0.0019 | 28 |
| Rio Grande | 17.7980 | 0.0018 | 29 |
| Bayamon | 17.5809 | 0.0017 | 30 |
| Humacao | 17.7381 | 0.0017 | 30 |
| San Sebastian | 13.7892 | 0.0014 | 32 |
| Ponce | 10.1577 | 0.001 | 33 |
| Hormigueros | 9.6635 | 0.0009 | 34 |
| Toa Alta | 9.1977 | 0.0009 | 34 |
| Florida | 8.1551 | 0.0008 | 36 |
| Guaynabo | 7.4028 | 0.0007 | 37 |
| Salinas | 7.0886 | 0.0007 | 37 |
| Coamo | 5.9639 | 0.0006 | 39 |
| Guayama | 6.6646 | 0.0006 | 39 |
| Juana Diaz | 5.7489 | 0.0006 | 39 |
| Lajas | 6.2089 | 0.0006 | 39 |
| Yauco | 6.0776 | 0.0006 | 39 |
| Carolina | 5.6993 | 0.0005 | 44 |
| Naguabo | 5.2494 | 0.0005 | 44 |
| Patillas | 4.7810 | 0.0005 | 44 |
| San German | 5.5153 | 0.0005 | 44 |
| Cayey | 4.0720 | 0.0004 | 48 |
| Guanica | 3.9473 | 0.0004 | 48 |
| Guayanilla | 4.2525 | 0.0004 | 48 |
| Las Marias | 4.7055 | 0.0004 | 48 |
| Maunabo | 3.7650 | 0.0004 | 48 |
| Penuelas | 4.4148 | 0.0004 | 48 |

| | | | |
|---------------|--------|--------|----|
| Lares | 2.7830 | 0.0003 | 54 |
| Maricao | 3.3116 | 0.0003 | 54 |
| Sabana Grande | 3.6266 | 0.0003 | 54 |
| Santa Isabel | 3.4983 | 0.0003 | 54 |
| Las Piedras | 2.3504 | 0.0002 | 58 |
| San Lorenzo | 2.0843 | 0.0002 | 58 |
| Villalba | 1.9062 | 0.0002 | 58 |
| Aibonito | 1.4296 | 0.0001 | 61 |
| Arroyo | 1.5225 | 0.0001 | 61 |
| Utua | 1.0000 | 0.0001 | 61 |
| Adjuntas | 0.7246 | 0.0000 | 64 |
| Aguas Buenas | 0.2615 | 0.0000 | 64 |
| Barranquitas | 0.2979 | 0.0000 | 64 |
| Caguas | 0.6169 | 0.0000 | 64 |
| Ciales | 0.6032 | 0.0000 | 64 |
| Cidra | 0.3168 | 0.0000 | 64 |
| Comerio | 0.2479 | 0.0000 | 64 |
| Corozal | 0.3700 | 0.0000 | 64 |
| Gurabo | 0.2461 | 0.0000 | 64 |
| Jayuya | 0.3870 | 0.0000 | 64 |
| Juncos | 0.4459 | 0.0000 | 64 |
| Morovis | 0.4732 | 0.0000 | 64 |
| Naranjito | 0.2411 | 0.0000 | 64 |
| Orocovis | 0.5542 | 0.0000 | 64 |
| Trujillo Alto | 0.7106 | 0.0000 | 64 |

Fog

Hazard Overview

Fog is a hazard to drivers, mariners, and aviators. Since 2003, three fatal plane crashes have been connected to fog events on Puerto Rico.²⁸ There are several different conditions under which fog forms. Across Puerto Rico, radiation fog is the most common type of fog. Radiation fog forms most frequently in the early morning as air near to the ground cools. When the air reaches saturation, fog will form. Initially, fog will form near or at the surface and will thicken as the air continues to cool (e.g., overnight) and also extend upward. Radiation fog mostly occurs in sheltered valleys and near bodies of water. Its appearance is usually patchy and localized since wind disrupts the development of radiation fog.²⁹ Fog in Puerto Rico dissipates quickly as air warms rapidly at daybreak.

Data and Methods

Global Historical Climatology Network (GHCN) data for Puerto Rico provided adequate information on fog hazard occurrence across eleven weather stations collecting this information between 1989-2018 (Figure 19). An island-wide depiction of daily fog frequency of occurrence was interpolated from these weather stations and summarized to the 0.5-mile hexagonal grid to provide a more nuanced understanding of fog hazard frequency across Puerto Rico.

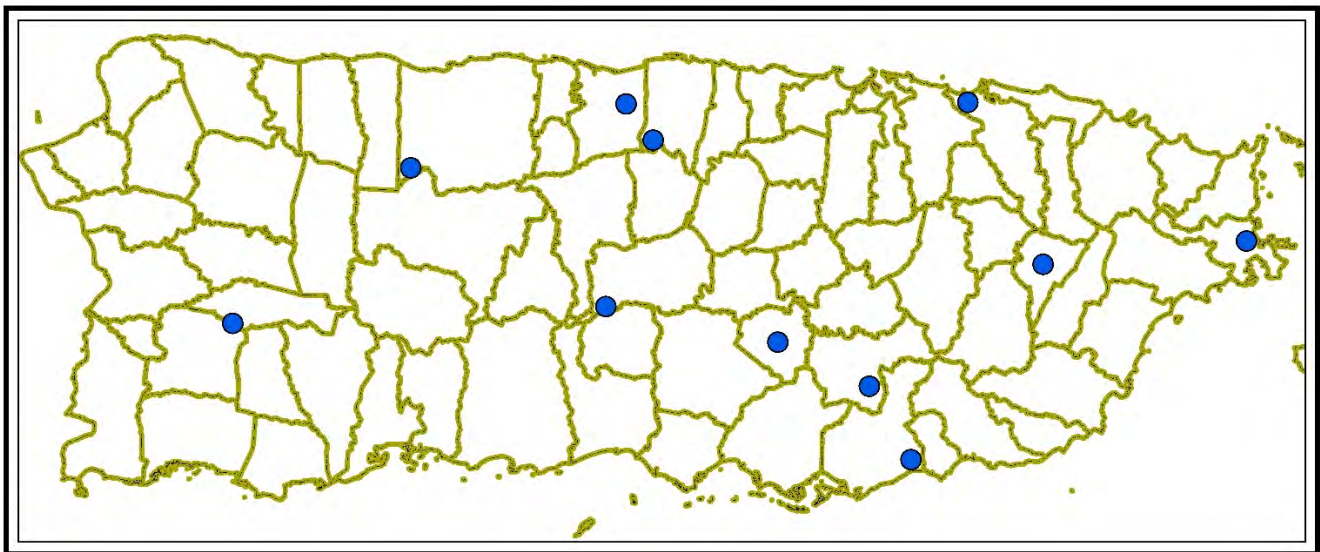


Figure 19: Weather Stations Collecting Daily Fog Hazard Information

²⁸ https://www.nts.gov/_layouts/nts.aviation/Results.aspx?queryId=cd2e02e2-52f4-43a4-8809-b5a2462b96a1

²⁹ <https://play.google.com/books/reader?id=n6MJAQAAIAAJ&hl=en&pg=GBS.PA1>

Hazard Frequency Analysis Results

Fog hazard is most frequent on eastern and northern portion of Puerto Rico with San Juan and surrounding municipios experiencing the highest average annual fog hazard occurrence. (Figure 20). Although fog is not a frequent hazard and does not cause significant damage to property and lives the spatial distribution of fog hazards affecting some places more than others should be noted (Table 56). Table 57 and Table 58 show the percentage of land area in each fog hazard class and Table 59 shows a total fog “score” and rank for each municipio across Puerto Rico.

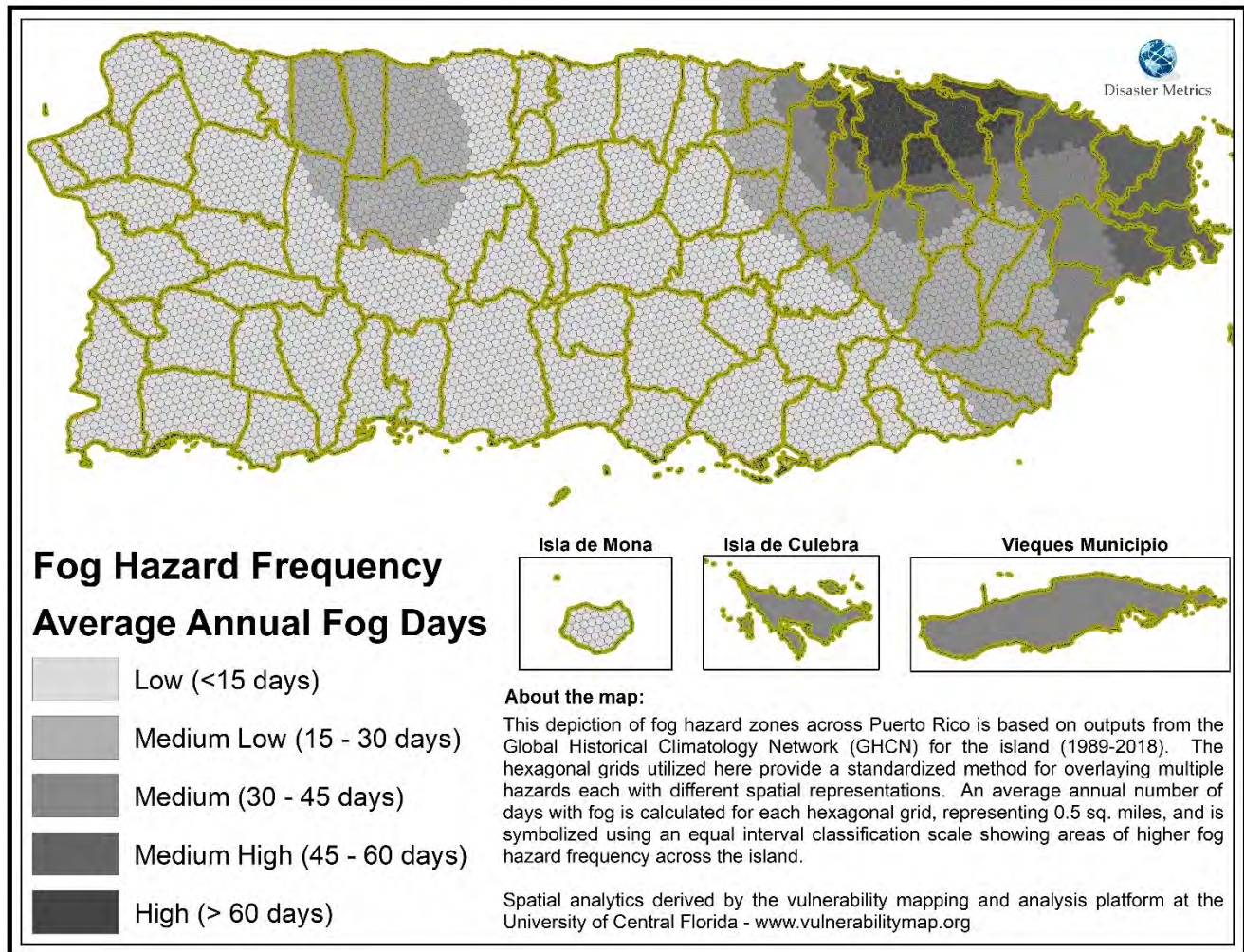


Figure 20: Fog Hazard Areas

Table 56: Fog Hazard by Municipio and Areal Extent

| Municipio | HEX GRID Area by Fog Hazard Frequency (Sq. miles) | | | | |
|--------------|---|---------------------------|-----------------------|----------------------------|------------------|
| | Low (< 16 days) | Medium Low (16 – 30 days) | Medium (31 – 45 days) | Medium High (46 – 60 days) | High (> 60 days) |
| Adjuntas | 64.19 | 2.91 | | | |
| Aguada | 30.92 | | | | |
| Aguadilla | 36.61 | | | | |
| Aguas Buenas | | 25.58 | 4.51 | | |

| | | | | | |
|--------------|-------|-------|-------|-------|-------|
| Aibonito | 31.34 | | | | |
| Anasco | 39.56 | | | | |
| Arecibo | 56.76 | 70.21 | | | |
| Arroyo | 15.05 | | | | |
| Barceloneta | 18.76 | | | | |
| Barranquitas | 34.28 | | | | |
| Bayamon | | 15.64 | 21.24 | 7.42 | 0.22 |
| Cabo Rojo | 73.12 | | | | |
| Caguas | 2.72 | 40.62 | 14.20 | 1.53 | |
| Camuy | 0.12 | 46.25 | | | |
| Canovanas | | 6.21 | 12.97 | 8.41 | 5.42 |
| Cantano | | 1.35 | 6.52 | 7.26 | 32.17 |
| Carolina | | | 0.00 | 4.44 | 0.64 |
| Cayey | 51.74 | 0.22 | | | |
| Ceiba | | | 2.02 | 28.35 | |
| Ciales | 66.71 | | | | |
| Cidra | 30.69 | 5.76 | | | |
| Coamo | 78.03 | | | | |
| Comerio | 22.09 | 6.44 | | | |
| Corozal | 42.51 | 0.07 | | | |
| Culebra | | | 13.31 | | |
| Dorado | 5.74 | 17.39 | 0.28 | | |
| Fajardo | | | 0.16 | 30.35 | |
| Florida | 15.22 | | | | |
| Guanica | 39.01 | | | | |
| Guayama | 65.87 | | | | |
| Guayanilla | 42.99 | | | | |
| Guaynabo | | 0.59 | 13.13 | 8.20 | 5.85 |
| Gurabo | | 11.15 | 15.16 | 2.00 | |
| Hatillo | | 41.84 | | | |
| Hormigueros | 11.34 | | | | |
| Humacao | | 19.48 | 25.63 | | |
| Isabela | 55.41 | | | | |
| Jayuya | 44.53 | | | | |
| Juana Diaz | 60.73 | | | | |
| Juncos | | 26.62 | | | |
| Lajas | 61.36 | | | | |
| Lares | 45.17 | 16.47 | | | |
| Las Marias | 46.51 | | | | |
| Las Piedras | | 29.58 | 4.31 | | |
| Loiza | | | | 6.93 | 13.61 |
| Luquillo | | | 0.98 | 24.88 | |

| | | | | | |
|---------------|---------|--------|--------|--------|--------|
| Manati | 46.82 | | | | |
| Maricao | 36.63 | | | | |
| Maunabo | 4.48 | 16.61 | | | |
| Mayaguez | 77.97 | | | | |
| Moca | 50.37 | | | | |
| Morovis | 38.93 | | | | |
| Naguabo | | 0.30 | 32.11 | 19.48 | |
| Naranjito | 12.87 | 14.88 | | | |
| Orocovis | 63.78 | | | | |
| Patillas | 46.27 | 0.95 | | | |
| Penuelas | 44.76 | | | | |
| Ponce | 116.98 | | | | |
| Quebradillas | 19.68 | 3.46 | | | |
| Rio Grande | 14.39 | | | | |
| Rincon | | | 35.10 | 25.71 | |
| Sabana Grande | 35.84 | | | | |
| Salinas | 70.06 | | | | |
| San German | 54.51 | | | | |
| San Juan | | | 0.88 | 8.06 | 40.58 |
| San Lorenzo | 2.14 | 51.07 | | | |
| San Sebastian | 71.18 | 0.04 | | | |
| Santa Isabel | 34.57 | | | | |
| Toa Alta | 3.47 | 23.64 | 0.45 | | |
| Toa Baja | | 11.43 | 11.26 | 1.11 | |
| Trujillo Alto | | | 2.35 | 7.37 | 11.66 |
| Utuado | 52.73 | 62.34 | | | |
| Vega Alta | 27.74 | | | | |
| Vega Baja | 46.65 | | | | |
| Vieques | | | 53.18 | 0.01 | |
| Villalba | 37.04 | | | | |
| Yabucoa | 1.71 | 53.70 | | | |
| Yauco | 68.82 | | | | |
| Grand Total | 2269.45 | 622.76 | 269.76 | 191.51 | 110.15 |

Table 57: Percent of (Municipio) Hexagonal Area by Fog Hazard per Municipio

| Municipio | Fog Hazard Percent Area by Total (Municipio) Land Area | | | | |
|-----------|--|---------------------------|-----------------------|----------------------------|------------------|
| | Low (< 16 days) | Medium Low (16 – 30 days) | Medium (31 – 45 days) | Medium High (46 – 60 days) | High (> 60 days) |
| Adjuntas | 95.67% | 4.33% | 0.00% | 0.00% | 0.00% |
| Aguada | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Aguadilla | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |

| | | | | | |
|--------------|---------|---------|---------|--------|--------|
| Aguas Buenas | 0.00% | 85.00% | 15.00% | 0.00% | 0.00% |
| Aibonito | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Anasco | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Arecibo | 44.70% | 55.30% | 0.00% | 0.00% | 0.00% |
| Arroyo | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Barceloneta | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Barranquitas | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Bayamon | 0.00% | 35.13% | 47.70% | 16.68% | 0.50% |
| Cabo Rojo | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Caguas | 4.60% | 68.77% | 24.05% | 2.59% | 0.00% |
| Camuy | 0.27% | 99.73% | 0.00% | 0.00% | 0.00% |
| Canovanas | 0.00% | 18.81% | 39.30% | 25.47% | 16.42% |
| Cantano | 0.00% | 2.85% | 13.79% | 15.34% | 68.02% |
| Carolina | 0.00% | 0.00% | 0.02% | 87.43% | 12.55% |
| Cayey | 99.58% | 0.42% | 0.00% | 0.00% | 0.00% |
| Ceiba | 0.00% | 0.00% | 6.65% | 93.35% | 0.00% |
| Ciales | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Cidra | 84.19% | 15.81% | 0.00% | 0.00% | 0.00% |
| Coamo | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Comerio | 77.43% | 22.57% | 0.00% | 0.00% | 0.00% |
| Corozal | 99.83% | 0.17% | 0.00% | 0.00% | 0.00% |
| Culebra | 0.00% | 0.00% | 100.00% | 0.00% | 0.00% |
| Dorado | 24.52% | 74.27% | 1.22% | 0.00% | 0.00% |
| Fajardo | 0.00% | 0.00% | 0.52% | 99.48% | 0.00% |
| Florida | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Guanica | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Guayama | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Guayanilla | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Guaynabo | 0.00% | 2.12% | 47.27% | 29.53% | 21.08% |
| Gurabo | 0.00% | 39.37% | 53.56% | 7.07% | 0.00% |
| Hatillo | 0.00% | 100.00% | 0.00% | 0.00% | 0.00% |
| Hormigueros | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Humacao | 0.00% | 43.18% | 56.82% | 0.00% | 0.00% |
| Isabela | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Jayuya | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Juana Diaz | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Juncos | 0.00% | 100.00% | 0.00% | 0.00% | 0.00% |
| Lajas | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Lares | 73.29% | 26.71% | 0.00% | 0.00% | 0.00% |
| Las Marias | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Las Piedras | 0.00% | 87.29% | 12.71% | 0.00% | 0.00% |
| Loiza | 0.00% | 0.00% | 0.00% | 33.74% | 66.26% |

| | | | | | |
|---------------|---------|--------|--------|--------|--------|
| Luquillo | 0.00% | 0.00% | 3.80% | 96.20% | 0.00% |
| Manati | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Maricao | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Maunabo | 21.25% | 78.75% | 0.00% | 0.00% | 0.00% |
| Mayaguez | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Moca | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Morovis | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Naguabo | 0.00% | 0.57% | 61.88% | 37.55% | 0.00% |
| Naranjito | 46.37% | 53.63% | 0.00% | 0.00% | 0.00% |
| Orocovis | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Patillas | 98.00% | 2.00% | 0.00% | 0.00% | 0.00% |
| Penuelas | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Ponce | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Quebradillas | 85.06% | 14.94% | 0.00% | 0.00% | 0.00% |
| Rio Grande | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Rincon | 0.00% | 0.00% | 57.72% | 42.28% | 0.00% |
| Sabana Grande | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Salinas | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| San German | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| San Juan | 0.00% | 0.00% | 1.78% | 16.28% | 81.94% |
| San Lorenzo | 4.02% | 95.98% | 0.00% | 0.00% | 0.00% |
| San Sebastian | 99.94% | 0.06% | 0.00% | 0.00% | 0.00% |
| Santa Isabel | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Toa Alta | 12.61% | 85.76% | 1.63% | 0.00% | 0.00% |
| Toa Baja | 0.00% | 48.02% | 47.30% | 4.68% | 0.00% |
| Trujillo Alto | 0.00% | 0.00% | 11.01% | 34.45% | 54.54% |
| Utua | 45.82% | 54.18% | 0.00% | 0.00% | 0.00% |
| Vega Alta | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Vega Baja | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Vieques | 0.00% | 0.00% | 99.99% | 0.01% | 0.00% |
| Villalba | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Yabucoa | 3.08% | 96.92% | 0.00% | 0.00% | 0.00% |
| Yauco | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |

Table 58: Percent of (Island) Hexagonal Area by Fog Hazard per Municipio

| Municipio | Fog Hazard Percent Area by Total (Island) Land Area | | | | |
|--------------|---|------------------------------|--------------------------|-------------------------------|----------------------|
| | Low (< 16 days) | Medium Low (16 – 30 days) | Medium (31 – 45 days) | Medium High (46 – 60 days) | High (> 60 days) |
| Adjuntas | 2.83% | 0.47% | 0.00% | 0.00% | 0.00% |
| Aguada | 1.36% | 0.00% | 0.00% | 0.00% | 0.00% |
| Aguadilla | 1.61% | 0.00% | 0.00% | 0.00% | 0.00% |
| Aguas Buenas | 0.00% | 4.11% | 1.67% | 0.00% | 0.00% |

| | | | | | |
|--------------|-------|--------|-------|--------|--------|
| Aibonito | 1.38% | 0.00% | 0.00% | 0.00% | 0.00% |
| Anasco | 1.74% | 0.00% | 0.00% | 0.00% | 0.00% |
| Arecibo | 2.50% | 11.27% | 0.00% | 0.00% | 0.00% |
| Arroyo | 0.66% | 0.00% | 0.00% | 0.00% | 0.00% |
| Barceloneta | 0.83% | 0.00% | 0.00% | 0.00% | 0.00% |
| Barranquitas | 1.51% | 0.00% | 0.00% | 0.00% | 0.00% |
| Bayamon | 0.00% | 2.51% | 7.87% | 3.88% | 0.20% |
| Cabo Rojo | 3.22% | 0.00% | 0.00% | 0.00% | 0.00% |
| Caguas | 0.12% | 6.52% | 5.27% | 0.80% | 0.00% |
| Camuy | 0.01% | 7.43% | 0.00% | 0.00% | 0.00% |
| Canovanas | 0.00% | 1.00% | 4.81% | 4.39% | 4.92% |
| Cantano | 0.00% | 0.22% | 2.42% | 3.79% | 29.21% |
| Carolina | 0.00% | 0.00% | 0.00% | 2.32% | 0.58% |
| Cayey | 2.28% | 0.04% | 0.00% | 0.00% | 0.00% |
| Ceiba | 0.00% | 0.00% | 0.75% | 14.80% | 0.00% |
| Ciales | 2.94% | 0.00% | 0.00% | 0.00% | 0.00% |
| Cidra | 1.35% | 0.93% | 0.00% | 0.00% | 0.00% |
| Coamo | 3.44% | 0.00% | 0.00% | 0.00% | 0.00% |
| Comerio | 0.97% | 1.03% | 0.00% | 0.00% | 0.00% |
| Corozal | 1.87% | 0.01% | 0.00% | 0.00% | 0.00% |
| Culebra | 0.00% | 0.00% | 4.93% | 0.00% | 0.00% |
| Dorado | 0.25% | 2.79% | 0.11% | 0.00% | 0.00% |
| Fajardo | 0.00% | 0.00% | 0.06% | 15.85% | 0.00% |
| Florida | 0.67% | 0.00% | 0.00% | 0.00% | 0.00% |
| Guanica | 1.72% | 0.00% | 0.00% | 0.00% | 0.00% |
| Guayama | 2.90% | 0.00% | 0.00% | 0.00% | 0.00% |
| Guayanilla | 1.89% | 0.00% | 0.00% | 0.00% | 0.00% |
| Guaynabo | 0.00% | 0.09% | 4.87% | 4.28% | 5.31% |
| Gurabo | 0.00% | 1.79% | 5.62% | 1.05% | 0.00% |
| Hatillo | 0.00% | 6.72% | 0.00% | 0.00% | 0.00% |
| Hormigueros | 0.50% | 0.00% | 0.00% | 0.00% | 0.00% |
| Humacao | 0.00% | 3.13% | 9.50% | 0.00% | 0.00% |
| Isabela | 2.44% | 0.00% | 0.00% | 0.00% | 0.00% |
| Jayuya | 1.96% | 0.00% | 0.00% | 0.00% | 0.00% |
| Juana Diaz | 2.68% | 0.00% | 0.00% | 0.00% | 0.00% |
| Juncos | 0.00% | 4.27% | 0.00% | 0.00% | 0.00% |
| Lajas | 2.70% | 0.00% | 0.00% | 0.00% | 0.00% |
| Lares | 1.99% | 2.64% | 0.00% | 0.00% | 0.00% |
| Las Marias | 2.05% | 0.00% | 0.00% | 0.00% | 0.00% |
| Las Piedras | 0.00% | 4.75% | 1.60% | 0.00% | 0.00% |
| Loiza | 0.00% | 0.00% | 0.00% | 3.62% | 12.35% |
| Luquillo | 0.00% | 0.00% | 0.36% | 12.99% | 0.00% |

| | | | | | |
|---------------|-------|--------|--------|--------|--------|
| Manati | 2.06% | 0.00% | 0.00% | 0.00% | 0.00% |
| Maricao | 1.61% | 0.00% | 0.00% | 0.00% | 0.00% |
| Maunabo | 0.20% | 2.67% | 0.00% | 0.00% | 0.00% |
| Mayaguez | 3.44% | 0.00% | 0.00% | 0.00% | 0.00% |
| Moca | 2.22% | 0.00% | 0.00% | 0.00% | 0.00% |
| Morovis | 1.72% | 0.00% | 0.00% | 0.00% | 0.00% |
| Naguabo | 0.00% | 0.05% | 11.90% | 10.17% | 0.00% |
| Naranjito | 0.57% | 2.39% | 0.00% | 0.00% | 0.00% |
| Orocovis | 2.81% | 0.00% | 0.00% | 0.00% | 0.00% |
| Patillas | 2.04% | 0.15% | 0.00% | 0.00% | 0.00% |
| Penuelas | 1.97% | 0.00% | 0.00% | 0.00% | 0.00% |
| Ponce | 5.15% | 0.00% | 0.00% | 0.00% | 0.00% |
| Quebradillas | 0.87% | 0.55% | 0.00% | 0.00% | 0.00% |
| Rio Grande | 0.63% | 0.00% | 0.00% | 0.00% | 0.00% |
| Rincon | 0.00% | 0.00% | 13.01% | 13.43% | 0.00% |
| Sabana Grande | 1.58% | 0.00% | 0.00% | 0.00% | 0.00% |
| Salinas | 3.09% | 0.00% | 0.00% | 0.00% | 0.00% |
| San German | 2.40% | 0.00% | 0.00% | 0.00% | 0.00% |
| San Juan | 0.00% | 0.00% | 0.33% | 4.21% | 36.84% |
| San Lorenzo | 0.09% | 8.20% | 0.00% | 0.00% | 0.00% |
| San Sebastian | 3.14% | 0.01% | 0.00% | 0.00% | 0.00% |
| Santa Isabel | 1.52% | 0.00% | 0.00% | 0.00% | 0.00% |
| Toa Alta | 0.15% | 3.80% | 0.17% | 0.00% | 0.00% |
| Toa Baja | 0.00% | 1.84% | 4.17% | 0.58% | 0.00% |
| Trujillo Alto | 0.00% | 0.00% | 0.87% | 3.85% | 10.59% |
| Utua | 2.32% | 10.01% | 0.00% | 0.00% | 0.00% |
| Vega Alta | 1.22% | 0.00% | 0.00% | 0.00% | 0.00% |
| Vega Baja | 2.06% | 0.00% | 0.00% | 0.00% | 0.00% |
| Vieques | 0.00% | 0.00% | 19.71% | 0.00% | 0.00% |
| Villalba | 1.63% | 0.00% | 0.00% | 0.00% | 0.00% |
| Yabucoa | 0.08% | 8.62% | 0.00% | 0.00% | 0.00% |
| Yauco | 3.03% | 0.00% | 0.00% | 0.00% | 0.00% |

Table 59: Fog Hazard Scores and Ranks by Municipio

| Municipio | Fog Hazard Score (Log Multiplied) | | |
|---------------|-----------------------------------|--------------------------|----------------------|
| | Total Score | Standardized Score (0-1) | Rank of Score (1-78) |
| San Juan | 10,267.3169 | 1.0000 | 1 |
| Cantano | 8,180.1550 | 0.7967 | 2 |
| Loiza | 3,580.9370 | 0.3488 | 3 |
| Trujillo Alto | 3,120.9439 | 0.3040 | 4 |
| Guaynabo | 1,737.0824 | 0.1692 | 5 |

| | | | |
|---------------|------------|--------|----|
| Canovanas | 1,638.0846 | 0.1595 | 6 |
| Fajardo | 1,000.2974 | 0.0974 | 7 |
| Ceiba | 937.8861 | 0.0913 | 8 |
| Rincon | 913.1486 | 0.0889 | 9 |
| Luquillo | 821.4448 | 0.08 | 10 |
| Naguabo | 702.1844 | 0.0684 | 11 |
| Bayamon | 341.0567 | 0.0332 | 12 |
| Carolina | 303.7264 | 0.0296 | 13 |
| Vieques | 100.1823 | 0.0097 | 14 |
| Gurabo | 96.0485 | 0.0093 | 15 |
| Caguas | 82.8287 | 0.0081 | 16 |
| Toa Baja | 59.5161 | 0.0058 | 17 |
| Humacao | 50.9674 | 0.005 | 18 |
| Culebra | 25.0239 | 0.0024 | 19 |
| Aguas Buenas | 12.1312 | 0.0012 | 20 |
| Las Piedras | 12.3153 | 0.0012 | 20 |
| Arecibo | 10.4852 | 0.001 | 22 |
| Utua | 9.3299 | 0.0009 | 23 |
| San Lorenzo | 7.2917 | 0.0007 | 24 |
| Yabucoa | 7.6626 | 0.0007 | 24 |
| Camuy | 6.5878 | 0.0006 | 26 |
| Hatillo | 5.9589 | 0.0006 | 26 |
| Juncos | 3.7907 | 0.0004 | 28 |
| Toa Alta | 4.2403 | 0.0004 | 28 |
| Dorado | 3.0614 | 0.0003 | 30 |
| Lares | 2.7313 | 0.0003 | 30 |
| Maunabo | 2.4035 | 0.0002 | 32 |
| Naranjito | 2.2294 | 0.0002 | 32 |
| Adjuntas | 0.9628 | 0.0001 | 34 |
| Cabo Rojo | 0.6250 | 0.0001 | 34 |
| Cidra | 1.0834 | 0.0001 | 34 |
| Coamo | 0.6670 | 0.0001 | 34 |
| Comerio | 1.1057 | 0.0001 | 34 |
| Mayaguez | 0.6665 | 0.0001 | 34 |
| Ponce | 1.0000 | 0.0001 | 34 |
| Quebradillas | 0.6605 | 0.0001 | 34 |
| San Sebastian | 0.6142 | 0.0001 | 34 |
| Aguada | 0.2644 | 0.0000 | 43 |
| Aguadilla | 0.3129 | 0.0000 | 43 |
| Aibonito | 0.2679 | 0.0000 | 43 |
| Anasco | 0.3382 | 0.0000 | 43 |
| Arroyo | 0.1286 | 0.0000 | 43 |

| | | | |
|---------------|--------|--------|----|
| Barceloneta | 0.1604 | 0.0000 | 43 |
| Barranquitas | 0.2931 | 0.0000 | 43 |
| Cayey | 0.4734 | 0.0000 | 43 |
| Ciales | 0.5702 | 0.0000 | 43 |
| Corozal | 0.3736 | 0.0000 | 43 |
| Florida | 0.1301 | 0.0000 | 43 |
| Guanica | 0.3335 | 0.0000 | 43 |
| Guayama | 0.5631 | 0.0000 | 43 |
| Guayanilla | 0.3675 | 0.0000 | 43 |
| Hormigueros | 0.0970 | 0.0000 | 43 |
| Isabela | 0.4737 | 0.0000 | 43 |
| Jayuya | 0.3807 | 0.0000 | 43 |
| Juana Diaz | 0.5192 | 0.0000 | 43 |
| Lajas | 0.5246 | 0.0000 | 43 |
| Las Marias | 0.3975 | 0.0000 | 43 |
| Manati | 0.4002 | 0.0000 | 43 |
| Maricao | 0.3131 | 0.0000 | 43 |
| Moca | 0.4305 | 0.0000 | 43 |
| Morovis | 0.3327 | 0.0000 | 43 |
| Orocovis | 0.5452 | 0.0000 | 43 |
| Patillas | 0.5303 | 0.0000 | 43 |
| Penuelas | 0.3826 | 0.0000 | 43 |
| Rjo Grande | 0.1230 | 0.0000 | 43 |
| Sabana Grande | 0.3064 | 0.0000 | 43 |
| Salinas | 0.5989 | 0.0000 | 43 |
| San German | 0.4660 | 0.0000 | 43 |
| Santa Isabel | 0.2956 | 0.0000 | 43 |
| Vega Alta | 0.2371 | 0.0000 | 43 |
| Vega Baja | 0.3988 | 0.0000 | 43 |
| Villalba | 0.3166 | 0.0000 | 43 |
| Yauco | 0.5883 | 0.0000 | 43 |

Hail

Hazard Overview

An infrequent hazard in Puerto Rico, hail can occur year-round during severe thunderstorms. Hail is a precipitation type, consisting of ice pellets that form when water droplets bounce above and below the freezing level of the atmosphere. The size of hail is a function of the intensity of the updraft and hence, the severity of the storm. Strong vertical motion can keep lifting hailstones so that they continue to accumulate in size. The speed when hail reaches the ground, or its terminal velocity, is a function of its size and weight. Hail can be small, generally pea-sized. But it may be larger, capable of damaging property and killing livestock and people.

Data and Methods

The hail climatology data (1996-2018) are obtained from the Severe Weather Database, NOAA Storm Prediction Center. Although the records of the entire dataset start from 1955, the earliest records in Puerto Rico start in 1996. Start and end locations for each hail event provide a general area of impact across the island. For each hexagon, the total frequency is calculated as the number of hail events intercepting each hexagon. Annual frequency is calculated by dividing the total frequency by the number of years in record.

Hazard Frequency Analysis Results

Hail hazards occur rarely across Puerto Rico. Since 1996 only thirty-two instances of hail in Puerto Rico have been recorded by NOAA. However, a general pattern of hail events indicates that this hazard has impacted central portions of the island more than coastal areas (Figure 21). Generally, most municipios have few hail events leaving most areas of the island in lower hazard zones (Table 60) and most municipios with generally low amounts of land in high hail hazard zones (Table 61 and Table 62).

Table 63 provides an overall hail hazard score and rank for each municipio.

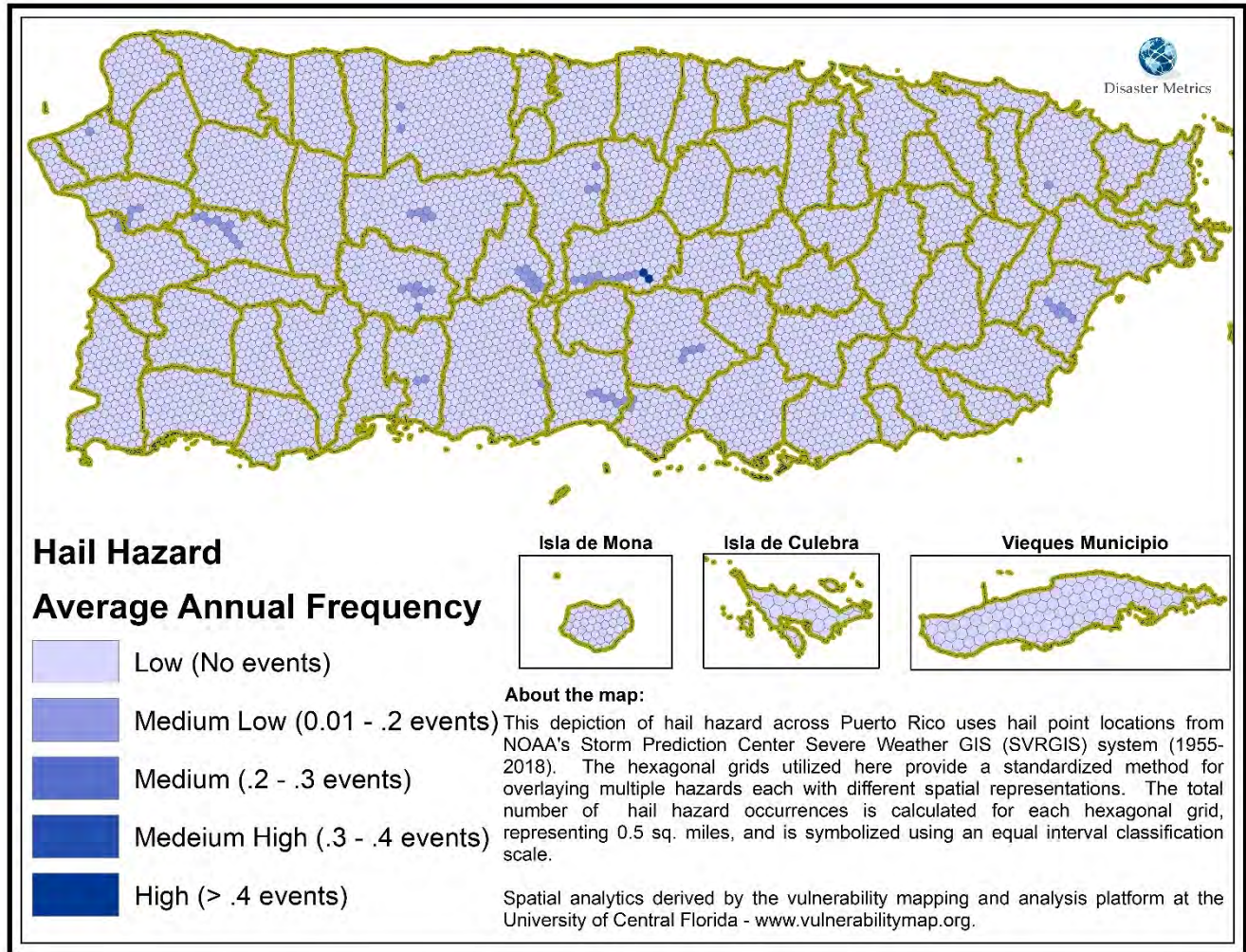


Figure 21: Hail Hazard Areas

Table 60: Hail Hazard by Municipio and Areal Extent

| Municipio | HEX GRID Area by Hail Hazard Frequency (Sq. miles) | | | | |
|--------------|--|---------------------------------|----------------------------|---------------------------------|-----------------------|
| | Low (No events) | Medium Low (.01 - .2 events) | Medium (.2 - .3 events) | Medium High (.3 - .4 events) | High (> .4 events) |
| Adjuntas | 63.60 | 3.50 | | | |
| Aguada | 30.42 | 0.50 | | | |
| Aguadilla | 36.61 | | | | |
| Aguas Buenas | 30.10 | | | | |
| Aibonito | 31.34 | | | | |
| Anasco | 37.56 | 2.00 | | | |
| Arecibo | 125.97 | 1.00 | | | |
| Arroyo | 15.05 | | | | |
| Barceloneta | 18.76 | | | | |
| Barranquitas | 34.28 | | | | |
| Bayamon | 44.51 | | | | |
| Cabo Rojo | 73.12 | | | | |

| | | | | |
|-------------|-------|------|--|--|
| Caguas | 59.07 | | | |
| Camuy | 46.37 | | | |
| Canovanas | 33.01 | | | |
| Cantano | 47.30 | | | |
| Carolina | 5.08 | | | |
| Cayey | 51.96 | | | |
| Ceiba | 30.37 | | | |
| Ciales | 65.20 | 1.50 | | |
| Cidra | 36.46 | | | |
| Coamo | 76.03 | 2.00 | | |
| Comerio | 28.52 | | | |
| Corozal | 42.58 | | | |
| Culebra | 13.31 | | | |
| Dorado | 23.42 | | | |
| Fajardo | 30.51 | | | |
| Florida | 15.22 | | | |
| Guanica | 39.01 | | | |
| Guayama | 65.87 | | | |
| Guayanilla | 42.99 | | | |
| Guaynabo | 27.76 | | | |
| Gurabo | 28.31 | | | |
| Hatillo | 41.84 | | | |
| Hormigueros | 11.34 | | | |
| Humacao | 42.10 | 3.00 | | |
| Isabela | 55.41 | | | |
| Jayuya | 40.54 | 4.00 | | |
| Juana Diaz | 57.27 | 3.46 | | |
| Juncos | 26.62 | | | |
| Lajas | 61.36 | | | |
| Lares | 61.64 | | | |
| Las Marias | 42.01 | 4.50 | | |
| Las Piedras | 33.89 | | | |
| Loiza | 20.53 | | | |
| Luquillo | 25.86 | | | |
| Manati | 46.82 | | | |
| Maricao | 36.63 | | | |
| Maunabo | 21.09 | | | |
| Mayaguez | 76.97 | 1.00 | | |
| Moca | 50.37 | | | |
| Morovis | 38.93 | | | |
| Naguabo | 51.88 | | | |
| Naranjito | 27.75 | | | |

| | | | | | |
|---------------|---------|-------|------|------|------|
| Orocovis | 57.54 | 5.23 | | | 1.00 |
| Patillas | 47.22 | | | | |
| Penuelas | 43.76 | 1.00 | | | |
| Ponce | 116.29 | 0.69 | | | |
| Quebradillas | 23.14 | | | | |
| Río Grande | 14.39 | | | | |
| Rincon | 60.31 | 0.50 | | | |
| Sabana Grande | 35.84 | | | | |
| Salinas | 70.06 | | | | |
| San German | 54.51 | | | | |
| San Juan | 49.53 | | | | |
| San Lorenzo | 53.21 | | | | |
| San Sebastian | 71.22 | | | | |
| Santa Isabel | 33.72 | 0.85 | | | |
| Toa Alta | 27.56 | | | | |
| Toa Baja | 23.80 | | | | |
| Trujillo Alto | 21.38 | | | | |
| Utuado | 112.57 | 2.50 | | | |
| Vega Alta | 27.74 | | | | |
| Vega Baja | 46.65 | | | | |
| Vieques | 53.18 | | | | |
| Villalba | 36.77 | 0.27 | | | |
| Yabucoa | 55.41 | | | | |
| Yauco | 68.82 | | | | |
| Grand Total | 3425.13 | 37.50 | 0.00 | 0.00 | 1.00 |

Table 61: Percent of (Municipio) Hexagonal Area by Hail Hazard per Municipio

| Municipio | Hail Hazard Percent Area by Total (Municipio) Land Area | | | | |
|--------------|---|---------------------------------|----------------------------|---------------------------------|-----------------------|
| | Low (No events) | Medium Low (.01 - .2 events) | Medium (.2 - .3 events) | Medium High (.3 - .4 events) | High (> .4 events) |
| Adjuntas | 94.78% | 5.22% | 0.00% | 0.00% | 0.00% |
| Aguada | 98.38% | 1.62% | 0.00% | 0.00% | 0.00% |
| Aguadilla | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Aguas Buenas | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Aibonito | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Anasco | 94.95% | 5.05% | 0.00% | 0.00% | 0.00% |
| Arecibo | 99.21% | 0.79% | 0.00% | 0.00% | 0.00% |
| Arroyo | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Barceloneta | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Barranquitas | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Bayamon | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Cabo Rojo | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |

| | | | | | |
|-------------|---------|-------|-------|-------|-------|
| Caguas | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Camuy | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Canovanas | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Cantano | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Carolina | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Cayey | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Ceiba | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Ciales | 97.75% | 2.25% | 0.00% | 0.00% | 0.00% |
| Cidra | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Coamo | 97.44% | 2.56% | 0.00% | 0.00% | 0.00% |
| Comerio | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Corozal | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Culebra | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Dorado | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Fajardo | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Florida | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Guanica | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Guayama | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Guayanilla | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Guaynabo | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Gurabo | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Hatillo | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Hormigueros | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Humacao | 93.35% | 6.65% | 0.00% | 0.00% | 0.00% |
| Isabela | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Jayuya | 91.02% | 8.98% | 0.00% | 0.00% | 0.00% |
| Juana Diaz | 94.30% | 5.70% | 0.00% | 0.00% | 0.00% |
| Juncos | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Lajas | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Lares | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Las Marias | 90.32% | 9.68% | 0.00% | 0.00% | 0.00% |
| Las Piedras | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Loiza | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Luquillo | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Manati | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Maricao | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Maunabo | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Mayaguez | 98.71% | 1.29% | 0.00% | 0.00% | 0.00% |
| Moca | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Morovis | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Naguabo | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Naranjito | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |

| | | | | | |
|---------------|---------|-------|-------|-------|-------|
| Orocovis | 90.23% | 8.21% | 0.00% | 0.00% | 1.57% |
| Patillas | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Penuelas | 97.77% | 2.23% | 0.00% | 0.00% | 0.00% |
| Ponce | 99.41% | 0.59% | 0.00% | 0.00% | 0.00% |
| Quebradillas | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Río Grande | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Rincon | 99.18% | 0.82% | 0.00% | 0.00% | 0.00% |
| Sabana Grande | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Salinas | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| San German | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| San Juan | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| San Lorenzo | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| San Sebastian | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Santa Isabel | 97.53% | 2.47% | 0.00% | 0.00% | 0.00% |
| Toa Alta | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Toa Baja | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Trujillo Alto | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Utuado | 97.83% | 2.17% | 0.00% | 0.00% | 0.00% |
| Vega Alta | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Vega Baja | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Vieques | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Villalba | 99.28% | 0.72% | 0.00% | 0.00% | 0.00% |
| Yabucoa | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Yauco | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |

Table 62: Percent of (Island) Hexagonal Area by Hail Hazard per Municipio

| Municipio | Hail Hazard Percent Area by Total (Island) Land Area | | | | |
|--------------|--|---------------------------------|----------------------------|---------------------------------|-----------------------|
| | Low (No events) | Medium Low (.01 - .2 events) | Medium (.2 - .3 events) | Medium High (.3 - .4 events) | High (> .4 events) |
| Adjuntas | 1.86% | 9.33% | 0.00% | 0.00% | 0.00% |
| Aguada | 0.89% | 1.33% | 0.00% | 0.00% | 0.00% |
| Aguadilla | 1.07% | 0.00% | 0.00% | 0.00% | 0.00% |
| Aguas Buenas | 0.88% | 0.00% | 0.00% | 0.00% | 0.00% |
| Aibonito | 0.91% | 0.00% | 0.00% | 0.00% | 0.00% |
| Anasco | 1.10% | 5.32% | 0.00% | 0.00% | 0.00% |
| Arecibo | 3.68% | 2.67% | 0.00% | 0.00% | 0.00% |
| Arroyo | 0.44% | 0.00% | 0.00% | 0.00% | 0.00% |
| Barceloneta | 0.55% | 0.00% | 0.00% | 0.00% | 0.00% |
| Barranquitas | 1.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Bayamon | 1.30% | 0.00% | 0.00% | 0.00% | 0.00% |
| Cabo Rojo | 2.13% | 0.00% | 0.00% | 0.00% | 0.00% |
| Caguas | 1.72% | 0.00% | 0.00% | 0.00% | 0.00% |

| | | | | | |
|-------------|-------|--------|-------|-------|---------|
| Camuy | 1.35% | 0.00% | 0.00% | 0.00% | 0.00% |
| Canovanas | 0.96% | 0.00% | 0.00% | 0.00% | 0.00% |
| Cantano | 1.38% | 0.00% | 0.00% | 0.00% | 0.00% |
| Carolina | 0.15% | 0.00% | 0.00% | 0.00% | 0.00% |
| Cayey | 1.52% | 0.00% | 0.00% | 0.00% | 0.00% |
| Ceiba | 0.89% | 0.00% | 0.00% | 0.00% | 0.00% |
| Ciales | 1.90% | 4.01% | 0.00% | 0.00% | 0.00% |
| Cidra | 1.06% | 0.00% | 0.00% | 0.00% | 0.00% |
| Coamo | 2.22% | 5.33% | 0.00% | 0.00% | 0.00% |
| Comerio | 0.83% | 0.00% | 0.00% | 0.00% | 0.00% |
| Corozal | 1.24% | 0.00% | 0.00% | 0.00% | 0.00% |
| Culebra | 0.39% | 0.00% | 0.00% | 0.00% | 0.00% |
| Dorado | 0.68% | 0.00% | 0.00% | 0.00% | 0.00% |
| Fajardo | 0.89% | 0.00% | 0.00% | 0.00% | 0.00% |
| Florida | 0.44% | 0.00% | 0.00% | 0.00% | 0.00% |
| Guanica | 1.14% | 0.00% | 0.00% | 0.00% | 0.00% |
| Guayama | 1.92% | 0.00% | 0.00% | 0.00% | 0.00% |
| Guayanilla | 1.26% | 0.00% | 0.00% | 0.00% | 0.00% |
| Guaynabo | 0.81% | 0.00% | 0.00% | 0.00% | 0.00% |
| Gurabo | 0.83% | 0.00% | 0.00% | 0.00% | 0.00% |
| Hatillo | 1.22% | 0.00% | 0.00% | 0.00% | 0.00% |
| Hormigueros | 0.33% | 0.00% | 0.00% | 0.00% | 0.00% |
| Humacao | 1.23% | 8.00% | 0.00% | 0.00% | 0.00% |
| Isabela | 1.62% | 0.00% | 0.00% | 0.00% | 0.00% |
| Jayuya | 1.18% | 10.66% | 0.00% | 0.00% | 0.00% |
| Juana Diaz | 1.67% | 9.23% | 0.00% | 0.00% | 0.00% |
| Juncos | 0.78% | 0.00% | 0.00% | 0.00% | 0.00% |
| Lajas | 1.79% | 0.00% | 0.00% | 0.00% | 0.00% |
| Lares | 1.80% | 0.00% | 0.00% | 0.00% | 0.00% |
| Las Marias | 1.23% | 12.00% | 0.00% | 0.00% | 0.00% |
| Las Piedras | 0.99% | 0.00% | 0.00% | 0.00% | 0.00% |
| Loiza | 0.60% | 0.00% | 0.00% | 0.00% | 0.00% |
| Luquillo | 0.75% | 0.00% | 0.00% | 0.00% | 0.00% |
| Manati | 1.37% | 0.00% | 0.00% | 0.00% | 0.00% |
| Maricao | 1.07% | 0.00% | 0.00% | 0.00% | 0.00% |
| Maunabo | 0.62% | 0.00% | 0.00% | 0.00% | 0.00% |
| Mayaguez | 2.25% | 2.68% | 0.00% | 0.00% | 0.00% |
| Moca | 1.47% | 0.00% | 0.00% | 0.00% | 0.00% |
| Morovis | 1.14% | 0.00% | 0.00% | 0.00% | 0.00% |
| Naguabo | 1.51% | 0.00% | 0.00% | 0.00% | 0.00% |
| Naranjito | 0.81% | 0.00% | 0.00% | 0.00% | 0.00% |
| Orocovis | 1.68% | 13.96% | 0.00% | 0.00% | 100.00% |

| | | | | | |
|---------------|-------|-------|-------|-------|-------|
| Patillas | 1.38% | 0.00% | 0.00% | 0.00% | 0.00% |
| Penuelas | 1.28% | 2.67% | 0.00% | 0.00% | 0.00% |
| Ponce | 3.40% | 1.83% | 0.00% | 0.00% | 0.00% |
| Quebradillas | 0.68% | 0.00% | 0.00% | 0.00% | 0.00% |
| Río Grande | 0.42% | 0.00% | 0.00% | 0.00% | 0.00% |
| Rincon | 1.76% | 1.33% | 0.00% | 0.00% | 0.00% |
| Sabana Grande | 1.05% | 0.00% | 0.00% | 0.00% | 0.00% |
| Salinas | 2.05% | 0.00% | 0.00% | 0.00% | 0.00% |
| San German | 1.59% | 0.00% | 0.00% | 0.00% | 0.00% |
| San Juan | 1.45% | 0.00% | 0.00% | 0.00% | 0.00% |
| San Lorenzo | 1.55% | 0.00% | 0.00% | 0.00% | 0.00% |
| San Sebastian | 2.08% | 0.00% | 0.00% | 0.00% | 0.00% |
| Santa Isabel | 0.98% | 2.27% | 0.00% | 0.00% | 0.00% |
| Toa Alta | 0.80% | 0.00% | 0.00% | 0.00% | 0.00% |
| Toa Baja | 0.69% | 0.00% | 0.00% | 0.00% | 0.00% |
| Trujillo Alto | 0.62% | 0.00% | 0.00% | 0.00% | 0.00% |
| Utua | 3.29% | 6.67% | 0.00% | 0.00% | 0.00% |
| Vega Alta | 0.81% | 0.00% | 0.00% | 0.00% | 0.00% |
| Vega Baja | 1.36% | 0.00% | 0.00% | 0.00% | 0.00% |
| Vieques | 1.55% | 0.00% | 0.00% | 0.00% | 0.00% |
| Villalba | 1.07% | 0.71% | 0.00% | 0.00% | 0.00% |
| Yabucoa | 1.62% | 0.00% | 0.00% | 0.00% | 0.00% |
| Yauco | 2.01% | 0.00% | 0.00% | 0.00% | 0.00% |

Table 63: Hail Hazard Scores and Ranks by Municipio

| Municipio | Hail Hazard Score (Log Multiplied) | | |
|------------|------------------------------------|--------------------------|----------------------|
| | Total Score | Standardized Score (0-1) | Rank of Score (1-78) |
| Orocovis | 10,010.4339 | 1.0000 | 1 |
| Las Marias | 8.9038 | 0.0009 | 2 |
| Jayuya | 7.9314 | 0.0008 | 3 |
| Adjuntas | 7.1716 | 0.0007 | 4 |
| Juana Diaz | 7.0423 | 0.0007 | 4 |
| Humacao | 6.0385 | 0.0006 | 6 |
| Utua | 5.6660 | 0.0006 | 6 |
| Anasco | 4.0824 | 0.0004 | 8 |
| Coamo | 4.4083 | 0.0004 | 8 |
| Arecibo | 2.9108 | 0.0003 | 10 |
| Ciales | 3.3683 | 0.0003 | 10 |
| Mayaguez | 2.5132 | 0.0003 | 10 |

| | | | |
|---------------|--------|--------|----|
| Penuelas | 2.2306 | 0.0002 | 13 |
| Ponce | 2.2339 | 0.0002 | 13 |
| Santa Isabel | 1.8660 | 0.0002 | 13 |
| Aguada | 1.1650 | 0.0001 | 16 |
| Cabo Rojo | 0.5628 | 0.0001 | 16 |
| Guayama | 0.5028 | 0.0001 | 16 |
| Rincon | 1.4122 | 0.0001 | 16 |
| Salinas | 0.5375 | 0.0001 | 16 |
| San Sebastian | 0.5471 | 0.0001 | 16 |
| Villalba | 0.7712 | 0.0001 | 16 |
| Yauco | 0.5272 | 0.0001 | 16 |
| Aguadilla | 0.2607 | 0.0000 | 24 |
| Agua Buenas | 0.2069 | 0.0000 | 24 |
| Aibonito | 0.2172 | 0.0000 | 24 |
| Arroyo | 0.0824 | 0.0000 | 24 |
| Barceloneta | 0.1131 | 0.0000 | 24 |
| Barranquitas | 0.2415 | 0.0000 | 24 |
| Bayamon | 0.3262 | 0.0000 | 24 |
| Caguas | 0.4465 | 0.0000 | 24 |
| Camuy | 0.3415 | 0.0000 | 24 |
| Canovanas | 0.2310 | 0.0000 | 24 |
| Cantano | 0.3492 | 0.0000 | 24 |
| Carolina | 0.0000 | 0.0000 | 24 |
| Cayey | 0.3878 | 0.0000 | 24 |
| Ceiba | 0.2092 | 0.0000 | 24 |
| Cidra | 0.2595 | 0.0000 | 24 |
| Comerio | 0.1939 | 0.0000 | 24 |
| Corozal | 0.3102 | 0.0000 | 24 |
| Culebra | 0.0680 | 0.0000 | 24 |
| Dorado | 0.1516 | 0.0000 | 24 |
| Fajardo | 0.2103 | 0.0000 | 24 |
| Florida | 0.0839 | 0.0000 | 24 |
| Guanica | 0.2806 | 0.0000 | 24 |
| Guayanilla | 0.3136 | 0.0000 | 24 |
| Guaynabo | 0.1876 | 0.0000 | 24 |
| Gurabo | 0.1921 | 0.0000 | 24 |
| Hatillo | 0.3040 | 0.0000 | 24 |
| Hormigueros | 0.0518 | 0.0000 | 24 |
| Isabela | 0.4163 | 0.0000 | 24 |
| Juncos | 0.1781 | 0.0000 | 24 |
| Lajas | 0.4655 | 0.0000 | 24 |
| Lares | 0.4678 | 0.0000 | 24 |

| | | | |
|---------------|--------|--------|----|
| Las Piedras | 0.2383 | 0.0000 | 24 |
| Loiza | 0.1278 | 0.0000 | 24 |
| Luquillo | 0.1718 | 0.0000 | 24 |
| Manati | 0.3452 | 0.0000 | 24 |
| Maricao | 0.2609 | 0.0000 | 24 |
| Maunabo | 0.1324 | 0.0000 | 24 |
| Moca | 0.3746 | 0.0000 | 24 |
| Morovis | 0.2799 | 0.0000 | 24 |
| Naguabo | 0.3871 | 0.0000 | 24 |
| Naranjito | 0.1875 | 0.0000 | 24 |
| Patillas | 0.3485 | 0.0000 | 24 |
| Quebradillas | 0.1494 | 0.0000 | 24 |
| Rio Grande | 0.0770 | 0.0000 | 24 |
| Sabana Grande | 0.2544 | 0.0000 | 24 |
| San German | 0.4088 | 0.0000 | 24 |
| San Juan | 0.3676 | 0.0000 | 24 |
| San Lorenzo | 0.3981 | 0.0000 | 24 |
| Toa Alta | 0.1859 | 0.0000 | 24 |
| Toa Baja | 0.1548 | 0.0000 | 24 |
| Trujillo Alto | 0.1348 | 0.0000 | 24 |
| Vega Alta | 0.1874 | 0.0000 | 24 |
| Vega Baja | 0.3438 | 0.0000 | 24 |
| Vieques | 0.3979 | 0.0000 | 24 |
| Yabucoa | 0.4163 | 0.0000 | 24 |

High Temperatures

Hazard Overview

A heat wave is an extended period of above normal temperatures over a given period of time. The World Meteorological Organization recommends the declaration of a heat wave when the daily maximum temperatures exceed the average maximum temperatures by 9 degrees Fahrenheit and last for a period of at least five days. Temperature alone is insufficient to describe the stress placed on humans as well as flora and fauna in hot weather. It is crucial to consider the effect of relative humidity since it is essential to the body's ability to perspire and cool off. Once air temperature reaches 95°F (35°C), perspiration becomes the most important manner of heat loss. Perspiration does not work if the water cannot evaporate (i.e. sweating in high relative humidity is less effective than in dry climate).

Data and Methods

A similar method to that of fog was used for high temperature data. Here, 14 stations have collected historical temperature data across the island. Linking these stations to Global Historical Climatology Network (GHCN) data for the island provided information on temperature across 14 weather stations that collected this information between 1989-2018 (Figure 22). An island-wide depiction of daily frequency of temperatures greater than 95° was interpolated from these weather stations and summarized to the 0.5 mile hexagonal grid to provide a more nuanced understanding of heat hazard frequency across Puerto Rico.

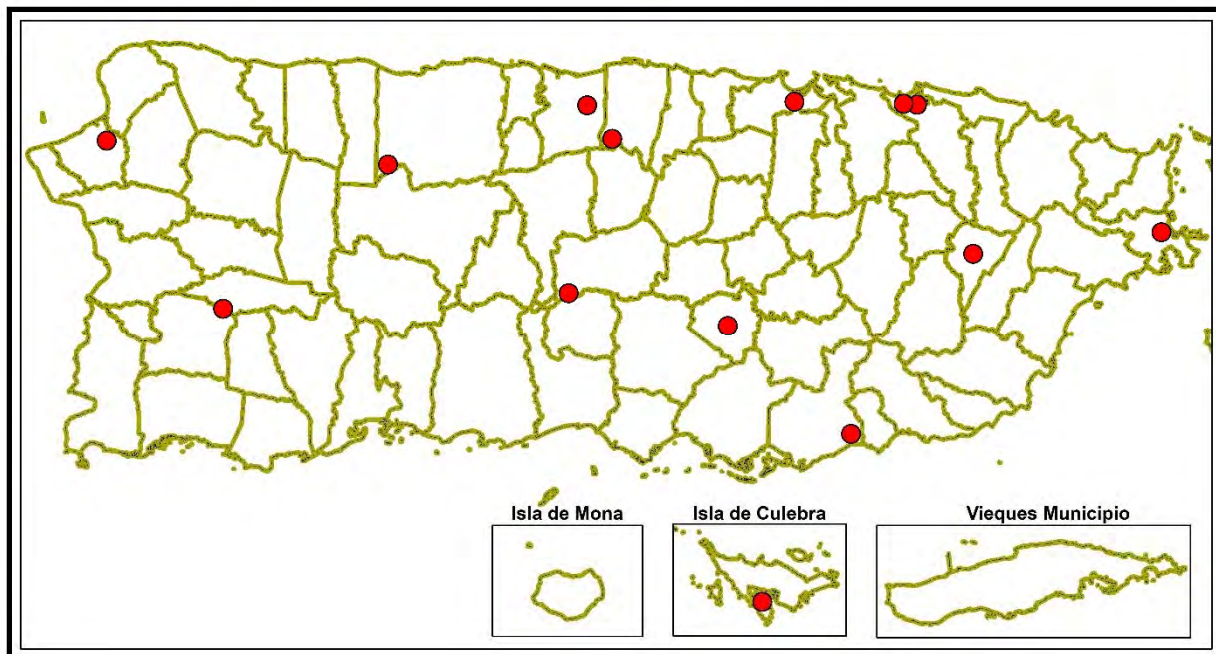


Figure 22: Weather Stations Collecting Daily Temperature Information

Hazard Frequency Analysis Results

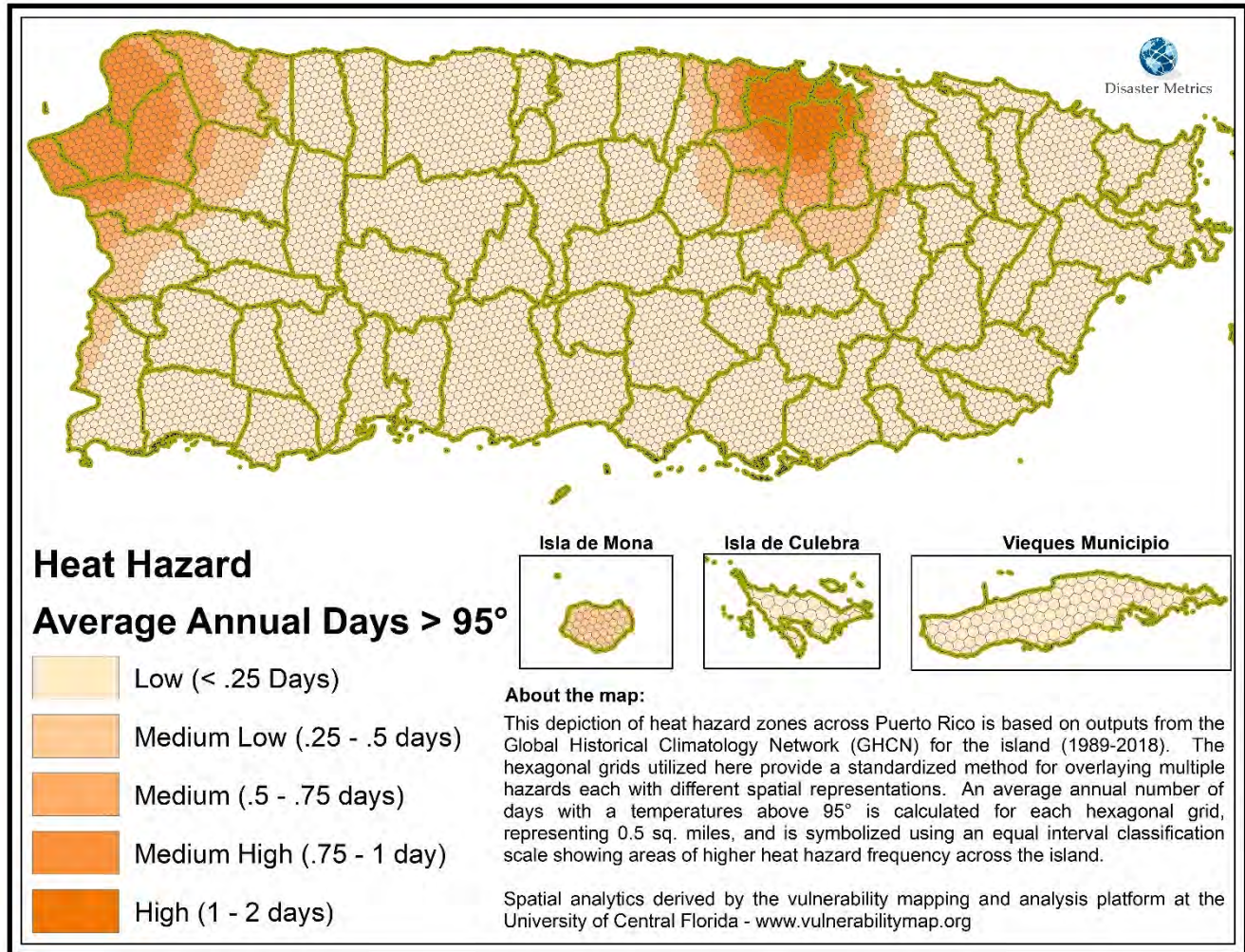


Figure 23: High Temperature Hazard Areas

Table 64: High Temperature Hazard by Municipio and Areal Extent

| Municipio | HEX GRID Area by Fog Hazard Frequency (Sq. miles) | | | | |
|--------------|---|----------------------------|------------------------|---------------------------|---------------|
| | Low (< .25 days) | Medium Low (.25 - .5 days) | Medium (.5 - .75 days) | Medium High (.75 - 1 day) | High (>1 day) |
| Adjuntas | 67.10 | | | | |
| Aguada | | | | 30.92 | |
| Aguadilla | | | 7.86 | 28.74 | |
| Aguas Buenas | 1.62 | 28.48 | | | |
| Aibonito | 31.34 | | | | |
| Anasco | | 6.52 | 19.83 | 13.21 | |
| Arecibo | 126.97 | | | | |
| Arroyo | 15.05 | | | | |
| Barceloneta | 18.76 | | | | |
| Barranquitas | 34.28 | | | | |

| | | | | | |
|-------------|-------|-------|-------|-------|-------|
| Bayamon | | 3.44 | 12.37 | 6.84 | 21.86 |
| Cabo Rojo | 57.48 | 15.64 | | | |
| Caguas | 51.71 | 7.36 | | | |
| Camuy | 46.24 | 0.13 | | | |
| Canovanas | 33.01 | | | | |
| Cantano | 47.30 | | | | |
| Carolina | | | | | 5.08 |
| Cayey | 51.96 | | | | |
| Ceiba | 30.37 | | | | |
| Ciales | 66.71 | | | | |
| Cidra | 35.83 | 0.63 | | | |
| Coamo | 78.03 | | | | |
| Comerio | 18.89 | 9.63 | | | |
| Corozal | 26.15 | 16.43 | | | |
| Culebra | 13.31 | | | | |
| Dorado | | 2.12 | 10.51 | 7.72 | 3.07 |
| Fajardo | 30.51 | | | | |
| Florida | 15.22 | | | | |
| Guanica | 39.01 | | | | |
| Guayama | 65.87 | | | | |
| Guayanilla | 42.99 | | | | |
| Guaynabo | | 7.21 | 10.80 | 5.48 | 4.27 |
| Gurabo | 28.31 | | | | |
| Hatillo | 41.84 | | | | |
| Hormigueros | 10.54 | 0.81 | | | |
| Humacao | 45.10 | | | | |
| Isabela | 0.02 | 28.09 | 27.30 | | |
| Jayuya | 44.53 | | | | |
| Juana Diaz | 60.73 | | | | |
| Juncos | 26.62 | | | | |
| Lajas | 61.36 | | | | |
| Lares | 61.64 | | | | |
| Las Marias | 39.75 | 6.76 | | | |
| Las Piedras | 33.89 | | | | |
| Loiza | 20.53 | | | | |
| Luquillo | 25.86 | | | | |
| Manati | 46.82 | | | | |
| Maricao | 36.63 | | | | |
| Maunabo | 21.09 | | | | |
| Mayaguez | 20.03 | 49.41 | 8.53 | | |
| Moca | | 0.16 | 19.62 | 30.58 | |
| Morovis | 38.93 | | | | |

| | | | | | |
|---------------|---------|--------|--------|--------|-------|
| Naguabo | 51.88 | | | | |
| Naranjito | 3.36 | 18.39 | 5.90 | 0.10 | |
| Orocovis | 63.78 | | | | |
| Patillas | 47.22 | | | | |
| Penuelas | 44.76 | | | | |
| Ponce | 116.98 | | | | |
| Quebradillas | 6.61 | 16.53 | | | |
| Rio Grande | | | | 14.39 | |
| Rincon | 60.81 | | | | |
| Sabana Grande | 35.84 | | | | |
| Salinas | 70.06 | | | | |
| San German | 54.51 | | | | |
| San Juan | 17.10 | 22.68 | 6.47 | 2.82 | 0.45 |
| San Lorenzo | 53.21 | | | | |
| San Sebastian | 27.70 | 35.06 | 8.45 | | |
| Santa Isabel | 34.57 | | | | |
| Toa Alta | | 3.57 | 9.43 | 8.09 | 6.46 |
| Toa Baja | | | | 1.03 | 22.77 |
| Trujillo Alto | 21.29 | 0.09 | | | |
| Utua | 115.07 | | | | |
| Vega Alta | 11.03 | 15.84 | 0.87 | | |
| Vega Baja | 45.68 | 0.97 | | | |
| Vieques | 53.18 | | | | |
| Villalba | 37.04 | | | | |
| Yabucoa | 55.41 | | | | |
| Yauco | 68.82 | | | | |
| Grand Total | 2805.83 | 295.93 | 147.95 | 149.94 | 63.98 |

Table 65: Percent of (Municipio) Hexagonal Area by High Temperature Hazard per Municipio

| Municipio | Heat Hazard Percent Area by Total (Municipio) Land Area | | | | |
|--------------|---|----------------------------|------------------------|---------------------------|---------------|
| | Low (< .25 days) | Medium Low (.25 - .5 days) | Medium (.5 - .75 days) | Medium High (.75 - 1 day) | High (>1 day) |
| Adjuntas | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Aguada | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Aguadilla | 0.00% | 0.00% | 21.47% | 78.53% | 0.00% |
| Aguas Buenas | 5.38% | 94.62% | 0.00% | 0.00% | 0.00% |
| Aibonito | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Anasco | 0.00% | 16.48% | 50.12% | 33.40% | 0.00% |
| Arecibo | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Arroyo | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Barceloneta | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |

| | | | | | |
|--------------|---------|--------|--------|--------|---------|
| Barranquitas | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Bayamon | 0.00% | 7.72% | 27.80% | 15.36% | 49.12% |
| Cabo Rojo | 78.62% | 21.38% | 0.00% | 0.00% | 0.00% |
| Caguas | 87.54% | 12.46% | 0.00% | 0.00% | 0.00% |
| Camuy | 99.72% | 0.28% | 0.00% | 0.00% | 0.00% |
| Canovanas | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Cantano | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Carolina | 0.00% | 0.00% | 0.00% | 0.00% | 100.00% |
| Cayey | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Ceiba | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Ciales | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Cidra | 98.28% | 1.72% | 0.00% | 0.00% | 0.00% |
| Coamo | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Comerio | 66.24% | 33.76% | 0.00% | 0.00% | 0.00% |
| Corozal | 61.42% | 38.58% | 0.00% | 0.00% | 0.00% |
| Culebra | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Dorado | 0.00% | 9.04% | 44.87% | 32.98% | 13.11% |
| Fajardo | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Florida | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Guanica | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Guayama | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Guayanilla | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Guaynabo | 0.00% | 25.98% | 38.89% | 19.75% | 15.37% |
| Gurabo | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Hatillo | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Hormigueros | 92.87% | 7.13% | 0.00% | 0.00% | 0.00% |
| Humacao | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Isabela | 0.04% | 50.69% | 49.27% | 0.00% | 0.00% |
| Jayuya | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Juana Diaz | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Juncos | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Lajas | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Lares | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Las Marias | 85.47% | 14.53% | 0.00% | 0.00% | 0.00% |
| Las Piedras | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Loiza | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Luquillo | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Manati | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Maricao | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Maunabo | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Mayaguez | 25.69% | 63.37% | 10.94% | 0.00% | 0.00% |
| Moca | 0.00% | 0.33% | 38.96% | 60.72% | 0.00% |

| | | | | | |
|---------------|---------|--------|--------|---------|--------|
| Morovis | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Naguabo | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Naranjito | 12.11% | 66.27% | 21.27% | 0.34% | 0.00% |
| Orocovis | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Patillas | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Penuelas | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Ponce | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Quebradillas | 28.59% | 71.41% | 0.00% | 0.00% | 0.00% |
| Rjo Grande | 0.00% | 0.00% | 0.00% | 100.00% | 0.00% |
| Rincon | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Sabana Grande | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Salinas | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| San German | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| San Juan | 34.52% | 45.80% | 13.07% | 5.70% | 0.91% |
| San Lorenzo | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| San Sebastian | 38.90% | 49.23% | 11.87% | 0.00% | 0.00% |
| Santa Isabel | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Toa Alta | 0.00% | 12.97% | 34.21% | 29.36% | 23.46% |
| Toa Baja | 0.00% | 0.00% | 0.00% | 4.32% | 95.68% |
| Trujillo Alto | 99.57% | 0.43% | 0.00% | 0.00% | 0.00% |
| Utuado | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Vega Alta | 39.74% | 57.11% | 3.15% | 0.00% | 0.00% |
| Vega Baja | 97.93% | 2.07% | 0.00% | 0.00% | 0.00% |
| Vieques | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Villalba | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Yabucoa | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Yauco | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |

Table 66: Percent of (Island) Hexagonal Area by High Temperature Hazard per Municipio

| Municipio | Heat Hazard Percent Area by Total (Island) Land Area | | | | |
|--------------|--|-------------------------------|---------------------------|------------------------------|------------------|
| | Low (< .25 days) | Medium Low (.25 - .5 days) | Medium (.5 – .75 days) | Medium High (.75 – 1 day) | High (>1 day) |
| Adjuntas | 2.39% | 0.00% | 0.00% | 0.00% | 0.00% |
| Aguada | 0.00% | 0.00% | 0.00% | 20.63% | 0.00% |
| Aguadilla | 0.00% | 0.00% | 5.31% | 19.17% | 0.00% |
| Aguas Buenas | 0.06% | 9.62% | 0.00% | 0.00% | 0.00% |
| Aibonito | 1.12% | 0.00% | 0.00% | 0.00% | 0.00% |
| Anasco | 0.00% | 2.20% | 13.40% | 8.81% | 0.00% |
| Arecibo | 4.53% | 0.00% | 0.00% | 0.00% | 0.00% |
| Arroyo | 0.54% | 0.00% | 0.00% | 0.00% | 0.00% |
| Barceloneta | 0.67% | 0.00% | 0.00% | 0.00% | 0.00% |

| | | | | | |
|--------------|-------|--------|--------|--------|--------|
| Barranquitas | 1.22% | 0.00% | 0.00% | 0.00% | 0.00% |
| Bayamon | 0.00% | 1.16% | 8.36% | 4.56% | 34.17% |
| Cabo Rojo | 2.05% | 5.28% | 0.00% | 0.00% | 0.00% |
| Caguas | 1.84% | 2.49% | 0.00% | 0.00% | 0.00% |
| Camuy | 1.65% | 0.04% | 0.00% | 0.00% | 0.00% |
| Canovanas | 1.18% | 0.00% | 0.00% | 0.00% | 0.00% |
| Cantano | 1.69% | 0.00% | 0.00% | 0.00% | 0.00% |
| Carolina | 0.00% | 0.00% | 0.00% | 0.00% | 7.95% |
| Cayey | 1.85% | 0.00% | 0.00% | 0.00% | 0.00% |
| Ceiba | 1.08% | 0.00% | 0.00% | 0.00% | 0.00% |
| Ciales | 2.38% | 0.00% | 0.00% | 0.00% | 0.00% |
| Cidra | 1.28% | 0.21% | 0.00% | 0.00% | 0.00% |
| Coamo | 2.78% | 0.00% | 0.00% | 0.00% | 0.00% |
| Comerio | 0.67% | 3.25% | 0.00% | 0.00% | 0.00% |
| Corozal | 0.93% | 5.55% | 0.00% | 0.00% | 0.00% |
| Culebra | 0.47% | 0.00% | 0.00% | 0.00% | 0.00% |
| Dorado | 0.00% | 0.72% | 7.10% | 5.15% | 4.80% |
| Fajardo | 1.09% | 0.00% | 0.00% | 0.00% | 0.00% |
| Florida | 0.54% | 0.00% | 0.00% | 0.00% | 0.00% |
| Guanica | 1.39% | 0.00% | 0.00% | 0.00% | 0.00% |
| Guayama | 2.35% | 0.00% | 0.00% | 0.00% | 0.00% |
| Guayanilla | 1.53% | 0.00% | 0.00% | 0.00% | 0.00% |
| Guaynabo | 0.00% | 2.44% | 7.30% | 3.66% | 6.67% |
| Gurabo | 1.01% | 0.00% | 0.00% | 0.00% | 0.00% |
| Hatillo | 1.49% | 0.00% | 0.00% | 0.00% | 0.00% |
| Hormigueros | 0.38% | 0.27% | 0.00% | 0.00% | 0.00% |
| Humacao | 1.61% | 0.00% | 0.00% | 0.00% | 0.00% |
| Isabela | 0.00% | 9.49% | 18.45% | 0.00% | 0.00% |
| Jayuya | 1.59% | 0.00% | 0.00% | 0.00% | 0.00% |
| Juana Diaz | 2.16% | 0.00% | 0.00% | 0.00% | 0.00% |
| Juncos | 0.95% | 0.00% | 0.00% | 0.00% | 0.00% |
| Lajas | 2.19% | 0.00% | 0.00% | 0.00% | 0.00% |
| Lares | 2.20% | 0.00% | 0.00% | 0.00% | 0.00% |
| Las Marias | 1.42% | 2.28% | 0.00% | 0.00% | 0.00% |
| Las Piedras | 1.21% | 0.00% | 0.00% | 0.00% | 0.00% |
| Loiza | 0.73% | 0.00% | 0.00% | 0.00% | 0.00% |
| Luquillo | 0.92% | 0.00% | 0.00% | 0.00% | 0.00% |
| Manati | 1.67% | 0.00% | 0.00% | 0.00% | 0.00% |
| Maricao | 1.31% | 0.00% | 0.00% | 0.00% | 0.00% |
| Maunabo | 0.75% | 0.00% | 0.00% | 0.00% | 0.00% |
| Mayaguez | 0.71% | 16.70% | 5.77% | 0.00% | 0.00% |
| Moca | 0.00% | 0.06% | 13.26% | 20.40% | 0.00% |

| | | | | | |
|---------------|-------|--------|-------|-------|--------|
| Morovis | 1.39% | 0.00% | 0.00% | 0.00% | 0.00% |
| Naguabo | 1.85% | 0.00% | 0.00% | 0.00% | 0.00% |
| Naranjito | 0.12% | 6.21% | 3.99% | 0.06% | 0.00% |
| Orocovis | 2.27% | 0.00% | 0.00% | 0.00% | 0.00% |
| Patillas | 1.68% | 0.00% | 0.00% | 0.00% | 0.00% |
| Penuelas | 1.60% | 0.00% | 0.00% | 0.00% | 0.00% |
| Ponce | 4.17% | 0.00% | 0.00% | 0.00% | 0.00% |
| Quebradillas | 0.24% | 5.58% | 0.00% | 0.00% | 0.00% |
| Rjo Grande | 0.00% | 0.00% | 0.00% | 9.60% | 0.00% |
| Rincon | 2.17% | 0.00% | 0.00% | 0.00% | 0.00% |
| Sabana Grande | 1.28% | 0.00% | 0.00% | 0.00% | 0.00% |
| Salinas | 2.50% | 0.00% | 0.00% | 0.00% | 0.00% |
| San German | 1.94% | 0.00% | 0.00% | 0.00% | 0.00% |
| San Juan | 0.61% | 7.66% | 4.38% | 1.88% | 0.70% |
| San Lorenzo | 1.90% | 0.00% | 0.00% | 0.00% | 0.00% |
| San Sebastian | 0.99% | 11.85% | 5.71% | 0.00% | 0.00% |
| Santa Isabel | 1.23% | 0.00% | 0.00% | 0.00% | 0.00% |
| Toa Alta | 0.00% | 1.21% | 6.37% | 5.40% | 10.11% |
| Toa Baja | 0.00% | 0.00% | 0.00% | 0.69% | 35.60% |
| Trujillo Alto | 0.76% | 0.03% | 0.00% | 0.00% | 0.00% |
| Utua | 4.10% | 0.00% | 0.00% | 0.00% | 0.00% |
| Vega Alta | 0.39% | 5.35% | 0.59% | 0.00% | 0.00% |
| Vega Baja | 1.63% | 0.33% | 0.00% | 0.00% | 0.00% |
| Vieques | 1.90% | 0.00% | 0.00% | 0.00% | 0.00% |
| Villalba | 1.32% | 0.00% | 0.00% | 0.00% | 0.00% |
| Yabucoa | 1.97% | 0.00% | 0.00% | 0.00% | 0.00% |
| Yauco | 2.45% | 0.00% | 0.00% | 0.00% | 0.00% |

Table 67: High Temperature Hazard Scores and Ranks by Municipio

| Municipio | Heat Hazard Score (Log Multiplied) | | |
|-----------|------------------------------------|--------------------------|----------------------|
| | Total Score | Standardized Score (0-1) | Rank of Score (1-78) |
| Toa Baja | 10,033.2729 | 1.0000 | 1 |
| Bayamon | 9,867.2373 | 0.9835 | 2 |
| Toa Alta | 3,135.5668 | 0.3125 | 3 |
| Carolina | 2,232.4417 | 0.2225 | 4 |
| Guaynabo | 2,092.2208 | 0.2085 | 5 |
| Dorado | 1,637.0938 | 0.1632 | 6 |
| Moca | 1,060.7565 | 0.1057 | 7 |
| Aguada | 1,000.0000 | 0.0997 | 8 |
| Aguadilla | 958.3078 | 0.0955 | 9 |
| Anasco | 501.2276 | 0.0499 | 10 |

| | | | |
|---------------|----------|--------|----|
| Río Grande | 465.3139 | 0.0464 | 11 |
| San Juan | 317.6753 | 0.0317 | 12 |
| Isabela | 105.6851 | 0.0105 | 13 |
| Mayaguez | 41.4158 | 0.0041 | 14 |
| San Sebastian | 38.2831 | 0.0038 | 15 |
| Naranjito | 28.4585 | 0.0028 | 16 |
| Aguas Buenas | 5.7762 | 0.0006 | 17 |
| Vega Alta | 6.4916 | 0.0006 | 17 |
| Cabo Rojo | 3.6174 | 0.0004 | 19 |
| Corozal | 3.5306 | 0.0003 | 20 |
| Quebradillas | 3.3967 | 0.0003 | 20 |
| Caguas | 1.8972 | 0.0002 | 22 |
| Comerio | 2.0978 | 0.0002 | 22 |
| Las Marias | 1.6805 | 0.0002 | 22 |
| Arecibo | 1.0000 | 0.0001 | 25 |
| Coamo | 0.6145 | 0.0001 | 25 |
| Ponce | 0.9213 | 0.0001 | 25 |
| Utua | 0.9062 | 0.0001 | 25 |
| Adjuntas | 0.5284 | 0 | 29 |
| Aibonito | 0.2468 | 0 | 29 |
| Arroyo | 0.1185 | 0 | 29 |
| Barceloneta | 0.1477 | 0 | 29 |
| Barranquitas | 0.2700 | 0 | 29 |
| Camuy | 0.3904 | 0 | 29 |
| Canovanas | 0.2599 | 0 | 29 |
| Cantano | 0.3725 | 0 | 29 |
| Cayey | 0.4092 | 0 | 29 |
| Ceiba | 0.2392 | 0 | 29 |
| Ciales | 0.5254 | 0 | 29 |
| Cidra | 0.4092 | 0 | 29 |
| Culebra | 0.1048 | 0 | 29 |
| Fajardo | 0.2403 | 0 | 29 |
| Florida | 0.1199 | 0 | 29 |
| Guanica | 0.3072 | 0 | 29 |
| Guayama | 0.5187 | 0 | 29 |
| Guayanilla | 0.3386 | 0 | 29 |
| Gurabo | 0.2230 | 0 | 29 |
| Hatillo | 0.3295 | 0 | 29 |
| Hormigueros | 0.2467 | 0 | 29 |
| Humacao | 0.3552 | 0 | 29 |
| Jayuya | 0.3507 | 0 | 29 |
| Juana Diaz | 0.4783 | 0 | 29 |

| | | | |
|---------------|--------|--------|----|
| Juncos | 0.2096 | 0 | 29 |
| Lajas | 0.4833 | 0 | 29 |
| Lares | 0.4854 | 0 | 29 |
| Las Piedras | 0.2669 | 0 | 29 |
| Loiza | 0.1617 | 0 | 29 |
| Luquillo | 0.2037 | 0 | 29 |
| Manati | 0.3687 | 0 | 29 |
| Maricao | 0.2885 | 0 | 29 |
| Maunabo | 0.1661 | 0 | 29 |
| Morovis | 0.3066 | 0 | 29 |
| Naguabo | 0.4086 | 0 | 29 |
| Orocovis | 0.5023 | 0 | 29 |
| Patillas | 0.3718 | 0 | 29 |
| Penuelas | 0.3525 | 0 | 29 |
| Rincon | 0.4789 | 0 | 29 |
| Sabana Grande | 0.2823 | 0 | 29 |
| Salinas | 0.5518 | 0 | 29 |
| San German | 0.4293 | 0.0000 | 29 |
| San Lorenzo | 0.4190 | 0.0000 | 29 |
| Santa Isabel | 0.2723 | 0.0000 | 29 |
| Trujillo Alto | 0.1862 | 0.0000 | 29 |
| Vega Baja | 0.5554 | 0.0000 | 29 |
| Vieques | 0.4188 | 0.0000 | 29 |
| Villalba | 0.2917 | 0.0000 | 29 |
| Yabucoa | 0.4364 | 0.0000 | 29 |
| Yauco | 0.5420 | 0.0000 | 29 |

Tornado

Hazard Overview

A tornado is a violent windstorm characterized by a twisting, funnel-shaped cloud extending to the ground. It is most often generated by a thunderstorm and produced when cool, dry air intersects and overrides a layer of warm, moist air forcing the warm air to rise rapidly. The damage from a tornado is a result of high wind velocity and wind-blown debris, although they are commonly accompanied by large hail as well. Tornadoes very rarely occur on Puerto Rico. Between 1959-2019 there have been only 32 confirmed tornadoes across the island.³⁰ However infrequent, tornadoes can cause serious damage when they do occur. Tornadoes are characterized by intensity linked to post-disaster damages. Since 2007, the intensity of tornadoes is measured by the Enhanced Fujita-Pearson Scale (Table 13). The most violent tornadoes have rotating winds of 200 miles per hour or more and can cause extreme destruction, including uprooting trees and well-made structures, and turning normally harmless objects into deadly missiles.

Data and Methods

Pinpointing past tornado occurrence provides a very limited understanding of tornado frequency and likely underestimates tornado threats. Utilizing tornado watch boxes, those areas where conditions were favorable for tornado development, provides a more nuanced understanding of historical hazard zones. For this assessment tornado warning polygons (2002-2019) were obtained from National Weather Service Watches and Warnings through the Iowa Environmental Mesonet (IEM). A total frequency is calculated for each hexagonal grid as the number of tornado warning polygons that intersect each hexagon. Average annual frequency is then calculated by dividing the total frequency by the number of years in record.

Hazard Frequency Analysis Results

Western portions of the island have historically had the largest number of tornado watches and warnings (Figure 24). Table 68 indicates that San Sebastian, Mayaguez, Anasco and Las Marias all have area in the high hazard class for tornadoes. Table 69 and Table 70 further describe the total municipio and island wide percent of land area by tornado class. Here we see that San Sebastian has both a high municipio percentage of land area in high tornado hazard zones and a high island wide land area in high tornado hazard zone. Finally, Table 71 scores and ranks historical tornado frequency by municipio.

³⁰ <https://www.spc.noaa.gov/gis/svrgis/>

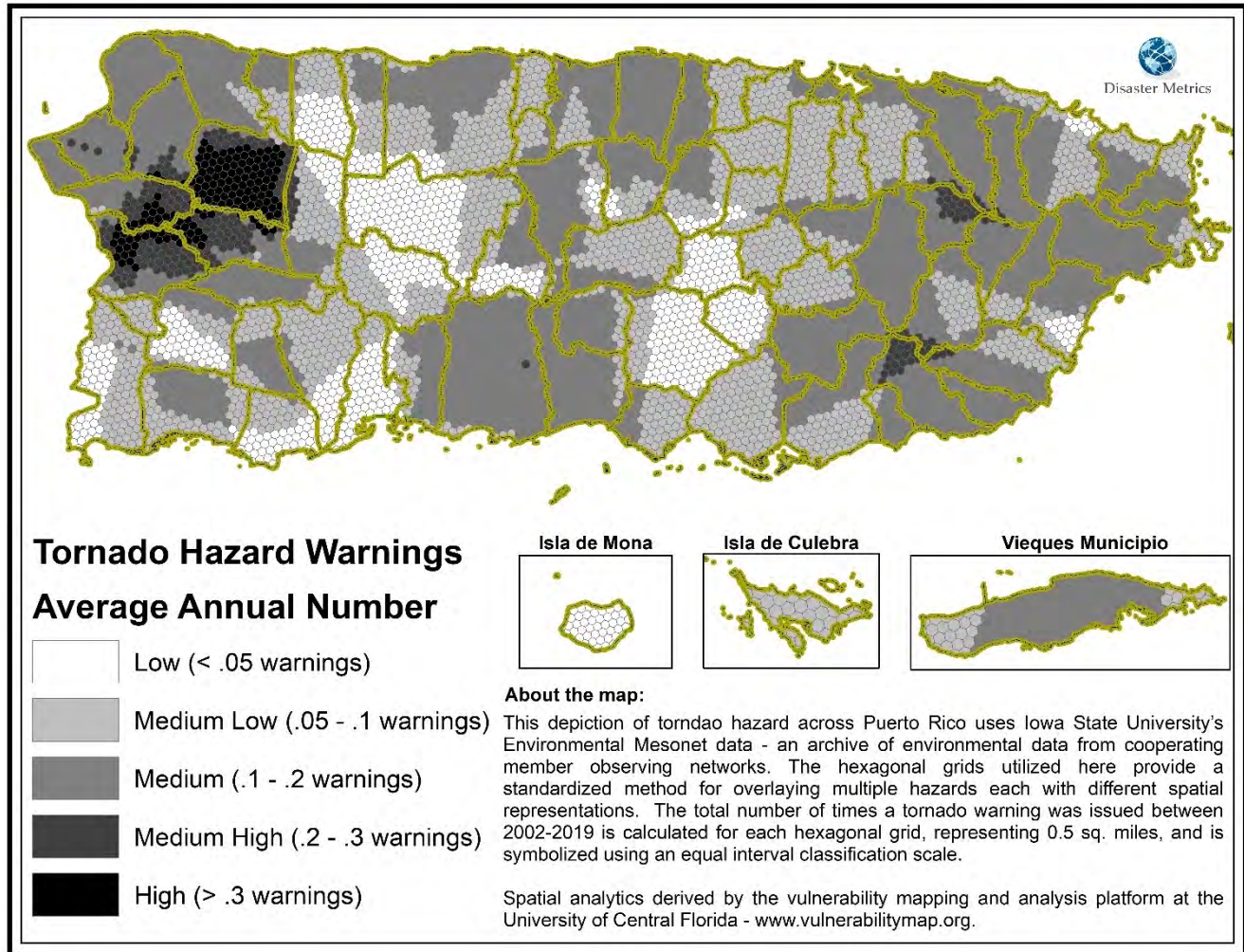


Figure 24: Tornado Hazard Areas

Table 68: Tornado Hazard by Municipio and Areal Extent

| Municipio | HEX GRID Area by Tornado Warning Hazard Frequency (Sq. miles) | | | | |
|--------------|---|--------------------------------|---------------------------|--------------------------------|---------------------|
| | Low (< .05 warnings) | Medium Low (.05 - .1 warnings) | Medium (.1 - .2 warnings) | Medium High (.2 - .3 warnings) | High (>.3 warnings) |
| Adjuntas | 30.42 | 34.88 | 1.79 | | |
| Aguada | | | 28.64 | 2.29 | |
| Aguadilla | | | 36.46 | 0.14 | |
| Aguas Buenas | | 8.70 | 21.40 | | |
| Aibonito | 25.14 | 5.89 | 0.31 | | |
| Anasco | | 1.21 | 14.97 | 14.44 | 8.95 |
| Arecibo | 8.70 | 60.14 | 58.13 | | |
| Arroyo | | 2.37 | 12.68 | 0.00 | |
| Barceloneta | 0.01 | 17.43 | 1.31 | | |
| Barranquitas | 29.17 | 5.11 | | | |
| Bayamon | | 40.11 | 4.40 | | |

| | | | | | |
|-------------|-------|-------|-------|-------|-------|
| Cabo Rojo | 25.67 | 46.45 | 1.00 | | |
| Caguas | | 0.15 | 58.92 | | |
| Camuy | 26.04 | 18.56 | 1.72 | 0.05 | |
| Canovanas | | | 31.87 | 1.14 | |
| Cantano | | | 45.51 | 1.80 | |
| Carolina | | 0.74 | 4.35 | | |
| Cayey | | 0.52 | 51.19 | 0.26 | |
| Ceiba | 2.67 | 9.00 | 18.70 | | |
| Ciales | 4.45 | 12.54 | 49.72 | | |
| Cidra | 0.03 | 29.68 | 6.74 | | |
| Coamo | 55.80 | 19.96 | 2.27 | | |
| Comerio | 0.42 | 26.55 | 1.56 | | |
| Corozal | 6.90 | 18.21 | 17.47 | | |
| Culebra | 0.65 | 12.66 | | | |
| Dorado | | 22.34 | 1.07 | | |
| Fajardo | 2.25 | 10.31 | 17.95 | | |
| Florida | | 10.18 | 5.05 | | |
| Guanica | 21.73 | 16.49 | 0.79 | | |
| Guayama | | 33.64 | 32.16 | 0.06 | |
| Guayanilla | 34.32 | 8.67 | | | |
| Guaynabo | | 23.31 | 4.45 | | |
| Gurabo | | | 18.33 | 9.99 | |
| Hatillo | 10.66 | 19.62 | 11.56 | | |
| Hormigueros | 0.72 | 10.60 | 0.03 | | |
| Humacao | 8.14 | 10.74 | 26.22 | | |
| Isabela | | 7.29 | 48.06 | 0.06 | |
| Jayuya | 14.89 | 11.45 | 18.03 | 0.16 | |
| Juana Diaz | 0.12 | 4.66 | 55.71 | 0.25 | |
| Juncos | | 1.31 | 23.83 | 1.48 | |
| Lajas | 1.29 | 31.89 | 28.18 | | |
| Lares | 13.47 | 29.51 | 12.85 | 5.82 | 0.00 |
| Las Marias | | 1.14 | 14.06 | 19.42 | 11.89 |
| Las Piedras | | 8.86 | 25.03 | | |
| Loiza | | 7.16 | 13.37 | | |
| Luquillo | 0.15 | 10.22 | 15.49 | | |
| Manati | | 12.98 | 33.84 | | |
| Maricao | | 6.98 | 29.62 | 0.03 | |
| Maunabo | | | 21.09 | | |
| Mayaguez | 22.77 | 4.04 | 13.00 | 25.14 | 13.02 |
| Moca | | | 40.96 | 7.68 | 1.73 |
| Morovis | 3.55 | 12.29 | 23.08 | | |
| Naguabo | | 0.39 | 51.49 | | |

| | | | | | |
|---------------|--------|---------|---------|--------|-------|
| Naranjito | 3.32 | 22.43 | 2.00 | | |
| Orocovis | 0.27 | 43.03 | 20.04 | 0.44 | |
| Patillas | 0.00 | 0.16 | 37.10 | 9.96 | |
| Penuelas | 5.76 | 11.77 | 27.22 | | |
| Ponce | 1.05 | 6.05 | 109.23 | 0.65 | |
| Quebradillas | 0.08 | 9.96 | 13.02 | 0.07 | |
| Rio Grande | | 0.09 | 14.30 | | |
| Rincon | 6.31 | 26.62 | 27.88 | | |
| Sabana Grande | | 16.91 | 18.93 | | |
| Salinas | 0.11 | 58.51 | 11.43 | | |
| San German | 22.25 | 18.08 | 14.18 | | |
| San Juan | | 32.34 | 17.19 | | |
| San Lorenzo | | 19.52 | 29.24 | 4.44 | |
| San Sebastian | 0.04 | 2.01 | 5.40 | 14.35 | 49.41 |
| Santa Isabel | 0.33 | 24.42 | 9.82 | | |
| Toa Alta | | 26.79 | 0.77 | | |
| Toa Baja | | 19.01 | 4.80 | | |
| Trujillo Alto | | 7.95 | 11.33 | 2.10 | |
| Utua | 78.13 | 35.24 | 1.71 | | |
| Vega Alta | | 1.55 | 26.19 | | |
| Vega Baja | | 0.03 | 46.62 | | |
| Vieques | | 12.85 | 40.33 | | |
| Villalba | | 8.48 | 28.56 | | |
| Yabucoa | | 20.23 | 32.89 | 2.28 | |
| Yauco | 16.62 | 47.25 | 4.95 | | |
| Grand Total | 484.45 | 1158.16 | 1611.54 | 124.49 | 85.00 |

Table 69: Percent of (Municipio) Hexagonal Area by Tornado Hazard per Municipio

| Municipio | Tornado Warning Hazard Percent Area by Total (Municipio) Land Area | | | | |
|--------------|--|--------------------------------|---------------------------|--------------------------------|---------------------|
| | Low (< .05 warnings) | Medium Low (.05 - .1 warnings) | Medium (.1 - .2 warnings) | Medium High (.2 - .3 warnings) | High (>.3 warnings) |
| Adjuntas | 45.35% | 51.98% | 2.67% | 0.00% | 0.00% |
| Aguada | 0.00% | 0.00% | 92.60% | 7.40% | 0.00% |
| Aguadilla | 0.00% | 0.00% | 99.61% | 0.39% | 0.00% |
| Aguas Buenas | 0.00% | 28.91% | 71.09% | 0.00% | 0.00% |
| Aibonito | 80.23% | 18.78% | 0.99% | 0.00% | 0.00% |
| Anasco | 0.00% | 3.05% | 37.84% | 36.49% | 22.62% |
| Arecibo | 6.86% | 47.36% | 45.78% | 0.00% | 0.00% |
| Arroyo | 0.00% | 15.72% | 84.27% | 0.01% | 0.00% |
| Barceloneta | 0.06% | 92.94% | 7.00% | 0.00% | 0.00% |

| | | | | | |
|--------------|--------|--------|---------|--------|--------|
| Barranquitas | 85.09% | 14.91% | 0.00% | 0.00% | 0.00% |
| Bayamon | 0.00% | 90.11% | 9.89% | 0.00% | 0.00% |
| Cabo Rojo | 35.11% | 63.52% | 1.37% | 0.00% | 0.00% |
| Caguas | 0.00% | 0.25% | 99.75% | 0.00% | 0.00% |
| Camuy | 56.16% | 40.03% | 3.70% | 0.11% | 0.00% |
| Canovanas | 0.00% | 0.00% | 96.55% | 3.45% | 0.00% |
| Cantano | 0.00% | 0.00% | 96.20% | 3.80% | 0.00% |
| Carolina | 0.00% | 14.50% | 85.50% | 0.00% | 0.00% |
| Cayey | 0.00% | 0.99% | 98.51% | 0.49% | 0.00% |
| Ceiba | 8.81% | 29.64% | 61.55% | 0.00% | 0.00% |
| Ciales | 6.67% | 18.80% | 74.53% | 0.00% | 0.00% |
| Cidra | 0.09% | 81.42% | 18.49% | 0.00% | 0.00% |
| Coamo | 71.51% | 25.58% | 2.91% | 0.00% | 0.00% |
| Comerio | 1.48% | 93.06% | 5.46% | 0.00% | 0.00% |
| Corozal | 16.20% | 42.76% | 41.04% | 0.00% | 0.00% |
| Culebra | 4.89% | 95.11% | 0.00% | 0.00% | 0.00% |
| Dorado | 0.00% | 95.41% | 4.59% | 0.00% | 0.00% |
| Fajardo | 7.39% | 33.79% | 58.82% | 0.00% | 0.00% |
| Florida | 0.00% | 66.85% | 33.15% | 0.00% | 0.00% |
| Guanica | 55.70% | 42.27% | 2.02% | 0.00% | 0.00% |
| Guayama | 0.00% | 51.08% | 48.83% | 0.09% | 0.00% |
| Guayanilla | 79.84% | 20.16% | 0.00% | 0.00% | 0.00% |
| Guaynabo | 0.00% | 83.97% | 16.03% | 0.00% | 0.00% |
| Gurabo | 0.00% | 0.00% | 64.73% | 35.27% | 0.00% |
| Hatillo | 25.48% | 46.89% | 27.63% | 0.00% | 0.00% |
| Hormigueros | 6.37% | 93.40% | 0.23% | 0.00% | 0.00% |
| Humacao | 18.05% | 23.81% | 58.13% | 0.00% | 0.00% |
| Isabela | 0.00% | 13.16% | 86.74% | 0.10% | 0.00% |
| Jayuya | 33.44% | 25.71% | 40.49% | 0.36% | 0.00% |
| Juana Diaz | 0.19% | 7.67% | 91.73% | 0.42% | 0.00% |
| Juncos | 0.00% | 4.92% | 89.53% | 5.54% | 0.00% |
| Lajas | 2.10% | 51.97% | 45.93% | 0.00% | 0.00% |
| Lares | 21.85% | 47.87% | 20.84% | 9.44% | 0.00% |
| Las Marias | 0.00% | 2.44% | 30.22% | 41.77% | 25.57% |
| Las Piedras | 0.00% | 26.14% | 73.86% | 0.00% | 0.00% |
| Loiza | 0.00% | 34.88% | 65.12% | 0.00% | 0.00% |
| Luquillo | 0.56% | 39.52% | 59.92% | 0.00% | 0.00% |
| Manati | 0.00% | 27.73% | 72.27% | 0.00% | 0.00% |
| Maricao | 0.00% | 19.06% | 80.86% | 0.09% | 0.00% |
| Maunabo | 0.00% | 0.00% | 100.00% | 0.00% | 0.00% |
| Mayaguez | 29.20% | 5.18% | 16.67% | 32.25% | 16.70% |
| Moca | 0.00% | 0.00% | 81.32% | 15.25% | 3.43% |

| | | | | | |
|---------------|--------|--------|--------|--------|--------|
| Morovis | 9.12% | 31.58% | 59.30% | 0.00% | 0.00% |
| Naguabo | 0.00% | 0.75% | 99.25% | 0.00% | 0.00% |
| Naranjito | 11.97% | 80.84% | 7.19% | 0.00% | 0.00% |
| Orocovis | 0.43% | 67.46% | 31.42% | 0.69% | 0.00% |
| Patillas | 0.01% | 0.33% | 78.57% | 21.09% | 0.00% |
| Penuelas | 12.87% | 26.30% | 60.82% | 0.00% | 0.00% |
| Ponce | 0.89% | 5.18% | 93.38% | 0.55% | 0.00% |
| Quebradillas | 0.37% | 43.06% | 56.27% | 0.31% | 0.00% |
| Rjo Grande | 0.00% | 0.60% | 99.40% | 0.00% | 0.00% |
| Rincon | 10.37% | 43.77% | 45.85% | 0.00% | 0.00% |
| Sabana Grande | 0.00% | 47.17% | 52.83% | 0.00% | 0.00% |
| Salinas | 0.16% | 83.52% | 16.32% | 0.00% | 0.00% |
| San German | 40.82% | 33.16% | 26.02% | 0.00% | 0.00% |
| San Juan | 0.00% | 65.30% | 34.70% | 0.00% | 0.00% |
| San Lorenzo | 0.00% | 36.69% | 54.95% | 8.35% | 0.00% |
| San Sebastian | 0.06% | 2.83% | 7.59% | 20.15% | 69.38% |
| Santa Isabel | 0.97% | 70.64% | 28.40% | 0.00% | 0.00% |
| Toa Alta | 0.00% | 97.20% | 2.80% | 0.00% | 0.00% |
| Toa Baja | 0.00% | 79.85% | 20.15% | 0.00% | 0.00% |
| Trujillo Alto | 0.00% | 37.19% | 52.99% | 9.83% | 0.00% |
| Utuado | 67.90% | 30.62% | 1.48% | 0.00% | 0.00% |
| Vega Alta | 0.00% | 5.60% | 94.40% | 0.00% | 0.00% |
| Vega Baja | 0.00% | 0.06% | 99.94% | 0.00% | 0.00% |
| Vieques | 0.00% | 24.16% | 75.84% | 0.00% | 0.00% |
| Villalba | 0.00% | 22.89% | 77.11% | 0.00% | 0.00% |
| Yabucoa | 0.00% | 36.52% | 59.37% | 4.11% | 0.00% |
| Yauco | 24.15% | 68.66% | 7.19% | 0.00% | 0.00% |

Table 70: Percent of (Island) Hexagonal Area by Tornado Hazard per Municipio

| Municipio | Tornado Warning Hazard Percent Area by Total (Island) Land Area | | | | |
|--------------|---|--------------------------------------|---------------------------------|--------------------------------------|---------------------------|
| | Low (< .05 warnings) | Medium Low (.05 - .1 warnings) | Medium (.1 – .2 warnings) | Medium High (.2 – .3 warnings) | High (>.3 warnings) |
| Adjuntas | 6.28% | 3.01% | 0.11% | 0.00% | 0.00% |
| Aguada | 0.00% | 0.00% | 1.78% | 1.84% | 0.00% |
| Aguadilla | 0.00% | 0.00% | 2.26% | 0.11% | 0.00% |
| Aguas Buenas | 0.00% | 0.75% | 1.33% | 0.00% | 0.00% |
| Aibonito | 5.19% | 0.51% | 0.02% | 0.00% | 0.00% |
| Anasco | 0.00% | 0.10% | 0.93% | 11.60% | 10.53% |
| Arecibo | 1.80% | 5.19% | 3.61% | 0.00% | 0.00% |
| Arroyo | 0.00% | 0.20% | 0.79% | 0.00% | 0.00% |
| Barceloneta | 0.00% | 1.51% | 0.08% | 0.00% | 0.00% |

| | | | | | |
|--------------|--------|-------|-------|--------|--------|
| Barranquitas | 6.02% | 0.44% | 0.00% | 0.00% | 0.00% |
| Bayamon | 0.00% | 3.46% | 0.27% | 0.00% | 0.00% |
| Cabo Rojo | 5.30% | 4.01% | 0.06% | 0.00% | 0.00% |
| Caguas | 0.00% | 0.01% | 3.66% | 0.00% | 0.00% |
| Camuy | 5.38% | 1.60% | 0.11% | 0.04% | 0.00% |
| Canovanas | 0.00% | 0.00% | 1.98% | 0.92% | 0.00% |
| Cantano | 0.00% | 0.00% | 2.82% | 1.44% | 0.00% |
| Carolina | 0.00% | 0.06% | 0.27% | 0.00% | 0.00% |
| Cayey | 0.00% | 0.04% | 3.18% | 0.21% | 0.00% |
| Ceiba | 0.55% | 0.78% | 1.16% | 0.00% | 0.00% |
| Ciales | 0.92% | 1.08% | 3.09% | 0.00% | 0.00% |
| Cidra | 0.01% | 2.56% | 0.42% | 0.00% | 0.00% |
| Coamo | 11.52% | 1.72% | 0.14% | 0.00% | 0.00% |
| Comerio | 0.09% | 2.29% | 0.10% | 0.00% | 0.00% |
| Corozal | 1.42% | 1.57% | 1.08% | 0.00% | 0.00% |
| Culebra | 0.13% | 1.09% | 0.00% | 0.00% | 0.00% |
| Dorado | 0.00% | 1.93% | 0.07% | 0.00% | 0.00% |
| Fajardo | 0.47% | 0.89% | 1.11% | 0.00% | 0.00% |
| Florida | 0.00% | 0.88% | 0.31% | 0.00% | 0.00% |
| Guanica | 4.49% | 1.42% | 0.05% | 0.00% | 0.00% |
| Guayama | 0.00% | 2.90% | 2.00% | 0.05% | 0.00% |
| Guayanilla | 7.09% | 0.75% | 0.00% | 0.00% | 0.00% |
| Guaynabo | 0.00% | 2.01% | 0.28% | 0.00% | 0.00% |
| Gurabo | 0.00% | 0.00% | 1.14% | 8.02% | 0.00% |
| Hatillo | 2.20% | 1.69% | 0.72% | 0.00% | 0.00% |
| Hormigueros | 0.15% | 0.91% | 0.00% | 0.00% | 0.00% |
| Humacao | 1.68% | 0.93% | 1.63% | 0.00% | 0.00% |
| Isabela | 0.00% | 0.63% | 2.98% | 0.04% | 0.00% |
| Jayuya | 3.07% | 0.99% | 1.12% | 0.13% | 0.00% |
| Juana Diaz | 0.02% | 0.40% | 3.46% | 0.20% | 0.00% |
| Juncos | 0.00% | 0.11% | 1.48% | 1.19% | 0.00% |
| Lajas | 0.27% | 2.75% | 1.75% | 0.00% | 0.00% |
| Lares | 2.78% | 2.55% | 0.80% | 4.67% | 0.00% |
| Las Marias | 0.00% | 0.10% | 0.87% | 15.60% | 13.99% |
| Las Piedras | 0.00% | 0.76% | 1.55% | 0.00% | 0.00% |
| Loiza | 0.00% | 0.62% | 0.83% | 0.00% | 0.00% |
| Luquillo | 0.03% | 0.88% | 0.96% | 0.00% | 0.00% |
| Manati | 0.00% | 1.12% | 2.10% | 0.00% | 0.00% |
| Maricao | 0.00% | 0.60% | 1.84% | 0.03% | 0.00% |
| Maunabo | 0.00% | 0.00% | 1.31% | 0.00% | 0.00% |
| Mayaguez | 4.70% | 0.35% | 0.81% | 20.20% | 15.32% |
| Moca | 0.00% | 0.00% | 2.54% | 6.17% | 2.03% |

| | | | | | |
|---------------|--------|-------|-------|--------|--------|
| Morovis | 0.73% | 1.06% | 1.43% | 0.00% | 0.00% |
| Naguabo | 0.00% | 0.03% | 3.20% | 0.00% | 0.00% |
| Naranjito | 0.69% | 1.94% | 0.12% | 0.00% | 0.00% |
| Orocovis | 0.06% | 3.71% | 1.24% | 0.35% | 0.00% |
| Patillas | 0.00% | 0.01% | 2.30% | 8.00% | 0.00% |
| Penuelas | 1.19% | 1.02% | 1.69% | 0.00% | 0.00% |
| Ponce | 0.22% | 0.52% | 6.78% | 0.52% | 0.00% |
| Quebradillas | 0.02% | 0.86% | 0.81% | 0.06% | 0.00% |
| Rjo Grande | 0.00% | 0.01% | 0.89% | 0.00% | 0.00% |
| Rincon | 1.30% | 2.30% | 1.73% | 0.00% | 0.00% |
| Sabana Grande | 0.00% | 1.46% | 1.17% | 0.00% | 0.00% |
| Salinas | 0.02% | 5.05% | 0.71% | 0.00% | 0.00% |
| San German | 4.59% | 1.56% | 0.88% | 0.00% | 0.00% |
| San Juan | 0.00% | 2.79% | 1.07% | 0.00% | 0.00% |
| San Lorenzo | 0.00% | 1.69% | 1.81% | 3.57% | 0.00% |
| San Sebastian | 0.01% | 0.17% | 0.34% | 11.53% | 58.13% |
| Santa Isabel | 0.07% | 2.11% | 0.61% | 0.00% | 0.00% |
| Toa Alta | 0.00% | 2.31% | 0.05% | 0.00% | 0.00% |
| Toa Baja | 0.00% | 1.64% | 0.30% | 0.00% | 0.00% |
| Trujillo Alto | 0.00% | 0.69% | 0.70% | 1.69% | 0.00% |
| Utuado | 16.13% | 3.04% | 0.11% | 0.00% | 0.00% |
| Vega Alta | 0.00% | 0.13% | 1.62% | 0.00% | 0.00% |
| Vega Baja | 0.00% | 0.00% | 2.89% | 0.00% | 0.00% |
| Vieques | 0.00% | 1.11% | 2.50% | 0.00% | 0.00% |
| Villalba | 0.00% | 0.73% | 1.77% | 0.00% | 0.00% |
| Yabucoa | 0.00% | 1.75% | 2.04% | 1.83% | 0.00% |
| Yauco | 3.43% | 4.08% | 0.31% | 0.00% | 0.00% |

Table 71: Tornado Hazard Scores and Ranks by Municipio

| Municipio | Tornado Hazard Score (Log Multiplied) | | |
|---------------|---------------------------------------|--------------------------|----------------------|
| | Total Score | Standardized Score (0-1) | Rank of Score (1-78) |
| San Sebastian | 10,575.9905 | 1 | 1 |
| Mayaguez | 3,648.6263 | 0.3449 | 2 |
| Las Marias | 3,192.0979 | 0.3017 | 3 |
| Anasco | 2,398.9407 | 0.2267 | 4 |
| Moca | 692.6825 | 0.0654 | 5 |
| Patillas | 429.9594 | 0.0405 | 6 |
| Gurabo | 413.9245 | 0.039 | 7 |
| Lares | 248.4782 | 0.0234 | 8 |
| San Lorenzo | 206.7745 | 0.0194 | 9 |
| Ponce | 126.7889 | 0.0119 | 10 |

| | | | |
|---------------|----------|--------|----|
| Yabucoa | 124.1260 | 0.0116 | 11 |
| Aguada | 117.2069 | 0.011 | 12 |
| Cantano | 113.1789 | 0.0106 | 13 |
| Trujillo Alto | 95.2469 | 0.0089 | 14 |
| Juncos | 80.7070 | 0.0075 | 15 |
| Canovanas | 74.4881 | 0.0069 | 16 |
| Arecibo | 63.3328 | 0.0059 | 17 |
| Juana Diaz | 61.8052 | 0.0057 | 18 |
| Cayey | 57.1671 | 0.0053 | 19 |
| Caguas | 53.9661 | 0.005 | 20 |
| Ciales | 47.6588 | 0.0044 | 21 |
| Isabela | 47.4188 | 0.0044 | 21 |
| Naguabo | 47.2061 | 0.0043 | 23 |
| Orocovis | 42.9951 | 0.004 | 24 |
| Vega Baja | 42.6846 | 0.0039 | 25 |
| Aguadilla | 39.0161 | 0.0036 | 26 |
| Vieques | 39.0613 | 0.0036 | 26 |
| Guayama | 37.4511 | 0.0034 | 28 |
| Manati | 33.1364 | 0.003 | 29 |
| Lajas | 31.1218 | 0.0028 | 30 |
| Maricao | 29.5223 | 0.0027 | 31 |
| Rincon | 30.0355 | 0.0027 | 31 |
| Villalba | 27.5551 | 0.0025 | 33 |
| Penuelas | 26.9532 | 0.0024 | 34 |
| Humacao | 25.8939 | 0.0023 | 35 |
| Jayuya | 24.9660 | 0.0022 | 36 |
| Las Piedras | 24.3905 | 0.0022 | 36 |
| Vega Alta | 24.2323 | 0.0022 | 36 |
| Morovis | 23.2200 | 0.0021 | 39 |
| Aguas Buenas | 21.0339 | 0.0019 | 40 |
| San Juan | 21.1129 | 0.0019 | 40 |
| Sabana Grande | 20.1455 | 0.0018 | 42 |
| Salinas | 20.1993 | 0.0018 | 42 |
| Corozal | 19.1122 | 0.0017 | 44 |
| Maunabo | 19.3065 | 0.0017 | 44 |
| Ceiba | 18.6464 | 0.0016 | 46 |
| Fajardo | 18.1730 | 0.0016 | 46 |
| Luquillo | 15.8852 | 0.0014 | 48 |
| Quebradillas | 16.4306 | 0.0014 | 48 |
| San German | 16.2746 | 0.0014 | 48 |
| Hatillo | 13.9830 | 0.0012 | 51 |
| Loiza | 13.4336 | 0.0012 | 51 |

| | | | |
|--------------|---------|--------|----|
| Río Grande | 13.1091 | 0.0011 | 53 |
| Santa Isabel | 13.0538 | 0.0011 | 53 |
| Yauco | 12.6028 | 0.0011 | 53 |
| Arroyo | 12.0840 | 0.001 | 56 |
| Bayamon | 10.7016 | 0.0009 | 57 |
| Cidra | 11.1079 | 0.0009 | 57 |
| Cabo Rojo | 8.9676 | 0.0007 | 59 |
| Utua | 8.4211 | 0.0007 | 59 |
| Adjuntas | 7.8321 | 0.0006 | 61 |
| Guaynabo | 7.9513 | 0.0006 | 61 |
| Toa Baja | 7.5512 | 0.0006 | 61 |
| Camuy | 6.9609 | 0.0005 | 64 |
| Coamo | 6.1087 | 0.0005 | 64 |
| Florida | 6.3114 | 0.0005 | 64 |
| Comerio | 5.8458 | 0.0004 | 67 |
| Naranjito | 5.5998 | 0.0004 | 67 |
| Toa Alta | 5.1611 | 0.0004 | 67 |
| Barceloneta | 4.1016 | 0.0003 | 70 |
| Carolina | 4.1021 | 0.0003 | 70 |
| Dorado | 4.6986 | 0.0003 | 70 |
| Guanica | 3.7434 | 0.0002 | 73 |
| Culebra | 2.1129 | 0.0001 | 74 |
| Guayanilla | 1.8803 | 0.0001 | 74 |
| Hormigueros | 1.7947 | 0.0001 | 74 |
| Aibonito | 1.5841 | 0.0000 | 77 |
| Barranquitas | 1.2231 | 0.0000 | 77 |

Wildfire

Hazard Overview

A wildfire is any type of forest, grass, brush, or outdoor fire that is not controlled or supervised. While wildfire occurrence and extent are generally controlled by climate, occurrence and extent of wildfires is also controlled by local factors such as ignition source, topography, local weather patterns, variations in fuel characteristics (type and condition), land-use practices, and overall management practices.³¹ Across much of the Caribbean, wildfires tend to occur mainly in grasslands, croplands, or dry forest areas. Time of day, climate, and land cover have been the most significant drivers of wildfire across Puerto Rico. Irrespective of how they start or how they spread, wildfires pose significant threat to lives and livelihoods across Puerto Rico.

Data and Methods

Like several other hazards in this assessment, wildfire extent data is not readily available for Puerto Rico from a national assessment such as the Monitoring Trends in Burn Severity (MTBS) database³² or the USGS Geospatial Multi-Agency Coordination (GeoMAC), or the National Interagency Fire Center³³. For this assessment, barrio level wildfire occurrence data associated with USDA and US Forest Service Research on wildfire predictability was provided for use by UDA Caribbean Climate Hub.³⁴ The average annual number of wildfire events (2003 – 2011) for each barrio was first calculated and then spatially joined with the Puerto Rico hexagonal grid to create a representation of wildfire hazard threat across the island.

Hazard Frequency Analysis Results

Wildfire threat is higher across southern Puerto Rico than the remainder of the commonwealth (Figure 25). Three municipios (Guayama, Salinas, and Santa Isabella) have high historical wildfire frequency using the classifications scheme provided by Monmany et al. (2017).³⁵ Table 72 shows an additional 17 municipios containing medium-high wildfire hazard areas. Table 73 and Table 74 provide a breakdown of wildfire hazard area by municipio and island area respectively. Finally, Table 75 ranks each municipio by its overall wildfire hazard score.

³¹ <https://www.fs.usda.gov/treearch/pubs/54146>

³² <https://www.mtbs.gov/>

³³ <https://www.nifc.gov/>

³⁴ Data provided by Dr. William Gould – Research Ecologist and Director of the USDA Caribbean Climate Hub

³⁵ <https://www.fs.usda.gov/treearch/pubs/54146>

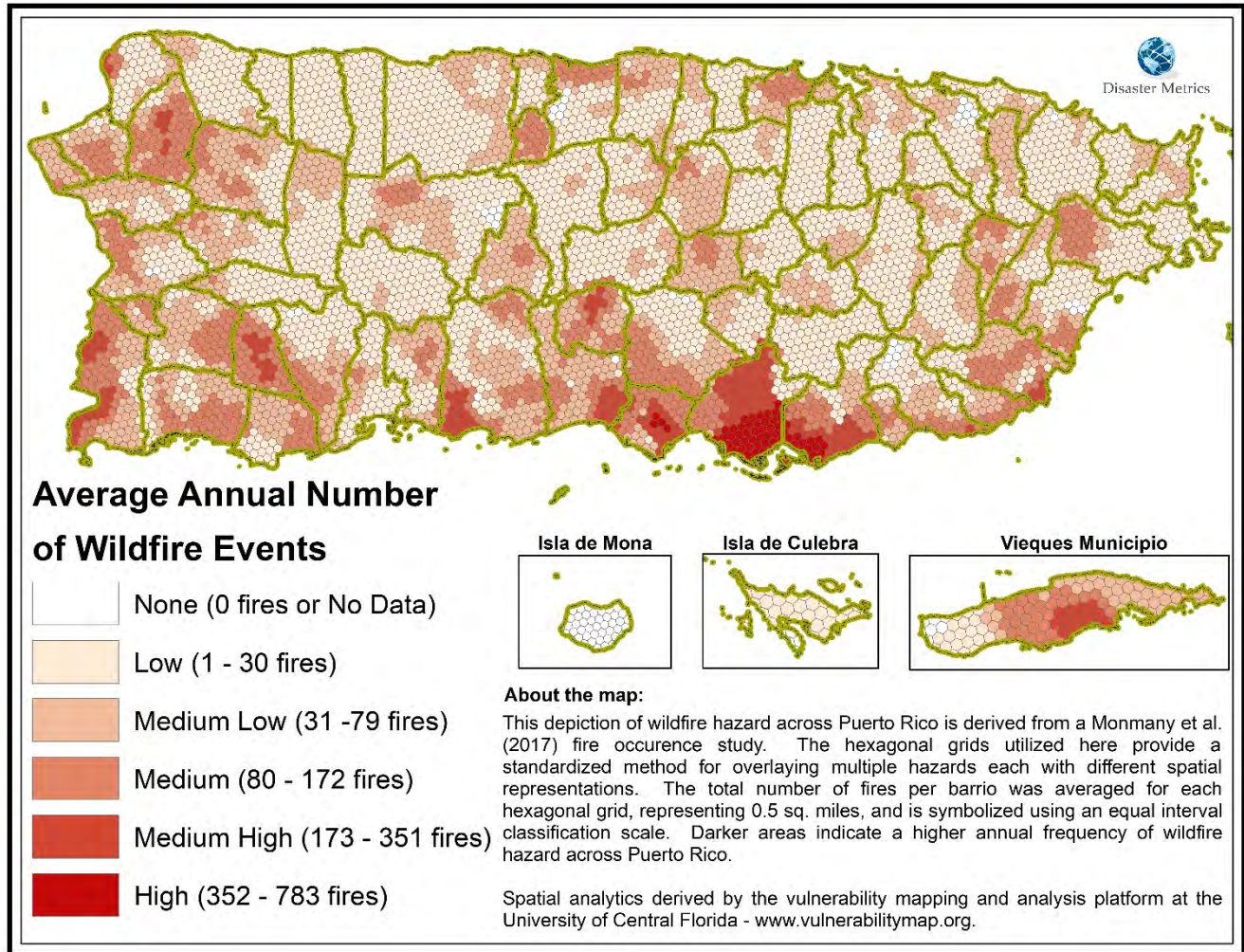


Figure 25: Wildfire Hazard Areas

Table 72: Wildfire Hazard by Municipio and Areal Extent

| Municipio | HEX GRID Area by Wildfire Hazard Frequency (Sq. miles) | | | | | |
|--------------|--|--------------------|----------------------------|-------------------------|-------------------------------|------------------------|
| | None (0 fires or No Data) | Low (1 – 30 fires) | Medium Low (31 – 79 fires) | Medium (80 – 172 fires) | Medium High (173 – 351 fires) | High (351 – 783 fires) |
| Adjuntas | | 60.84 | 6.25 | | | |
| Aguada | | 5.75 | 15.58 | 9.60 | | |
| Aguadilla | 0.01 | 24.20 | 7.87 | 2.81 | 1.71 | |
| Aguas Buenas | | 20.67 | 9.42 | | | |
| Aibonito | | 19.59 | 10.40 | 0.43 | 0.92 | |
| Anasco | | 12.93 | 25.06 | 1.57 | | |
| Arecibo | 0.00 | 90.57 | 36.40 | | | |
| Arroyo | | 3.01 | 6.70 | 5.33 | | |
| Barceloneta | | 9.95 | 8.81 | | | |
| Barranquitas | | 1.39 | 26.89 | 6.00 | | |
| Bayamon | 0.50 | 42.01 | 2.01 | | | |

| | | | | | | |
|-------------|-------|-------|-------|-------|-------|------|
| Cabo Rojo | 0.00 | 7.02 | 25.07 | 27.24 | 13.79 | |
| Caguas | | 49.48 | 9.59 | | | |
| Camuy | | 44.30 | 2.07 | | | |
| Canovanas | 0.21 | 13.93 | 18.17 | 0.69 | | |
| Carolina | 4.29 | 31.25 | 11.77 | | | |
| Catano | | 0.69 | 4.11 | 0.28 | | |
| Cayey | 0.50 | 49.65 | 0.67 | 0.83 | 0.30 | |
| Ceiba | 2.60 | 26.91 | 0.86 | | | |
| Ciales | | 59.46 | 7.24 | | | |
| Cidra | | 22.63 | 13.83 | | | |
| Coamo | 1.00 | 30.67 | 21.71 | 23.97 | 0.68 | |
| Comerio | | 24.04 | 4.48 | | | |
| Corozal | | 11.10 | 28.84 | 2.64 | | |
| Culebra | 1.17 | 12.14 | | | | |
| Dorado | | 22.42 | 1.00 | | | |
| Fajardo | 0.00 | 21.16 | 9.35 | | | |
| Florida | | | 5.72 | 9.50 | | |
| Guanica | 0.00 | 9.41 | 16.80 | 12.80 | | |
| Guayama | 0.00 | 16.31 | 10.05 | 15.68 | 14.27 | 9.55 |
| Guayanilla | 0.14 | 31.20 | 9.84 | 1.81 | | |
| Guaynabo | | 26.83 | 0.93 | | | |
| Gurabo | | 16.92 | 10.78 | 0.61 | | |
| Hatillo | | 41.28 | 0.56 | | | |
| Hormigueros | | 0.50 | 7.49 | 3.36 | | |
| Humacao | 2.78 | 21.70 | 13.41 | 7.21 | | |
| Isabela | | 41.65 | 13.76 | | | |
| Jayuya | | 12.39 | 28.65 | 3.50 | | |
| Juana Diaz | 0.50 | 3.23 | 33.74 | 14.90 | 8.37 | |
| Juncos | | 3.90 | 15.52 | 7.20 | | |
| Lajas | | 13.81 | 24.46 | 23.09 | | |
| Lares | | 39.13 | 22.50 | | | |
| Las Marias | | 21.68 | 22.33 | 2.50 | | |
| Las Piedras | | 9.10 | 18.27 | 6.52 | | |
| Loiza | | 13.82 | 6.71 | | | |
| Luquillo | | 19.66 | 6.20 | | | |
| Manati | 3.20 | 23.44 | 10.53 | 9.65 | | |
| Maricao | | 28.85 | 6.76 | 1.02 | | |
| Maunabo | 0.00 | 5.40 | 7.72 | 7.62 | 0.34 | |
| Mayaguez | 23.18 | 16.34 | 26.86 | 11.60 | | |
| Moca | | 3.92 | 11.44 | 31.50 | 3.50 | |
| Morovis | | 25.98 | 11.76 | 1.18 | | |
| Naguabo | | 24.66 | 12.24 | 14.98 | | |

| | | | | | | |
|---------------|-------|---------|---------|--------|--------|-------|
| Naranjito | | 24.54 | 3.21 | | | |
| Orocovis | | 48.48 | 13.43 | 1.86 | | |
| Patillas | 3.50 | 21.26 | 12.67 | 8.71 | 1.07 | |
| Penuelas | | 17.20 | 20.25 | 7.30 | | |
| Ponce | 0.50 | 34.40 | 45.53 | 26.98 | 9.58 | |
| Quebradillas | | 22.92 | 0.22 | | | |
| Rincon | 0.09 | 0.38 | 11.91 | 2.02 | | |
| Rio Grande | 0.84 | 51.87 | 8.10 | | | |
| Sabana Grande | | 3.65 | 3.22 | 21.97 | 7.00 | |
| Salinas | | 6.46 | 2.14 | 12.68 | 26.32 | 22.45 |
| San German | | 11.60 | 26.86 | 16.04 | | |
| San Juan | 2.00 | 30.88 | 16.65 | | | |
| San Lorenzo | | 31.73 | 21.48 | | | |
| San Sebastian | | 19.17 | 37.45 | 14.60 | | |
| Santa Isabel | 0.05 | 0.50 | 5.29 | 15.58 | 11.16 | 2.00 |
| Toa Alta | | 21.37 | 6.19 | | | |
| Toa Baja | | 3.97 | 9.75 | 10.08 | | |
| Trujillo Alto | | 18.25 | 3.13 | | | |
| Utua | 4.00 | 70.50 | 33.07 | 7.50 | | |
| Vega Alta | | 15.34 | 12.40 | | | |
| Vega Baja | | 22.14 | 21.32 | 3.18 | | |
| Vieques | 2.41 | 8.76 | 18.92 | 16.33 | 6.76 | |
| Villalba | | 1.48 | 15.63 | 15.93 | 4.00 | |
| Yabucoa | | 11.35 | 20.90 | 20.11 | 3.05 | |
| Yauco | 1.00 | 33.17 | 20.29 | 14.36 | | |
| Grand Total | 54.48 | 1720.25 | 1059.22 | 482.85 | 112.82 | 34.00 |

Table 73: Percent of (Municipio) Hexagonal Area by Wildfire Hazard per Municipio

| Municipio | Wildfire Hazard Percent Area by Total (Municipio) Land Area | | | | | |
|--------------|---|--------------------------|----------------------------------|-------------------------------|-------------------------------------|------------------------------|
| | None (0 fires or No Data) | Low (1 – 30 fires) | Medium Low (31 – 79 fires) | Medium (80 – 172 fires) | Medium High (173 – 351 fires) | High (351 – 783 fires) |
| Adjuntas | 0.00% | 90.68% | 9.32% | 0.00% | 0.00% | 0.00% |
| Aguada | 0.00% | 18.60% | 50.37% | 31.03% | 0.00% | 0.00% |
| Aguadilla | 0.03% | 66.11% | 21.51% | 7.67% | 4.68% | 0.00% |
| Aguas Buenas | 0.00% | 68.70% | 31.30% | 0.00% | 0.00% | 0.00% |
| Aibonito | 0.00% | 62.51% | 33.17% | 1.37% | 2.94% | 0.00% |
| Anasco | 0.00% | 32.68% | 63.36% | 3.97% | 0.00% | 0.00% |
| Arecibo | 0.00% | 71.33% | 28.67% | 0.00% | 0.00% | 0.00% |
| Arroyo | 0.00% | 20.02% | 44.53% | 35.45% | 0.00% | 0.00% |
| Barceloneta | 0.00% | 53.02% | 46.98% | 0.00% | 0.00% | 0.00% |

| | | | | | | |
|--------------|--------|--------|--------|--------|--------|--------|
| Barranquitas | 0.00% | 4.06% | 78.44% | 17.50% | 0.00% | 0.00% |
| Bayamon | 1.12% | 94.36% | 4.51% | 0.00% | 0.00% | 0.00% |
| Cabo Rojo | 0.00% | 9.60% | 34.28% | 37.25% | 18.86% | 0.00% |
| Caguas | 0.00% | 83.77% | 16.23% | 0.00% | 0.00% | 0.00% |
| Camuy | 0.00% | 95.54% | 4.46% | 0.00% | 0.00% | 0.00% |
| Canovanas | 0.65% | 42.20% | 55.06% | 2.09% | 0.00% | 0.00% |
| Carolina | 9.06% | 66.07% | 24.87% | 0.00% | 0.00% | 0.00% |
| Catano | 0.00% | 13.63% | 80.92% | 5.44% | 0.00% | 0.00% |
| Cayey | 0.96% | 95.56% | 1.30% | 1.60% | 0.59% | 0.00% |
| Ceiba | 8.57% | 88.61% | 2.82% | 0.00% | 0.00% | 0.00% |
| Ciales | 0.00% | 89.14% | 10.86% | 0.00% | 0.00% | 0.00% |
| Cidra | 0.00% | 62.08% | 37.92% | 0.00% | 0.00% | 0.00% |
| Coamo | 1.28% | 39.31% | 27.82% | 30.72% | 0.87% | 0.00% |
| Comerio | 0.00% | 84.29% | 15.71% | 0.00% | 0.00% | 0.00% |
| Corozal | 0.00% | 26.08% | 67.73% | 6.19% | 0.00% | 0.00% |
| Culebra | 8.77% | 91.23% | 0.00% | 0.00% | 0.00% | 0.00% |
| Dorado | 0.00% | 95.74% | 4.26% | 0.00% | 0.00% | 0.00% |
| Fajardo | 0.00% | 69.35% | 30.65% | 0.00% | 0.00% | 0.00% |
| Florida | 0.00% | 0.00% | 37.59% | 62.41% | 0.00% | 0.00% |
| Guanica | 0.00% | 24.11% | 43.07% | 32.81% | 0.00% | 0.00% |
| Guayama | 0.00% | 24.76% | 15.26% | 23.81% | 21.66% | 14.50% |
| Guayanilla | 0.33% | 72.57% | 22.89% | 4.21% | 0.00% | 0.00% |
| Guaynabo | 0.00% | 96.64% | 3.36% | 0.00% | 0.00% | 0.00% |
| Gurabo | 0.00% | 59.75% | 38.09% | 2.16% | 0.00% | 0.00% |
| Hatillo | 0.00% | 98.67% | 1.33% | 0.00% | 0.00% | 0.00% |
| Hormigueros | 0.00% | 4.41% | 65.99% | 29.61% | 0.00% | 0.00% |
| Humacao | 6.17% | 48.11% | 29.73% | 16.00% | 0.00% | 0.00% |
| Isabela | 0.00% | 75.17% | 24.83% | 0.00% | 0.00% | 0.00% |
| Jayuya | 0.00% | 27.81% | 64.33% | 7.86% | 0.00% | 0.00% |
| Juana Diaz | 0.82% | 5.31% | 55.56% | 24.53% | 13.78% | 0.00% |
| Juncos | 0.00% | 14.65% | 58.31% | 27.04% | 0.00% | 0.00% |
| Lajas | 0.00% | 22.51% | 39.85% | 37.63% | 0.00% | 0.00% |
| Lares | 0.00% | 63.49% | 36.51% | 0.00% | 0.00% | 0.00% |
| Las Marias | 0.00% | 46.61% | 48.02% | 5.38% | 0.00% | 0.00% |
| Las Piedras | 0.00% | 26.85% | 53.90% | 19.24% | 0.00% | 0.00% |
| Loiza | 0.00% | 67.32% | 32.68% | 0.00% | 0.00% | 0.00% |
| Luquillo | 0.00% | 76.01% | 23.99% | 0.00% | 0.00% | 0.00% |
| Manati | 6.84% | 50.06% | 22.49% | 20.61% | 0.00% | 0.00% |
| Maricao | 0.00% | 78.76% | 18.47% | 2.78% | 0.00% | 0.00% |
| Maunabo | 0.00% | 25.60% | 36.63% | 36.15% | 1.62% | 0.00% |
| Mayaguez | 29.73% | 20.95% | 34.44% | 14.88% | 0.00% | 0.00% |
| Moca | 0.00% | 7.79% | 22.71% | 62.55% | 6.95% | 0.00% |

| | | | | | | |
|---------------|-------|--------|--------|--------|--------|--------|
| Morovis | 0.00% | 66.75% | 30.21% | 3.04% | 0.00% | 0.00% |
| Naguabo | 0.00% | 47.54% | 23.59% | 28.87% | 0.00% | 0.00% |
| Naranjito | 0.00% | 88.43% | 11.57% | 0.00% | 0.00% | 0.00% |
| Orocovis | 0.00% | 76.02% | 21.06% | 2.92% | 0.00% | 0.00% |
| Patillas | 7.42% | 45.04% | 26.84% | 18.44% | 2.26% | 0.00% |
| Penuelas | 0.00% | 38.43% | 45.25% | 16.32% | 0.00% | 0.00% |
| Ponce | 0.43% | 29.40% | 38.92% | 23.06% | 8.19% | 0.00% |
| Quebradillas | 0.00% | 99.05% | 0.95% | 0.00% | 0.00% | 0.00% |
| Rincon | 0.60% | 2.62% | 82.78% | 14.01% | 0.00% | 0.00% |
| Rio Grande | 1.38% | 85.29% | 13.33% | 0.00% | 0.00% | 0.00% |
| Sabana Grande | 0.00% | 10.19% | 9.00% | 61.28% | 19.53% | 0.00% |
| Salinas | 0.00% | 9.22% | 3.06% | 18.11% | 37.57% | 32.04% |
| San German | 0.00% | 21.29% | 49.28% | 29.43% | 0.00% | 0.00% |
| San Juan | 4.04% | 62.34% | 33.62% | 0.00% | 0.00% | 0.00% |
| San Lorenzo | 0.00% | 59.63% | 40.37% | 0.00% | 0.00% | 0.00% |
| San Sebastian | 0.00% | 26.91% | 52.58% | 20.50% | 0.00% | 0.00% |
| Santa Isabel | 0.14% | 1.45% | 15.30% | 45.06% | 32.27% | 5.78% |
| Toa Alta | 0.00% | 77.55% | 22.45% | 0.00% | 0.00% | 0.00% |
| Toa Baja | 0.00% | 16.69% | 40.96% | 42.36% | 0.00% | 0.00% |
| Trujillo Alto | 0.00% | 85.34% | 14.66% | 0.00% | 0.00% | 0.00% |
| Utuado | 3.48% | 61.26% | 28.74% | 6.52% | 0.00% | 0.00% |
| Vega Alta | 0.00% | 55.29% | 44.71% | 0.00% | 0.00% | 0.00% |
| Vega Baja | 0.00% | 47.47% | 45.71% | 6.82% | 0.00% | 0.00% |
| Vieques | 4.53% | 16.48% | 35.57% | 30.70% | 12.71% | 0.00% |
| Villalba | 0.00% | 3.99% | 42.19% | 43.01% | 10.80% | 0.00% |
| Yabucoa | 0.00% | 20.48% | 37.72% | 36.29% | 5.51% | 0.00% |
| Yauco | 1.45% | 48.20% | 29.48% | 20.87% | 0.00% | 0.00% |

Table 74: Percent of (Island) Hexagonal Area by Wildfire Hazard per Municipio

| Municipio | Wildfire Hazard Percent Area by Total (Island) Land Area | | | | | |
|--------------|--|--------------------------|----------------------------------|-------------------------------|-------------------------------------|------------------------------|
| | None (0 fires or No Data) | Low (1 – 30 fires) | Medium Low (31 – 79 fires) | Medium (80 – 172 fires) | Medium High (173 – 351 fires) | High (351 – 783 fires) |
| Adjuntas | 0.00% | 3.54% | 0.59% | 0.00% | 0.00% | 0.00% |
| Aguada | 0.00% | 0.33% | 1.47% | 1.99% | 0.00% | 0.00% |
| Aguadilla | 0.02% | 1.41% | 0.74% | 0.58% | 1.52% | 0.00% |
| Aguas Buenas | 0.00% | 1.20% | 0.89% | 0.00% | 0.00% | 0.00% |
| Aibonito | 0.00% | 1.14% | 0.98% | 0.09% | 0.82% | 0.00% |
| Anasco | 0.00% | 0.75% | 2.37% | 0.33% | 0.00% | 0.00% |
| Arecibo | 0.00% | 5.27% | 3.44% | 0.00% | 0.00% | 0.00% |
| Arroyo | 0.00% | 0.18% | 0.63% | 1.10% | 0.00% | 0.00% |
| Barceloneta | 0.00% | 0.58% | 0.83% | 0.00% | 0.00% | 0.00% |

| | | | | | | |
|--------------|--------|-------|-------|-------|--------|--------|
| Barranquitas | 0.00% | 0.08% | 2.54% | 1.24% | 0.00% | 0.00% |
| Bayamon | 0.92% | 2.44% | 0.19% | 0.00% | 0.00% | 0.00% |
| Cabo Rojo | 0.00% | 0.41% | 2.37% | 5.64% | 12.22% | 0.00% |
| Caguas | 0.00% | 2.88% | 0.91% | 0.00% | 0.00% | 0.00% |
| Camuy | 0.00% | 2.58% | 0.20% | 0.00% | 0.00% | 0.00% |
| Canovanas | 0.39% | 0.81% | 1.72% | 0.14% | 0.00% | 0.00% |
| Carolina | 7.87% | 1.82% | 1.11% | 0.00% | 0.00% | 0.00% |
| Catano | 0.00% | 0.04% | 0.39% | 0.06% | 0.00% | 0.00% |
| Cayey | 0.92% | 2.89% | 0.06% | 0.17% | 0.27% | 0.00% |
| Ceiba | 4.78% | 1.56% | 0.08% | 0.00% | 0.00% | 0.00% |
| Ciales | 0.00% | 3.46% | 0.68% | 0.00% | 0.00% | 0.00% |
| Cidra | 0.00% | 1.32% | 1.31% | 0.00% | 0.00% | 0.00% |
| Coamo | 1.84% | 1.78% | 2.05% | 4.96% | 0.60% | 0.00% |
| Comerio | 0.00% | 1.40% | 0.42% | 0.00% | 0.00% | 0.00% |
| Corozal | 0.00% | 0.65% | 2.72% | 0.55% | 0.00% | 0.00% |
| Culebra | 2.14% | 0.71% | 0.00% | 0.00% | 0.00% | 0.00% |
| Dorado | 0.00% | 1.30% | 0.09% | 0.00% | 0.00% | 0.00% |
| Fajardo | 0.00% | 1.23% | 0.88% | 0.00% | 0.00% | 0.00% |
| Florida | 0.00% | 0.00% | 0.54% | 1.97% | 0.00% | 0.00% |
| Guanica | 0.00% | 0.55% | 1.59% | 2.65% | 0.00% | 0.00% |
| Guayama | 0.01% | 0.95% | 0.95% | 3.25% | 12.65% | 28.10% |
| Guayanilla | 0.26% | 1.81% | 0.93% | 0.38% | 0.00% | 0.00% |
| Guaynabo | 0.00% | 1.56% | 0.09% | 0.00% | 0.00% | 0.00% |
| Gurabo | 0.00% | 0.98% | 1.02% | 0.13% | 0.00% | 0.00% |
| Hatillo | 0.00% | 2.40% | 0.05% | 0.00% | 0.00% | 0.00% |
| Hormigueros | 0.00% | 0.03% | 0.71% | 0.70% | 0.00% | 0.00% |
| Humacao | 5.11% | 1.26% | 1.27% | 1.49% | 0.00% | 0.00% |
| Isabela | 0.00% | 2.42% | 1.30% | 0.00% | 0.00% | 0.00% |
| Jayuya | 0.00% | 0.72% | 2.70% | 0.72% | 0.00% | 0.00% |
| Juana Diaz | 0.92% | 0.19% | 3.19% | 3.08% | 7.42% | 0.00% |
| Juncos | 0.00% | 0.23% | 1.47% | 1.49% | 0.00% | 0.00% |
| Lajas | 0.00% | 0.80% | 2.31% | 4.78% | 0.00% | 0.00% |
| Lares | 0.00% | 2.27% | 2.12% | 0.00% | 0.00% | 0.00% |
| Las Marias | 0.00% | 1.26% | 2.11% | 0.52% | 0.00% | 0.00% |
| Las Piedras | 0.00% | 0.53% | 1.72% | 1.35% | 0.00% | 0.00% |
| Loiza | 0.00% | 0.80% | 0.63% | 0.00% | 0.00% | 0.00% |
| Luquillo | 0.00% | 1.14% | 0.59% | 0.00% | 0.00% | 0.00% |
| Manati | 5.88% | 1.36% | 0.99% | 2.00% | 0.00% | 0.00% |
| Maricao | 0.00% | 1.68% | 0.64% | 0.21% | 0.00% | 0.00% |
| Maunabo | 0.00% | 0.31% | 0.73% | 1.58% | 0.30% | 0.00% |
| Mayaguez | 42.55% | 0.95% | 2.54% | 2.40% | 0.00% | 0.00% |
| Moca | 0.00% | 0.23% | 1.08% | 6.52% | 3.10% | 0.00% |

| | | | | | | |
|---------------|-------|-------|-------|-------|--------|--------|
| Morovis | 0.00% | 1.51% | 1.11% | 0.24% | 0.00% | 0.00% |
| Naguabo | 0.00% | 1.43% | 1.16% | 3.10% | 0.00% | 0.00% |
| Naranjito | 0.00% | 1.43% | 0.30% | 0.00% | 0.00% | 0.00% |
| Orocovis | 0.00% | 2.82% | 1.27% | 0.39% | 0.00% | 0.00% |
| Patillas | 6.43% | 1.24% | 1.20% | 1.80% | 0.95% | 0.00% |
| Penuelas | 0.00% | 1.00% | 1.91% | 1.51% | 0.00% | 0.00% |
| Ponce | 0.92% | 2.00% | 4.30% | 5.59% | 8.49% | 0.00% |
| Quebradillas | 0.00% | 1.33% | 0.02% | 0.00% | 0.00% | 0.00% |
| Rincon | 0.16% | 0.02% | 1.12% | 0.42% | 0.00% | 0.00% |
| Rio Grande | 1.54% | 3.02% | 0.77% | 0.00% | 0.00% | 0.00% |
| Sabana Grande | 0.00% | 0.21% | 0.30% | 4.55% | 6.20% | 0.00% |
| Salinas | 0.00% | 0.38% | 0.20% | 2.63% | 23.33% | 66.02% |
| San German | 0.00% | 0.67% | 2.54% | 3.32% | 0.00% | 0.00% |
| San Juan | 3.67% | 1.79% | 1.57% | 0.00% | 0.00% | 0.00% |
| San Lorenzo | 0.00% | 1.84% | 2.03% | 0.00% | 0.00% | 0.00% |
| San Sebastian | 0.00% | 1.11% | 3.54% | 3.02% | 0.00% | 0.00% |
| Santa Isabel | 0.09% | 0.03% | 0.50% | 3.23% | 9.89% | 5.88% |
| Toa Alta | 0.00% | 1.24% | 0.58% | 0.00% | 0.00% | 0.00% |
| Toa Baja | 0.00% | 0.23% | 0.92% | 2.09% | 0.00% | 0.00% |
| Trujillo Alto | 0.00% | 1.06% | 0.30% | 0.00% | 0.00% | 0.00% |
| Utuado | 7.34% | 4.10% | 3.12% | 1.55% | 0.00% | 0.00% |
| Vega Alta | 0.00% | 0.89% | 1.17% | 0.00% | 0.00% | 0.00% |
| Vega Baja | 0.00% | 1.29% | 2.01% | 0.66% | 0.00% | 0.00% |
| Vieques | 4.42% | 0.51% | 1.79% | 3.38% | 5.99% | 0.00% |
| Villalba | 0.00% | 0.09% | 1.48% | 3.30% | 3.55% | 0.00% |
| Yabucoa | 0.00% | 0.66% | 1.97% | 4.16% | 2.70% | 0.00% |
| Yauco | 1.84% | 1.93% | 1.92% | 2.97% | 0.00% | 0.00% |

Table 75: Wildfire Hazard Scores and Ranks by Municipio

| Municipio | Wildfire Hazard Score (Log Multiplied) | | |
|---------------|--|--------------------------|----------------------|
| | Total Score | Standardized Score (0-1) | Rank of Score (1-78) |
| Salinas | 11040.8046 | 1 | 1 |
| Guayama | 4850.2696 | 0.4393 | 2 |
| Santa Isabel | 1365.4277 | 0.1237 | 3 |
| Cabo Rojo | 615.9485 | 0.0558 | 4 |
| Ponce | 459.7944 | 0.0416 | 5 |
| Juana Diaz | 372.6145 | 0.0337 | 6 |
| Sabana Grande | 336.3948 | 0.0305 | 7 |
| Vieques | 312.9490 | 0.0283 | 8 |
| Moca | 235.5172 | 0.0213 | 9 |
| Villalba | 205.9708 | 0.0186 | 10 |

| | | | |
|---------------|----------|--------|----|
| Yabucoa | 184.4270 | 0.0167 | 11 |
| Coamo | 106.8698 | 0.0097 | 12 |
| Lajas | 78.8231 | 0.0071 | 13 |
| Aguadilla | 75.9966 | 0.0069 | 14 |
| Patillas | 71.2373 | 0.0064 | 15 |
| San German | 56.9504 | 0.0051 | 16 |
| San Sebastian | 54.7805 | 0.0049 | 17 |
| Naguabo | 50.5010 | 0.0046 | 18 |
| Yauco | 50.4004 | 0.0046 | 18 |
| Guanica | 44.4271 | 0.004 | 20 |
| Mayaguez | 42.8964 | 0.0039 | 21 |
| Aibonito | 38.9091 | 0.0035 | 22 |
| Maunabo | 38.9207 | 0.0035 | 22 |
| Aguada | 33.9464 | 0.0031 | 24 |
| Toa Baja | 34.1865 | 0.0031 | 24 |
| Manati | 33.2041 | 0.003 | 26 |
| Utua | 31.8481 | 0.0029 | 27 |
| Florida | 31.4108 | 0.0028 | 28 |
| Penuelas | 27.8171 | 0.0025 | 29 |
| Humacao | 26.0839 | 0.0024 | 30 |
| Juncos | 26.2957 | 0.0024 | 30 |
| Barranquitas | 24.9666 | 0.0022 | 32 |
| Las Piedras | 24.8161 | 0.0022 | 32 |
| Arroyo | 18.4362 | 0.0017 | 34 |
| Jayuya | 17.5386 | 0.0016 | 35 |
| Cayey | 14.9117 | 0.0013 | 36 |
| Corozal | 14.8236 | 0.0013 | 36 |
| Vega Baja | 15.0282 | 0.0013 | 36 |
| Las Marias | 13.0784 | 0.0012 | 39 |
| Hormigueros | 12.3105 | 0.0011 | 40 |
| Anasco | 10.6302 | 0.001 | 41 |
| Arecibo | 8.9951 | 0.0008 | 42 |
| Orocovis | 9.3908 | 0.0008 | 42 |
| Rincon | 9.0189 | 0.0008 | 42 |
| Guayanilla | 8.2560 | 0.0007 | 45 |
| Canovanas | 6.3361 | 0.0006 | 46 |
| Morovis | 6.6211 | 0.0006 | 46 |
| Lares | 5.3747 | 0.0005 | 48 |
| Gurabo | 4.5006 | 0.0004 | 49 |
| Maricao | 5.0320 | 0.0004 | 49 |
| San Lorenzo | 5.0677 | 0.0004 | 49 |
| Carolina | 2.9292 | 0.0003 | 52 |

| | | | |
|---------------|--------|--------|----|
| Cidra | 3.2865 | 0.0003 | 52 |
| Isabela | 3.4820 | 0.0003 | 52 |
| San Juan | 3.9976 | 0.0003 | 52 |
| Adjuntas | 2.0450 | 0.0002 | 56 |
| Aguas Buenas | 2.2975 | 0.0002 | 56 |
| Barceloneta | 2.0457 | 0.0002 | 56 |
| Caguas | 2.6523 | 0.0002 | 56 |
| Ciales | 2.2474 | 0.0002 | 56 |
| Fajardo | 2.2876 | 0.0002 | 56 |
| Rio Grande | 2.3526 | 0.0002 | 56 |
| Vega Alta | 2.8935 | 0.0002 | 56 |
| Bayamon | 0.9051 | 0.0001 | 64 |
| Camuy | 0.9438 | 0.0001 | 64 |
| Catano | 1.7897 | 0.0001 | 64 |
| Comerio | 1.2499 | 0.0001 | 64 |
| Loiza | 1.6264 | 0.0001 | 64 |
| Luquillo | 1.5795 | 0.0001 | 64 |
| Naranjito | 0.9761 | 0.0001 | 64 |
| Toa Alta | 1.5949 | 0.0001 | 64 |
| Trujillo Alto | 0.8899 | 0.0001 | 64 |
| Ceiba | 0.4851 | 0.0000 | 73 |
| Culebra | 0.1340 | 0.0000 | 73 |
| Dorado | 0.4666 | 0.0000 | 73 |
| Guaynabo | 0.5013 | 0.0000 | 73 |
| Hatillo | 0.5783 | 0.0000 | 73 |
| Quebradillas | 0.3013 | 0.0000 | 73 |

Human Caused Hazards

Hazard Overview

Human induced hazards including chemical spills and terrorist incidents have the capacity to impact lives and livelihoods in many of the same ways natural hazards do. For the purposes of this assessment, terrorism is officially defined (by the Federal Bureau of Investigation) as "...the unlawful use of force and violence against persons or property to intimidate or coerce the government, the civilian population or any segment thereof, in the detriment of achieving political or social objectives."³⁶ The term technological hazard refers to incidents arising from human activities such as manufacturing, transportation, storage and use of hazardous materials. While terrorist events are not accidental, FEMA presumes that chemical spills and other technological events are accidental and unintentional.³⁷

Data and Methods

Terrorist incidents (1970-2018) collected from the global terrorism database and transportation incidents resulting in chemical spills (2005-2019) collected from the Pipeline and Hazardous Materials Safety Administration were summarized at the city level across Puerto Rico and annual frequencies for each were calculated. Resulting polygons representing the spatial distribution of human-caused hazard frequencies were intersected with the hexagonal grid and the maximum frequency between terrorist events and chemical spills was transposed to the hex grid as a representation of annual frequency.

Hazard Frequency Analysis Results

San Juan and Carolina stand out with the largest historical number of terrorism and transportation accidents, followed by Caguas, Aguadilla, Cataño and Guaynabo (Figure 26). San Juan and Carolina each have large amount of land (Table 76) representing greater than 60% of their land area in high human hazard zones (Table 77). This pattern continues when looking at total island-wide land area (Table 78) and places these municipios at the top in terms of overall human hazard score and ranks (Table 79).

³⁶ <https://www.fbi.gov/stats-services/publications/terrorism-2002-2005>

³⁷ <https://www.fema.gov/media-library-data/20130726-1524-20490-3869/howto7.pdf>

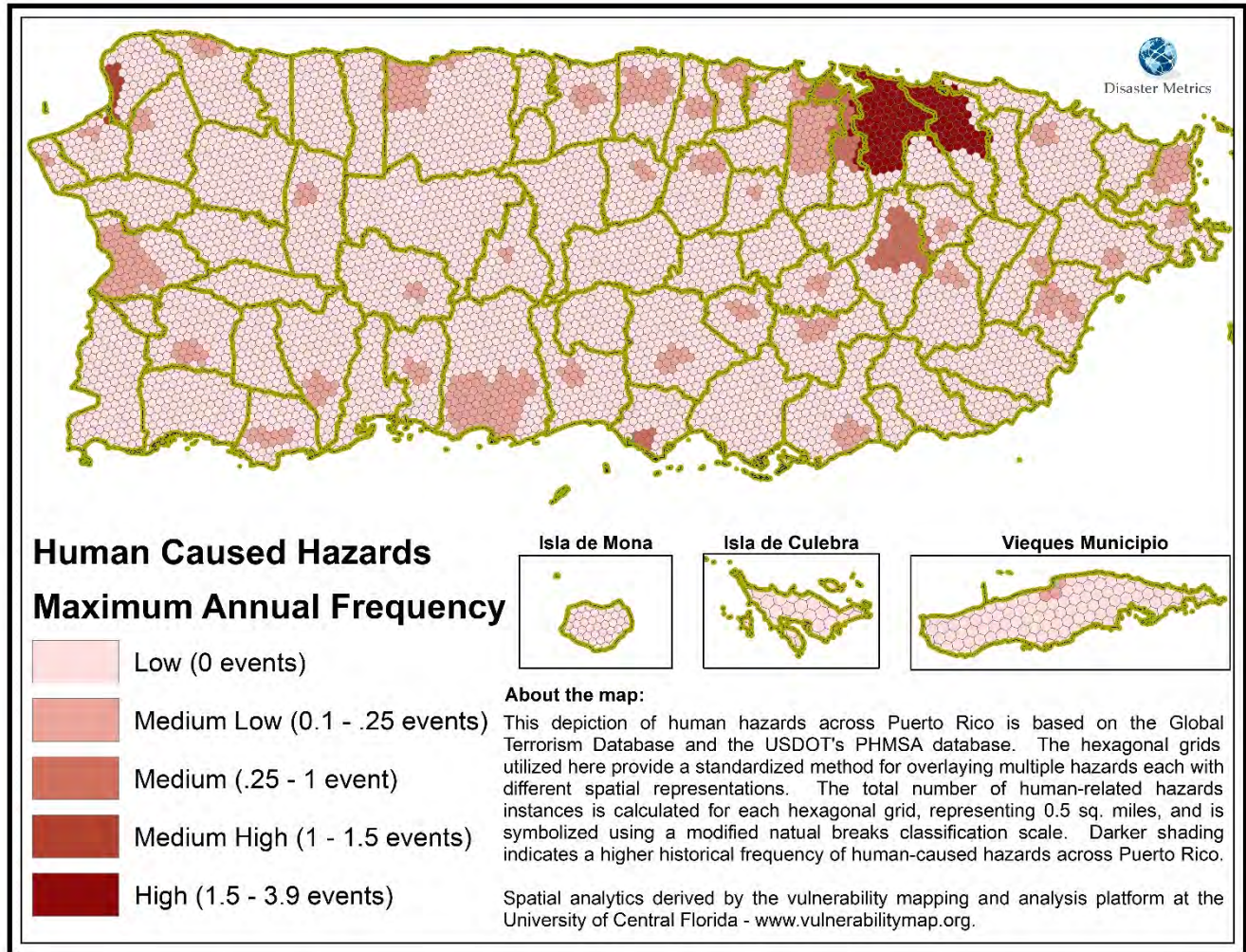


Figure 26: Human Caused Hazard Areas

Table 76: Human Caused Hazard by Municipio and Areal Extent

| Municipio | HEX GRID Area by Human Caused Hazard Frequency (Sq. miles) | | | | |
|--------------|--|---------------------------------|----------------------------|---------------------------------|----------------------------|
| | Low (0 events) | Medium Low (.1 - .25 events) | Medium (.25 – 1 events) | Medium High (1 – 1.5 events) | High (1.5 - 3.9 events) |
| Adjuntas | 64.10 | 3.00 | | | |
| Aguada | 28.16 | 2.00 | | 0.77 | |
| Aguadilla | 30.96 | 0.34 | | 5.30 | |
| Aguas Buenas | 30.10 | | | | |
| Aibonito | 27.34 | 4.00 | | | |
| Anasco | 38.53 | 1.03 | | | |
| Arecibo | 106.35 | 20.63 | | | |
| Arroyo | 15.05 | | | | |
| Barceloneta | 18.76 | | | | |
| Barranquitas | 34.28 | | | | |
| Bayamon | 15.70 | 24.79 | 4.03 | | |
| Cabo Rojo | 72.12 | 1.00 | | | |

| | | | | |
|-------------|-------|-------|-------|-------|
| Caguas | 38.26 | | 20.81 | |
| Camuy | 46.37 | | | |
| Canovanas | 32.49 | | | 0.52 |
| Cantano | 19.37 | | | 27.93 |
| Carolina | | | 4.99 | 0.10 |
| Cayey | 45.01 | 6.95 | | |
| Ceiba | 26.44 | 3.93 | | |
| Ciales | 66.71 | | | |
| Cidra | 32.91 | 3.55 | | |
| Coamo | 72.03 | 6.00 | | |
| Comerio | 28.52 | | | |
| Corozal | 36.59 | 5.99 | | |
| Culebra | 13.31 | | | |
| Dorado | 16.78 | 6.63 | | |
| Fajardo | 17.78 | 12.73 | | |
| Florida | 15.22 | | | |
| Guanica | 32.52 | 6.49 | | |
| Guayama | 58.43 | 7.44 | | |
| Guayanilla | 42.99 | | | |
| Guaynabo | 12.79 | 0.53 | 9.99 | 4.45 |
| Gurabo | 23.67 | 3.00 | 1.64 | |
| Hatillo | 39.73 | 2.11 | | |
| Hormigueros | 10.56 | 0.79 | | |
| Humacao | 34.53 | 10.57 | | |
| Isabela | 50.00 | 5.41 | | |
| Jayuya | 43.03 | 1.50 | | |
| Juana Diaz | 56.23 | 4.50 | | |
| Juncos | 26.62 | | | |
| Lajas | 61.20 | 0.17 | | |
| Lares | 57.64 | 4.00 | | |
| Las Marias | 46.51 | | | |
| Las Piedras | 30.52 | 3.37 | | |
| Loiza | 19.53 | | | 1.01 |
| Luquillo | 24.36 | 1.49 | | |
| Manati | 40.55 | 6.27 | | |
| Maricao | 36.63 | | | |
| Maunabo | 21.09 | | | |
| Mayaguez | 49.34 | 28.63 | | |
| Moca | 46.71 | 3.66 | | |
| Morovis | 35.93 | 3.00 | | |
| Naguabo | 48.32 | 3.56 | | |
| Naranjito | 26.25 | 1.50 | | |

| | | | | | |
|---------------|---------|--------|-------|------|-------|
| Orocovis | 63.78 | | | | |
| Patillas | 47.22 | | | | |
| Penuelas | 40.25 | 4.50 | | | |
| Ponce | 76.14 | 40.84 | | | |
| Quebradillas | 23.14 | | | | |
| Río Grande | 12.74 | 1.65 | | | |
| Rincon | 56.31 | 4.50 | | | |
| Sabana Grande | 35.84 | | | | |
| Salinas | 70.06 | | | | |
| San German | 48.17 | 6.34 | | | |
| San Juan | 5.56 | | | | 43.96 |
| San Lorenzo | 48.65 | 4.50 | 0.05 | | |
| San Sebastian | 71.22 | | | | |
| Santa Isabel | 31.21 | | 3.37 | | |
| Toa Alta | 26.11 | 1.45 | | | |
| Toa Baja | 15.79 | 6.44 | 1.58 | | |
| Trujillo Alto | 19.16 | | | | 2.22 |
| Utuado | 115.07 | | | | |
| Vega Alta | 22.81 | 4.94 | | | |
| Vega Baja | 32.42 | 14.23 | | | |
| Vieques | 51.53 | 1.66 | | | |
| Villalba | 37.04 | | | | |
| Yabucoa | 55.41 | | | | |
| Yauco | 61.82 | 7.00 | | | |
| Grand Total | 3032.33 | 298.59 | 46.44 | 6.06 | 80.20 |

Table 77: Percent of (Municipio) Hexagonal Area by Human Caused Hazard per Municipio

| Municipio | Human Caused Hazard Percent Area by Total (Municipio) Land Area | | | | |
|--------------|---|---------------------------------|----------------------------|---------------------------------|----------------------------|
| | Low (0 events) | Medium Low (.1 - .25 events) | Medium (.25 – 1 events) | Medium High (1 – 1.5 events) | High (1.5 - 3.9 events) |
| Adjuntas | 95.53% | 4.47% | 0.00% | 0.00% | 0.00% |
| Aguada | 91.06% | 6.47% | 0.00% | 2.47% | 0.00% |
| Aguadilla | 84.59% | 0.94% | 0.00% | 14.47% | 0.00% |
| Aguas Buenas | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Aibonito | 87.24% | 12.76% | 0.00% | 0.00% | 0.00% |
| Anasco | 97.40% | 2.60% | 0.00% | 0.00% | 0.00% |
| Arecibo | 83.76% | 16.24% | 0.00% | 0.00% | 0.00% |
| Arroyo | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Barceloneta | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Barranquitas | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Bayamon | 35.27% | 55.69% | 9.05% | 0.00% | 0.00% |

| | | | | | |
|-------------|---------|--------|--------|-------|--------|
| Cabo Rojo | 98.63% | 1.37% | 0.00% | 0.00% | 0.00% |
| Caguas | 64.78% | 0.00% | 35.22% | 0.00% | 0.00% |
| Camuy | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Canovanas | 98.43% | 0.00% | 0.00% | 0.00% | 1.57% |
| Cantano | 0.00% | 0.00% | 98.05% | 0.00% | 1.95% |
| Carolina | 40.95% | 0.00% | 0.00% | 0.00% | 59.05% |
| Cayey | 86.62% | 13.38% | 0.00% | 0.00% | 0.00% |
| Ceiba | 87.05% | 12.95% | 0.00% | 0.00% | 0.00% |
| Ciales | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Cidra | 90.27% | 9.73% | 0.00% | 0.00% | 0.00% |
| Coamo | 92.31% | 7.69% | 0.00% | 0.00% | 0.00% |
| Comerio | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Corozal | 85.93% | 14.07% | 0.00% | 0.00% | 0.00% |
| Culebra | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Dorado | 71.67% | 28.33% | 0.00% | 0.00% | 0.00% |
| Fajardo | 58.28% | 41.72% | 0.00% | 0.00% | 0.00% |
| Florida | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Guanica | 83.35% | 16.65% | 0.00% | 0.00% | 0.00% |
| Guayama | 88.70% | 11.30% | 0.00% | 0.00% | 0.00% |
| Guayanilla | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Guaynabo | 46.08% | 1.92% | 35.97% | 0.00% | 16.04% |
| Gurabo | 83.61% | 10.60% | 5.79% | 0.00% | 0.00% |
| Hatillo | 94.96% | 5.04% | 0.00% | 0.00% | 0.00% |
| Hormigueros | 93.07% | 6.93% | 0.00% | 0.00% | 0.00% |
| Humacao | 76.56% | 23.44% | 0.00% | 0.00% | 0.00% |
| Isabela | 90.24% | 9.76% | 0.00% | 0.00% | 0.00% |
| Jayuya | 96.63% | 3.37% | 0.00% | 0.00% | 0.00% |
| Juana Diaz | 92.59% | 7.41% | 0.00% | 0.00% | 0.00% |
| Juncos | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Lajas | 99.73% | 0.27% | 0.00% | 0.00% | 0.00% |
| Lares | 93.51% | 6.49% | 0.00% | 0.00% | 0.00% |
| Las Marias | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Las Piedras | 90.06% | 9.94% | 0.00% | 0.00% | 0.00% |
| Loiza | 95.09% | 0.00% | 0.00% | 0.00% | 4.91% |
| Luquillo | 94.22% | 5.78% | 0.00% | 0.00% | 0.00% |
| Manati | 86.61% | 13.39% | 0.00% | 0.00% | 0.00% |
| Maricao | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Maunabo | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Mayaguez | 63.28% | 36.72% | 0.00% | 0.00% | 0.00% |
| Moca | 92.74% | 7.26% | 0.00% | 0.00% | 0.00% |
| Morovis | 92.29% | 7.71% | 0.00% | 0.00% | 0.00% |
| Naguabo | 93.14% | 6.86% | 0.00% | 0.00% | 0.00% |

| | | | | | |
|---------------|---------|--------|-------|-------|--------|
| Naranjito | 94.59% | 5.41% | 0.00% | 0.00% | 0.00% |
| Orocovis | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Patillas | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Penuelas | 89.94% | 10.06% | 0.00% | 0.00% | 0.00% |
| Ponce | 65.09% | 34.91% | 0.00% | 0.00% | 0.00% |
| Quebradillas | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Rio Grande | 88.51% | 11.49% | 0.00% | 0.00% | 0.00% |
| Rincon | 92.60% | 7.40% | 0.00% | 0.00% | 0.00% |
| Sabana Grande | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Salinas | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| San German | 88.37% | 11.63% | 0.00% | 0.00% | 0.00% |
| San Juan | 11.24% | 0.00% | 0.00% | 0.00% | 88.76% |
| San Lorenzo | 91.44% | 8.46% | 0.10% | 0.00% | 0.00% |
| San Sebastian | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Santa Isabel | 90.26% | 0.00% | 9.74% | 0.00% | 0.00% |
| Toa Alta | 94.75% | 5.25% | 0.00% | 0.00% | 0.00% |
| Toa Baja | 66.33% | 27.05% | 6.62% | 0.00% | 0.00% |
| Trujillo Alto | 89.61% | 0.00% | 0.00% | 0.00% | 10.39% |
| Utuado | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Vega Alta | 82.21% | 17.79% | 0.00% | 0.00% | 0.00% |
| Vega Baja | 69.49% | 30.51% | 0.00% | 0.00% | 0.00% |
| Vieques | 96.89% | 3.11% | 0.00% | 0.00% | 0.00% |
| Villalba | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Yabucoa | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Yauco | 89.83% | 10.17% | 0.00% | 0.00% | 0.00% |

Table 78: Percent of (Island) Hexagonal Area by Human Caused Hazard per Municipio

| Municipio | Human Caused Hazard Percent Area by Total (Island) Land Area | | | | |
|--------------|--|---------------------------------|----------------------------|---------------------------------|----------------------------|
| | Low (0 events) | Medium Low (.1 - .25 events) | Medium (.25 – 1 events) | Medium High (1 – 1.5 events) | High (1.5 - 3.9 events) |
| Adjuntas | 1.85% | 0.09% | 0.00% | 0.00% | 0.00% |
| Aguada | 0.81% | 0.06% | 0.00% | 0.02% | 0.00% |
| Aguadilla | 0.89% | 0.01% | 0.00% | 0.15% | 0.00% |
| Aguas Buenas | 0.87% | 0.00% | 0.00% | 0.00% | 0.00% |
| Aibonito | 0.79% | 0.12% | 0.00% | 0.00% | 0.00% |
| Anasco | 1.11% | 0.03% | 0.00% | 0.00% | 0.00% |
| Arecibo | 3.07% | 0.60% | 0.00% | 0.00% | 0.00% |
| Arroyo | 0.43% | 0.00% | 0.00% | 0.00% | 0.00% |
| Barceloneta | 0.54% | 0.00% | 0.00% | 0.00% | 0.00% |
| Barranquitas | 0.99% | 0.00% | 0.00% | 0.00% | 0.00% |
| Bayamon | 0.45% | 0.72% | 0.12% | 0.00% | 0.00% |
| Cabo Rojo | 2.08% | 0.03% | 0.00% | 0.00% | 0.00% |

| | | | | | |
|-------------|-------|-------|-------|-------|-------|
| Caguas | 1.10% | 0.00% | 0.60% | 0.00% | 0.00% |
| Camuy | 1.34% | 0.00% | 0.00% | 0.00% | 0.00% |
| Canovanas | 0.94% | 0.00% | 0.00% | 0.00% | 0.01% |
| Cantano | 0.00% | 0.00% | 0.14% | 0.00% | 0.00% |
| Carolina | 0.56% | 0.00% | 0.00% | 0.00% | 0.81% |
| Cayey | 1.30% | 0.20% | 0.00% | 0.00% | 0.00% |
| Ceiba | 0.76% | 0.11% | 0.00% | 0.00% | 0.00% |
| Ciales | 1.93% | 0.00% | 0.00% | 0.00% | 0.00% |
| Cidra | 0.95% | 0.10% | 0.00% | 0.00% | 0.00% |
| Coamo | 2.08% | 0.17% | 0.00% | 0.00% | 0.00% |
| Comerio | 0.82% | 0.00% | 0.00% | 0.00% | 0.00% |
| Corozal | 1.06% | 0.17% | 0.00% | 0.00% | 0.00% |
| Culebra | 0.38% | 0.00% | 0.00% | 0.00% | 0.00% |
| Dorado | 0.48% | 0.19% | 0.00% | 0.00% | 0.00% |
| Fajardo | 0.51% | 0.37% | 0.00% | 0.00% | 0.00% |
| Florida | 0.44% | 0.00% | 0.00% | 0.00% | 0.00% |
| Guanica | 0.94% | 0.19% | 0.00% | 0.00% | 0.00% |
| Guayama | 1.69% | 0.21% | 0.00% | 0.00% | 0.00% |
| Guayanilla | 1.24% | 0.00% | 0.00% | 0.00% | 0.00% |
| Guaynabo | 0.37% | 0.02% | 0.29% | 0.00% | 0.13% |
| Gurabo | 0.68% | 0.09% | 0.05% | 0.00% | 0.00% |
| Hatillo | 1.15% | 0.06% | 0.00% | 0.00% | 0.00% |
| Hormigueros | 0.30% | 0.02% | 0.00% | 0.00% | 0.00% |
| Humacao | 1.00% | 0.31% | 0.00% | 0.00% | 0.00% |
| Isabela | 1.44% | 0.16% | 0.00% | 0.00% | 0.00% |
| Jayuya | 1.24% | 0.04% | 0.00% | 0.00% | 0.00% |
| Juana Diaz | 1.62% | 0.13% | 0.00% | 0.00% | 0.00% |
| Juncos | 0.77% | 0.00% | 0.00% | 0.00% | 0.00% |
| Lajas | 1.77% | 0.00% | 0.00% | 0.00% | 0.00% |
| Lares | 1.66% | 0.12% | 0.00% | 0.00% | 0.00% |
| Las Marias | 1.34% | 0.00% | 0.00% | 0.00% | 0.00% |
| Las Piedras | 0.88% | 0.10% | 0.00% | 0.00% | 0.00% |
| Loiza | 0.56% | 0.00% | 0.00% | 0.00% | 0.03% |
| Luquillo | 0.70% | 0.04% | 0.00% | 0.00% | 0.00% |
| Manati | 1.17% | 0.18% | 0.00% | 0.00% | 0.00% |
| Maricao | 1.06% | 0.00% | 0.00% | 0.00% | 0.00% |
| Maunabo | 0.61% | 0.00% | 0.00% | 0.00% | 0.00% |
| Mayaguez | 1.42% | 0.83% | 0.00% | 0.00% | 0.00% |
| Moca | 1.35% | 0.11% | 0.00% | 0.00% | 0.00% |
| Morovis | 1.04% | 0.09% | 0.00% | 0.00% | 0.00% |
| Naguabo | 1.40% | 0.10% | 0.00% | 0.00% | 0.00% |
| Naranjito | 0.76% | 0.04% | 0.00% | 0.00% | 0.00% |

| | | | | | |
|---------------|-------|-------|-------|-------|-------|
| Orocovis | 1.84% | 0.00% | 0.00% | 0.00% | 0.00% |
| Patillas | 1.36% | 0.00% | 0.00% | 0.00% | 0.00% |
| Penuelas | 1.16% | 0.13% | 0.00% | 0.00% | 0.00% |
| Ponce | 2.20% | 1.18% | 0.00% | 0.00% | 0.00% |
| Quebradillas | 0.67% | 0.00% | 0.00% | 0.00% | 0.00% |
| Rjo Grande | 0.37% | 0.05% | 0.00% | 0.00% | 0.00% |
| Rincon | 1.63% | 0.13% | 0.00% | 0.00% | 0.00% |
| Sabana Grande | 1.03% | 0.00% | 0.00% | 0.00% | 0.00% |
| Salinas | 2.02% | 0.00% | 0.00% | 0.00% | 0.00% |
| San German | 1.39% | 0.18% | 0.00% | 0.00% | 0.00% |
| San Juan | 0.16% | 0.00% | 0.00% | 0.00% | 1.27% |
| San Lorenzo | 1.40% | 0.13% | 0.00% | 0.00% | 0.00% |
| San Sebastian | 2.06% | 0.00% | 0.00% | 0.00% | 0.00% |
| Santa Isabel | 0.90% | 0.00% | 0.10% | 0.00% | 0.00% |
| Toa Alta | 0.75% | 0.04% | 0.00% | 0.00% | 0.00% |
| Toa Baja | 0.46% | 0.19% | 0.05% | 0.00% | 0.00% |
| Trujillo Alto | 0.55% | 0.00% | 0.00% | 0.00% | 0.06% |
| Utuado | 3.32% | 0.00% | 0.00% | 0.00% | 0.00% |
| Vega Alta | 0.66% | 0.14% | 0.00% | 0.00% | 0.00% |
| Vega Baja | 0.94% | 0.41% | 0.00% | 0.00% | 0.00% |
| Vieques | 1.49% | 0.05% | 0.00% | 0.00% | 0.00% |
| Villalba | 1.07% | 0.00% | 0.00% | 0.00% | 0.00% |
| Yabucoa | 1.60% | 0.00% | 0.00% | 0.00% | 0.00% |
| Yauco | 1.78% | 0.20% | 0.00% | 0.00% | 0.00% |

Table 79: Human Caused Hazard Scores and Ranks by Municipio

| Municipio | Human Caused Hazard Score (Log Multiplied) | | |
|---------------|--|--------------------------|----------------------|
| | Total Score | Standardized Score (0-1) | Rank of Score (1-78) |
| San Juan | 10,000.0484 | 1.0000 | 1 |
| Carolina | 6,354.3376 | 0.6354 | 2 |
| Guaynabo | 1,061.0618 | 0.1061 | 3 |
| Aguadilla | 1,000.3534 | 0.1000 | 4 |
| Trujillo Alto | 505.5319 | 0.0505 | 5 |
| Loiza | 229.5227 | 0.0229 | 6 |
| Aguada | 145.2241 | 0.0145 | 7 |
| Canovanas | 118.2374 | 0.0118 | 8 |
| Caguas | 100.3325 | 0.0100 | 9 |
| Cantano | 46.5066 | 0.0046 | 10 |
| Bayamon | 25.5670 | 0.0025 | 11 |
| Santa Isabel | 16.4612 | 0.0016 | 12 |
| Ponce | 10.6617 | 0.0011 | 13 |

| | | | |
|---------------|--------|--------|----|
| Gurabo | 8.8239 | 0.0009 | 14 |
| Toa Baja | 9.2897 | 0.0009 | 14 |
| Mayaguez | 7.4389 | 0.0007 | 16 |
| Arecibo | 5.9751 | 0.0006 | 17 |
| Vega Baja | 3.7666 | 0.0004 | 18 |
| Fajardo | 3.2714 | 0.0003 | 19 |
| Humacao | 2.8890 | 0.0003 | 19 |
| Cayey | 2.0934 | 0.0002 | 21 |
| Coamo | 2.0952 | 0.0002 | 21 |
| Corozal | 1.7852 | 0.0002 | 21 |
| Dorado | 1.7702 | 0.0002 | 21 |
| Guanica | 1.8728 | 0.0002 | 21 |
| Guayama | 2.3298 | 0.0002 | 21 |
| Isabela | 1.7582 | 0.0002 | 21 |
| Manati | 1.8874 | 0.0002 | 21 |
| San German | 1.9708 | 0.0002 | 21 |
| San Lorenzo | 1.7848 | 0.0002 | 21 |
| Yauco | 2.2513 | 0.0002 | 21 |
| Adjuntas | 1.2916 | 0.0001 | 32 |
| Aibonito | 1.2171 | 0.0001 | 32 |
| Cabo Rojo | 0.8715 | 0.0001 | 32 |
| Ceiba | 1.1928 | 0.0001 | 32 |
| Cidra | 1.1549 | 0.0001 | 32 |
| Hatillo | 0.8617 | 0.0001 | 32 |
| Jayuya | 0.7413 | 0.0001 | 32 |
| Juana Diaz | 1.5906 | 0.0001 | 32 |
| Lares | 1.4804 | 0.0001 | 32 |
| Las Piedras | 1.0904 | 0.0001 | 32 |
| Moca | 1.3012 | 0.0001 | 32 |
| Morovis | 1.0468 | 0.0001 | 32 |
| Naguabo | 1.2912 | 0.0001 | 32 |
| Penuelas | 1.4526 | 0.0001 | 32 |
| Rincon | 1.5913 | 0.0001 | 32 |
| San Sebastian | 0.6189 | 0.0001 | 32 |
| Utua | 1.0000 | 0.0001 | 32 |
| Vega Alta | 1.4067 | 0.0001 | 32 |
| Vieques | 0.8533 | 0.0001 | 32 |
| Aguas Buenas | 0.2615 | 0.0000 | 51 |
| Anasco | 0.5868 | 0.0000 | 51 |
| Arroyo | 0.1308 | 0.0000 | 51 |
| Barceloneta | 0.1630 | 0.0000 | 51 |
| Barranquitas | 0.2979 | 0.0000 | 51 |

| | | | |
|---------------|--------|--------|----|
| Camuy | 0.4030 | 0.0000 | 51 |
| Ciales | 0.5797 | 0.0000 | 51 |
| Comerio | 0.2479 | 0.0000 | 51 |
| Culebra | 0.1156 | 0.0000 | 51 |
| Florida | 0.1323 | 0.0000 | 51 |
| Guayanilla | 0.3736 | 0.0000 | 51 |
| Hormigueros | 0.2842 | 0.0000 | 51 |
| Juncos | 0.2313 | 0.0000 | 51 |
| Lajas | 0.5729 | 0.0000 | 51 |
| Las Marias | 0.4042 | 0.0000 | 51 |
| Luquillo | 0.5776 | 0.0000 | 51 |
| Maricao | 0.3183 | 0.0000 | 51 |
| Maunabo | 0.1833 | 0.0000 | 51 |
| Naranjito | 0.5954 | 0.0000 | 51 |
| Orocovis | 0.5542 | 0.0000 | 51 |
| Patillas | 0.4103 | 0.0000 | 51 |
| Quebradillas | 0.2011 | 0.0000 | 51 |
| Río Grande | 0.5154 | 0.0000 | 51 |
| Sabana Grande | 0.3115 | 0.0000 | 51 |
| Salinas | 0.6088 | 0.0000 | 51 |
| Toa Alta | 0.5811 | 0.0000 | 51 |
| Villalba | 0.3219 | 0.0000 | 51 |
| Yabucoa | 0.4815 | 0.0000 | 51 |

Liquefaction

Hazard Overview

Liquefaction is a phenomenon causing unconsolidated soils to lose strength and act like viscous fluid when subjected to earthquake ground shaking. Liquefaction can result subsidence of land during an earthquake event. Liquefaction frequency and intensity is based on several factors, including the geologic conditions of the area, groundwater depth, ground shaking intensity, and the magnitude of the earthquake.³⁸

Data and Methods

Universidad Metropolitana, in partnership with URS Corporation, completed an integrated hazard assessment for Puerto Rico (2002). One output of this work was an assessment of liquefaction-induced ground failure potential hazard zones across most of Puerto Rico (excluding Vieques, Isla de Culebra, and Isla de Mona). Relative liquefaction susceptibility was characterized by evaluating soil/geologic conditions and groundwater depth. Based on these characteristics, a relative liquefaction susceptibility rating (e.g., very low to very high) was assigned based on classification systems established by Youd and Perkins (1978).³⁹ Sandy soils with shallower water tables present a greater liquefaction threat than rock or rock-like materials which were considered low liquefaction hazard. These zones, originally created for each municipio, were combined and mapped using the same classification system provided in the initial assessment.

Hazard Frequency Analysis Results

Largely a coastal and river basin phenomena, liquefaction hazard zones can be found in nearly every contiguous municipio across Puerto Rico. Each municipio, with the exception of Maricao in Western Puerto Rico has at least some areas with greater than low liquefaction hazard potential (Figure 27). Table 80 displays municipio area in each liquefaction hazard zone and identifies 18 municipios containing high liquefaction hazard zones. Table 81 and Table 82 provide municipio- and island-wide area by liquefaction hazard respectively. Table 83 provides a total liquefaction hazard score, a standardized score and rank by municipio.

³⁸ <http://www.geopr.org/free-data.html>

³⁹ https://www.researchgate.net/profile/T_Youd/publication/279600523_Mapping_liquefaction-induced_ground_failure_potential/links/5733901f08aea45ee838f8f2.pdf

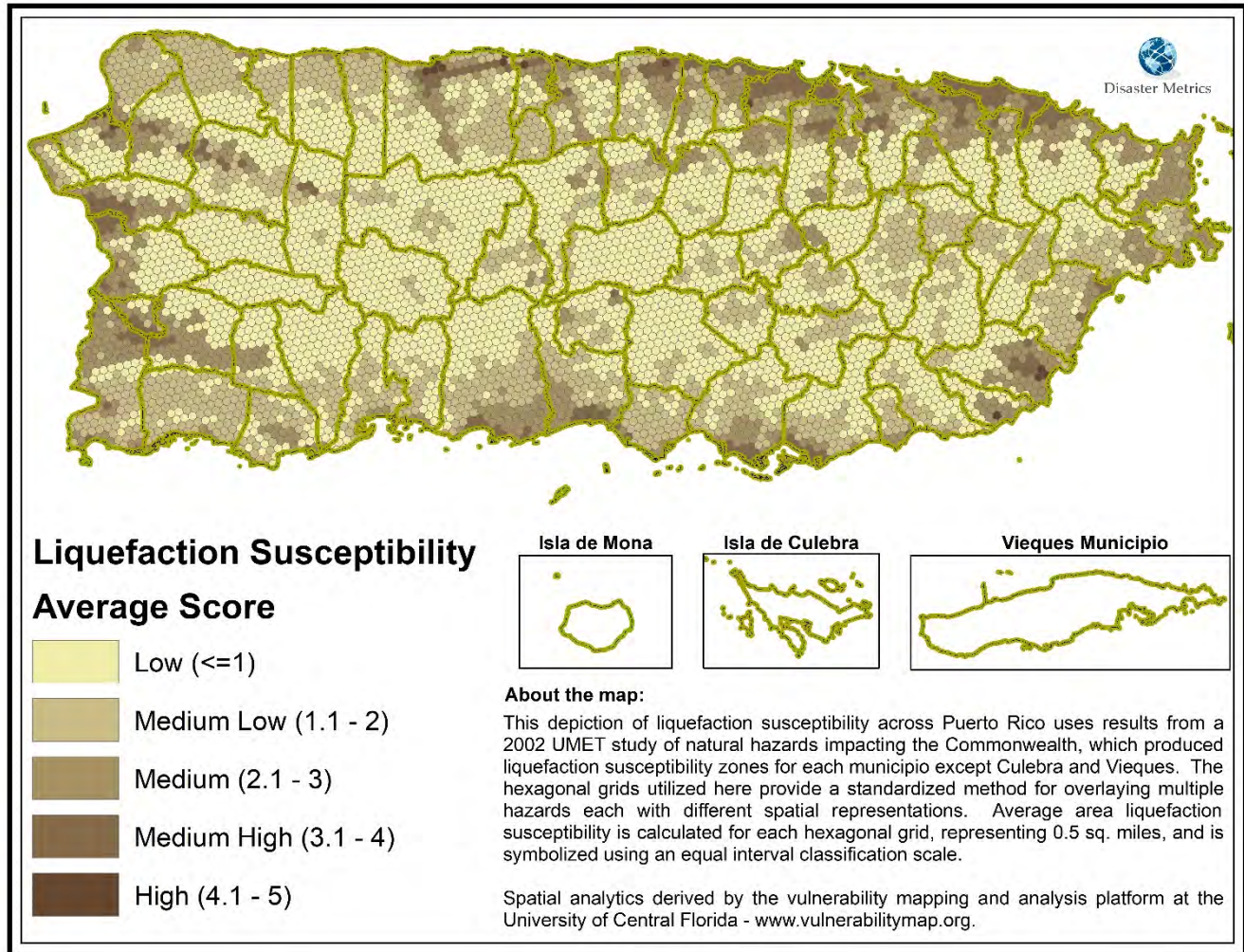


Figure 27: Liquefaction Hazard Areas

Table 80: Liquefaction Hazard by Municipio and Areal Extent

| Municipio | HEX GRID Area by Liquefaction Hazard Susceptibility (Sq. miles) | | | | | |
|--------------|---|---------------|----------------------|------------------|-----------------------|----------------|
| | None (No Data) | Low (Class 1) | Medium Low (Class 2) | Medium (Class 3) | Medium High (Class 4) | High (Class 5) |
| Adjuntas | | 64.60 | 2.50 | | | |
| Aguada | 0.00 | 17.05 | 3.98 | 6.98 | 1.01 | 1.90 |
| Aguadilla | | 2.20 | 27.47 | 6.00 | 0.58 | 0.36 |
| Aguas Buenas | | 25.57 | 1.39 | 3.13 | | |
| Aibonito | | 20.73 | 10.61 | | | |
| Anasco | | 16.08 | 4.04 | 11.99 | 7.45 | 0.00 |
| Arecibo | 0.00 | 53.69 | 46.77 | 15.23 | 8.24 | 3.05 |
| Arroyo | | 5.65 | 6.43 | 2.51 | 0.46 | |
| Barceloneta | 0.01 | 4.96 | 5.14 | 6.16 | 1.84 | 0.65 |
| Barranquitas | | 25.62 | 8.66 | | | |
| Bayamon | | 20.10 | 9.61 | 10.92 | 3.89 | |
| Cabo Rojo | 0.04 | 10.95 | 26.59 | 29.77 | 5.77 | |

| | | | | | | |
|-------------|-------|-------|-------|-------|-------|------|
| Caguas | | 32.90 | 26.17 | | | |
| Camuy | | 27.42 | 17.16 | 1.71 | 0.08 | |
| Canovanas | | 22.60 | 2.55 | 6.84 | 1.01 | |
| Carolina | 0.04 | 18.59 | 2.94 | 18.15 | 7.60 | |
| Catano | 0.02 | | | 0.63 | 4.43 | |
| Cayey | | 39.72 | 11.24 | 1.00 | | |
| Ceiba | 0.01 | 9.87 | 9.54 | 10.39 | 0.44 | 0.13 |
| Ciales | | 50.75 | 10.60 | 5.36 | | |
| Cidra | | 25.39 | 11.06 | | | |
| Coamo | | 67.05 | 10.98 | | | |
| Comerio | | 18.00 | 6.66 | 3.87 | | |
| Corozal | | 31.93 | 6.67 | 3.98 | | |
| Culebra | 13.31 | | | | | |
| Dorado | | 3.61 | 5.40 | 8.20 | 5.87 | 0.33 |
| Fajardo | 0.56 | 8.08 | 1.63 | 19.73 | 0.51 | |
| Florida | | 1.82 | 13.40 | | | |
| Guanica | 0.01 | 13.56 | 18.62 | 6.32 | 0.50 | |
| Guayama | 0.13 | 37.63 | 18.91 | 3.43 | 5.78 | |
| Guayanilla | 0.14 | 20.94 | 19.26 | 2.60 | 0.06 | |
| Guaynabo | | 13.92 | 6.93 | 6.54 | 0.38 | |
| Gurabo | | 12.74 | 15.57 | | | |
| Hatillo | | 23.19 | 17.40 | 0.77 | 0.48 | |
| Hormigueros | | 2.48 | 0.91 | 4.74 | 3.21 | |
| Humacao | 0.18 | 10.97 | 26.35 | 4.25 | 3.35 | |
| Isabela | 0.00 | 22.26 | 28.83 | 4.09 | | 0.22 |
| Jayuya | | 32.23 | 9.85 | 2.45 | | |
| Juana Diaz | 0.12 | 19.97 | 23.34 | 12.19 | 5.08 | 0.03 |
| Juncos | | 14.68 | 11.93 | | | |
| Lajas | 0.17 | 10.40 | 48.41 | 2.25 | 0.14 | |
| Lares | | 51.47 | 8.17 | 0.50 | 1.50 | |
| Las Marias | | 42.99 | 3.44 | 0.08 | | |
| Las Piedras | | 23.40 | 10.49 | | | |
| Loiza | | | 0.56 | 4.33 | 15.30 | 0.35 |
| Luquillo | | 14.53 | 1.85 | 9.19 | 0.29 | |
| Manati | 0.20 | 15.71 | 16.43 | 11.31 | 2.82 | 0.36 |
| Maricao | | 36.63 | | | | |
| Maunabo | | 12.41 | 0.75 | 7.43 | | 0.50 |
| Mayaguez | 22.77 | 31.20 | 3.59 | 13.90 | 6.51 | |
| Moca | | 26.64 | 11.63 | 8.94 | 3.16 | |
| Morovis | | 23.75 | 12.99 | 2.19 | | |
| Naguabo | | 23.17 | 18.87 | 9.54 | 0.29 | |
| Naranjito | | 23.97 | 3.77 | | | |

| | | | | | | |
|---------------|-------|---------|--------|--------|--------|-------|
| Orocovis | | 60.94 | 2.84 | | | |
| Patillas | 0.00 | 33.59 | 12.06 | 1.41 | 0.11 | 0.04 |
| Penuelas | 0.13 | 31.00 | 11.32 | 2.03 | 0.27 | |
| Ponce | 0.70 | 52.30 | 38.61 | 20.27 | 5.10 | |
| Quebradillas | 0.00 | 10.27 | 11.40 | 1.46 | | |
| Rincon | 0.09 | 5.69 | 4.69 | 3.64 | | 0.27 |
| Rio Grande | 0.00 | 39.43 | 1.00 | 13.87 | 6.51 | |
| Sabana Grande | | 23.44 | 5.68 | 6.72 | | |
| Salinas | 0.39 | 28.66 | 25.74 | 10.47 | 4.79 | |
| San German | | 29.00 | 1.13 | 21.93 | 2.44 | |
| San Juan | 0.00 | 20.40 | 8.59 | 14.15 | 6.34 | 0.05 |
| San Lorenzo | | 41.77 | 11.44 | | | |
| San Sebastian | | 40.45 | 21.23 | 5.97 | 3.57 | |
| Santa Isabel | 0.13 | 4.87 | 24.60 | 3.31 | 1.67 | |
| Toa Alta | | 10.70 | 7.67 | 9.19 | | |
| Toa Baja | 0.00 | 1.00 | 3.62 | 6.27 | 12.10 | 0.81 |
| Trujillo Alto | | 13.51 | 3.52 | 4.35 | | |
| Utuado | | 100.82 | 14.25 | | | |
| Vega Alta | | 8.66 | 9.03 | 8.05 | 2.00 | |
| Vega Baja | 0.01 | 13.19 | 18.30 | 8.68 | 5.97 | 0.50 |
| Vieques | 53.18 | | | | | |
| Villalba | | 24.90 | 9.14 | 2.50 | 0.50 | |
| Yabucoa | | 25.27 | 6.50 | 17.54 | 4.60 | 1.49 |
| Yauco | | 54.49 | 13.88 | 0.45 | | |
| Grand Total | 92.34 | 1860.11 | 894.29 | 451.83 | 154.00 | 11.05 |

Table 81: Percent of (Municipio) Hexagonal Area by Liquefaction Hazard per Municipio

| Municipio | Liquefaction Hazard Susceptibility Percent Area by Total (Municipio) Land Area | | | | | |
|--------------|--|------------------|-------------------------|---------------------|--------------------------|-------------------|
| | None (No Data) | Low (Class 1) | Medium Low (Class 2) | Medium (Class 3) | Medium High (Class 4) | High (Class 5) |
| Adjuntas | 0.00% | 96.27% | 3.73% | 0.00% | 0.00% | 0.00% |
| Aguada | 0.01% | 55.14% | 12.87% | 22.58% | 3.25% | 6.15% |
| Aguadilla | 0.00% | 6.00% | 75.03% | 16.40% | 1.59% | 0.98% |
| Aguas Buenas | 0.00% | 84.97% | 4.62% | 10.41% | 0.00% | 0.00% |
| Aibonito | 0.00% | 66.16% | 33.84% | 0.00% | 0.00% | 0.00% |
| Anasco | 0.00% | 40.65% | 10.21% | 30.30% | 18.84% | 0.01% |
| Arecibo | 0.00% | 42.28% | 36.83% | 11.99% | 6.49% | 2.41% |
| Arroyo | 0.00% | 37.53% | 42.72% | 16.71% | 3.03% | 0.00% |
| Barceloneta | 0.06% | 26.44% | 27.40% | 32.81% | 9.84% | 3.45% |
| Barranquitas | 0.00% | 74.73% | 25.27% | 0.00% | 0.00% | 0.00% |
| Bayamon | 0.00% | 45.15% | 21.59% | 24.54% | 8.73% | 0.00% |
| Cabo Rojo | 0.05% | 14.98% | 36.36% | 40.72% | 7.89% | 0.00% |

| | | | | | | |
|-------------|---------|---------|--------|--------|--------|-------|
| Caguas | 0.00% | 55.70% | 44.30% | 0.00% | 0.00% | 0.00% |
| Camuy | 0.00% | 59.13% | 37.01% | 3.69% | 0.17% | 0.00% |
| Canovanas | 0.00% | 68.48% | 7.74% | 20.71% | 3.07% | 0.00% |
| Carolina | 0.08% | 39.29% | 6.21% | 38.36% | 16.06% | 0.00% |
| Catano | 0.42% | 0.00% | 0.00% | 12.39% | 87.19% | 0.00% |
| Cayey | 0.00% | 76.45% | 21.62% | 1.92% | 0.00% | 0.00% |
| Ceiba | 0.02% | 32.50% | 31.39% | 34.21% | 1.46% | 0.42% |
| Ciales | 0.00% | 76.07% | 15.89% | 8.03% | 0.00% | 0.00% |
| Cidra | 0.00% | 69.66% | 30.34% | 0.00% | 0.00% | 0.00% |
| Coamo | 0.00% | 85.93% | 14.07% | 0.00% | 0.00% | 0.00% |
| Comerio | 0.00% | 63.10% | 23.35% | 13.55% | 0.00% | 0.00% |
| Corozal | 0.00% | 74.99% | 15.67% | 9.34% | 0.00% | 0.00% |
| Culebra | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Dorado | 0.00% | 15.42% | 23.05% | 35.03% | 25.07% | 1.43% |
| Fajardo | 1.84% | 26.49% | 5.34% | 64.67% | 1.67% | 0.00% |
| Florida | 0.00% | 11.95% | 88.05% | 0.00% | 0.00% | 0.00% |
| Guanica | 0.03% | 34.76% | 47.72% | 16.21% | 1.27% | 0.00% |
| Guayama | 0.19% | 57.12% | 28.70% | 5.20% | 8.78% | 0.00% |
| Guayanilla | 0.33% | 48.70% | 44.79% | 6.04% | 0.14% | 0.00% |
| Guaynabo | 0.00% | 50.14% | 24.96% | 23.55% | 1.35% | 0.00% |
| Gurabo | 0.00% | 45.00% | 55.00% | 0.00% | 0.00% | 0.00% |
| Hatillo | 0.00% | 55.43% | 41.59% | 1.84% | 1.14% | 0.00% |
| Hormigueros | 0.00% | 21.85% | 8.01% | 41.83% | 28.31% | 0.00% |
| Humacao | 0.40% | 24.32% | 58.43% | 9.42% | 7.43% | 0.00% |
| Isabela | 0.01% | 40.18% | 52.03% | 7.38% | 0.00% | 0.40% |
| Jayuya | 0.00% | 72.38% | 22.12% | 5.51% | 0.00% | 0.00% |
| Juana Diaz | 0.19% | 32.88% | 38.44% | 20.07% | 8.36% | 0.06% |
| Juncos | 0.00% | 55.16% | 44.84% | 0.00% | 0.00% | 0.00% |
| Lajas | 0.28% | 16.95% | 78.89% | 3.66% | 0.22% | 0.00% |
| Lares | 0.00% | 83.50% | 13.25% | 0.81% | 2.43% | 0.00% |
| Las Marias | 0.00% | 92.43% | 7.41% | 0.16% | 0.00% | 0.00% |
| Las Piedras | 0.00% | 69.04% | 30.96% | 0.00% | 0.00% | 0.00% |
| Loiza | 0.00% | 0.00% | 2.74% | 21.06% | 74.49% | 1.70% |
| Luquillo | 0.00% | 56.18% | 7.15% | 35.55% | 1.12% | 0.00% |
| Manati | 0.43% | 33.55% | 35.08% | 24.15% | 6.02% | 0.76% |
| Maricao | 0.00% | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Maunabo | 0.00% | 58.85% | 3.54% | 35.24% | 0.00% | 2.37% |
| Mayaguez | 29.20% | 40.01% | 4.60% | 17.83% | 8.35% | 0.00% |
| Moca | 0.00% | 52.90% | 23.08% | 17.75% | 6.27% | 0.00% |
| Morovis | 0.00% | 61.01% | 33.37% | 5.62% | 0.00% | 0.00% |
| Naguabo | 0.00% | 44.67% | 36.38% | 18.40% | 0.56% | 0.00% |
| Naranjito | 0.00% | 86.40% | 13.60% | 0.00% | 0.00% | 0.00% |

| | | | | | | |
|---------------|---------|--------|--------|--------|--------|-------|
| Orocovis | 0.00% | 95.55% | 4.45% | 0.00% | 0.00% | 0.00% |
| Patillas | 0.01% | 71.14% | 25.55% | 2.99% | 0.23% | 0.09% |
| Penuelas | 0.30% | 69.27% | 25.29% | 4.54% | 0.60% | 0.00% |
| Ponce | 0.60% | 44.70% | 33.01% | 17.33% | 4.36% | 0.00% |
| Quebradillas | 0.01% | 44.40% | 49.27% | 6.32% | 0.00% | 0.00% |
| Rincon | 0.60% | 39.55% | 32.62% | 25.32% | 0.00% | 1.91% |
| Rio Grande | 0.00% | 64.84% | 1.64% | 22.80% | 10.71% | 0.00% |
| Sabana Grande | 0.00% | 65.39% | 15.85% | 18.76% | 0.00% | 0.00% |
| Salinas | 0.56% | 40.91% | 36.74% | 14.95% | 6.84% | 0.00% |
| San German | 0.00% | 53.21% | 2.08% | 40.24% | 4.48% | 0.00% |
| San Juan | 0.00% | 41.19% | 17.34% | 28.57% | 12.80% | 0.10% |
| San Lorenzo | 0.00% | 78.50% | 21.50% | 0.00% | 0.00% | 0.00% |
| San Sebastian | 0.00% | 56.79% | 29.81% | 8.39% | 5.01% | 0.00% |
| Santa Isabel | 0.37% | 14.09% | 71.15% | 9.57% | 4.83% | 0.00% |
| Toa Alta | 0.00% | 38.83% | 27.82% | 33.35% | 0.00% | 0.00% |
| Toa Baja | 0.00% | 4.20% | 15.23% | 26.33% | 50.84% | 3.40% |
| Trujillo Alto | 0.00% | 63.19% | 16.48% | 20.33% | 0.00% | 0.00% |
| Utuado | 0.00% | 87.62% | 12.38% | 0.00% | 0.00% | 0.00% |
| Vega Alta | 0.00% | 31.22% | 32.57% | 29.01% | 7.20% | 0.00% |
| Vega Baja | 0.02% | 28.28% | 39.23% | 18.60% | 12.80% | 1.07% |
| Vieques | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Villalba | 0.00% | 67.22% | 24.68% | 6.75% | 1.35% | 0.00% |
| Yabucoa | 0.00% | 45.61% | 11.73% | 31.66% | 8.29% | 2.69% |
| Yauco | 0.00% | 79.18% | 20.17% | 0.65% | 0.00% | 0.00% |

Table 82: Percent of (Island) Hexagonal Area by Liquefaction Hazard per Municipio

| Municipio | Liquefaction Hazard Susceptibility Percent Area by Total (Island) Land Area | | | | | |
|--------------|---|------------------|-------------------------|---------------------|--------------------------|-------------------|
| | None (No Data) | Low (Class 1) | Medium Low (Class 2) | Medium (Class 3) | Medium High (Class 4) | High (Class 5) |
| Adjuntas | 0.00% | 3.47% | 0.28% | 0.00% | 0.00% | 0.00% |
| Aguada | 0.00% | 0.92% | 0.45% | 1.55% | 0.65% | 17.22% |
| Aguadilla | 0.00% | 0.12% | 3.07% | 1.33% | 0.38% | 3.24% |
| Aguas Buenas | 0.00% | 1.37% | 0.16% | 0.69% | 0.00% | 0.00% |
| Aibonito | 0.00% | 1.11% | 1.19% | 0.00% | 0.00% | 0.00% |
| Anasco | 0.00% | 0.86% | 0.45% | 2.65% | 4.84% | 0.03% |
| Arecibo | 0.00% | 2.89% | 5.23% | 3.37% | 5.35% | 27.64% |
| Arroyo | 0.00% | 0.30% | 0.72% | 0.56% | 0.30% | 0.00% |
| Barceloneta | 0.01% | 0.27% | 0.57% | 1.36% | 1.20% | 5.85% |
| Barranquitas | 0.00% | 1.38% | 0.97% | 0.00% | 0.00% | 0.00% |
| Bayamon | 0.00% | 1.08% | 1.07% | 2.42% | 2.52% | 0.00% |
| Cabo Rojo | 0.04% | 0.59% | 2.97% | 6.59% | 3.75% | 0.00% |
| Caguas | 0.00% | 1.77% | 2.93% | 0.00% | 0.00% | 0.00% |

| | | | | | | |
|-------------|--------|-------|-------|-------|-------|-------|
| Camuy | 0.00% | 1.47% | 1.92% | 0.38% | 0.05% | 0.00% |
| Canovanas | 0.00% | 1.22% | 0.29% | 1.51% | 0.66% | 0.00% |
| Carolina | 0.04% | 1.00% | 0.33% | 4.02% | 4.93% | 0.00% |
| Catano | 0.02% | 0.00% | 0.00% | 0.14% | 2.88% | 0.00% |
| Cayey | 0.00% | 2.14% | 1.26% | 0.22% | 0.00% | 0.00% |
| Ceiba | 0.01% | 0.53% | 1.07% | 2.30% | 0.29% | 1.14% |
| Ciales | 0.00% | 2.73% | 1.19% | 1.19% | 0.00% | 0.00% |
| Cidra | 0.00% | 1.37% | 1.24% | 0.00% | 0.00% | 0.00% |
| Coamo | 0.00% | 3.60% | 1.23% | 0.00% | 0.00% | 0.00% |
| Comerio | 0.00% | 0.97% | 0.74% | 0.86% | 0.00% | 0.00% |
| Corozal | 0.00% | 1.72% | 0.75% | 0.88% | 0.00% | 0.00% |
| Culebra | 14.41% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Dorado | 0.00% | 0.19% | 0.60% | 1.82% | 3.81% | 3.03% |
| Fajardo | 0.61% | 0.43% | 0.18% | 4.37% | 0.33% | 0.00% |
| Florida | 0.00% | 0.10% | 1.50% | 0.00% | 0.00% | 0.00% |
| Guanica | 0.01% | 0.73% | 2.08% | 1.40% | 0.32% | 0.00% |
| Guayama | 0.14% | 2.02% | 2.11% | 0.76% | 3.75% | 0.00% |
| Guayanilla | 0.15% | 1.13% | 2.15% | 0.57% | 0.04% | 0.00% |
| Guaynabo | 0.00% | 0.75% | 0.77% | 1.45% | 0.24% | 0.00% |
| Gurabo | 0.00% | 0.68% | 1.74% | 0.00% | 0.00% | 0.00% |
| Hatillo | 0.00% | 1.25% | 1.95% | 0.17% | 0.31% | 0.00% |
| Hormigueros | 0.00% | 0.13% | 0.10% | 1.05% | 2.09% | 0.00% |
| Humacao | 0.20% | 0.59% | 2.95% | 0.94% | 2.18% | 0.00% |
| Isabela | 0.00% | 1.20% | 3.22% | 0.91% | 0.00% | 2.00% |
| Jayuya | 0.00% | 1.73% | 1.10% | 0.54% | 0.00% | 0.00% |
| Juana Diaz | 0.13% | 1.07% | 2.61% | 2.70% | 3.30% | 0.30% |
| Juncos | 0.00% | 0.79% | 1.33% | 0.00% | 0.00% | 0.00% |
| Lajas | 0.18% | 0.56% | 5.41% | 0.50% | 0.09% | 0.00% |
| Lares | 0.00% | 2.77% | 0.91% | 0.11% | 0.97% | 0.00% |
| Las Marias | 0.00% | 2.31% | 0.39% | 0.02% | 0.00% | 0.00% |
| Las Piedras | 0.00% | 1.26% | 1.17% | 0.00% | 0.00% | 0.00% |
| Loiza | 0.00% | 0.00% | 0.06% | 0.96% | 9.93% | 3.16% |
| Luquillo | 0.00% | 0.78% | 0.21% | 2.03% | 0.19% | 0.00% |
| Manati | 0.22% | 0.84% | 1.84% | 2.50% | 1.83% | 3.21% |
| Maricao | 0.00% | 1.97% | 0.00% | 0.00% | 0.00% | 0.00% |
| Maunabo | 0.00% | 0.67% | 0.08% | 1.64% | 0.00% | 4.52% |
| Mayaguez | 24.66% | 1.68% | 0.40% | 3.08% | 4.23% | 0.00% |
| Moca | 0.00% | 1.43% | 1.30% | 1.98% | 2.05% | 0.00% |
| Morovis | 0.00% | 1.28% | 1.45% | 0.48% | 0.00% | 0.00% |
| Naguabo | 0.00% | 1.25% | 2.11% | 2.11% | 0.19% | 0.00% |
| Naranjito | 0.00% | 1.29% | 0.42% | 0.00% | 0.00% | 0.00% |
| Orocovis | 0.00% | 3.28% | 0.32% | 0.00% | 0.00% | 0.00% |

| | | | | | | |
|---------------|--------|-------|-------|-------|-------|--------|
| Patillas | 0.00% | 1.81% | 1.35% | 0.31% | 0.07% | 0.38% |
| Penuelas | 0.14% | 1.67% | 1.27% | 0.45% | 0.18% | 0.00% |
| Ponce | 0.76% | 2.81% | 4.32% | 4.49% | 3.31% | 0.00% |
| Quebradillas | 0.00% | 0.55% | 1.27% | 0.32% | 0.00% | 0.00% |
| Rincon | 0.09% | 0.31% | 0.52% | 0.81% | 0.00% | 2.49% |
| Rio Grande | 0.00% | 2.12% | 0.11% | 3.07% | 4.23% | 0.00% |
| Sabana Grande | 0.00% | 1.26% | 0.64% | 1.49% | 0.00% | 0.00% |
| Salinas | 0.42% | 1.54% | 2.88% | 2.32% | 3.11% | 0.00% |
| San German | 0.00% | 1.56% | 0.13% | 4.85% | 1.58% | 0.00% |
| San Juan | 0.00% | 1.10% | 0.96% | 3.13% | 4.12% | 0.45% |
| San Lorenzo | 0.00% | 2.25% | 1.28% | 0.00% | 0.00% | 0.00% |
| San Sebastian | 0.00% | 2.17% | 2.37% | 1.32% | 2.32% | 0.00% |
| Santa Isabel | 0.14% | 0.26% | 2.75% | 0.73% | 1.08% | 0.00% |
| Toa Alta | 0.00% | 0.58% | 0.86% | 2.03% | 0.00% | 0.00% |
| Toa Baja | 0.00% | 0.05% | 0.41% | 1.39% | 7.86% | 7.33% |
| Trujillo Alto | 0.00% | 0.73% | 0.39% | 0.96% | 0.00% | 0.00% |
| Utua | 0.00% | 5.42% | 1.59% | 0.00% | 0.00% | 0.00% |
| Vega Alta | 0.00% | 0.47% | 1.01% | 1.78% | 1.30% | 0.00% |
| Vega Baja | 0.01% | 0.71% | 2.05% | 1.92% | 3.88% | 4.52% |
| Vieques | 57.59% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Villalba | 0.00% | 1.34% | 1.02% | 0.55% | 0.32% | 0.00% |
| Yabucoa | 0.00% | 1.36% | 0.73% | 3.88% | 2.98% | 13.50% |
| Yauco | 0.00% | 2.93% | 1.55% | 0.10% | 0.00% | 0.00% |

Table 83: Liquefaction Hazard Scores and Ranks by Municipio

| Municipio | Liquefaction Hazard Susceptibility Score (Log Multiplied) | | |
|---------------|---|--------------------------|----------------------|
| | Total Score | Standardized Score (0-1) | Rank of Score (1-78) |
| San Juan | 10,000.0484 | 1.0000 | 1 |
| Carolina | 6,354.3376 | 0.6354 | 2 |
| Guaynabo | 1,061.0618 | 0.1061 | 3 |
| Aguadilla | 1,000.3534 | 0.1000 | 4 |
| Trujillo Alto | 505.5319 | 0.0505 | 5 |
| Loiza | 229.5227 | 0.0229 | 6 |
| Aguada | 145.2241 | 0.0145 | 7 |
| Canovanas | 118.2374 | 0.0118 | 8 |
| Caguas | 100.3325 | 0.0100 | 9 |
| Cantano | 46.5066 | 0.0046 | 10 |
| Bayamon | 25.5670 | 0.0025 | 11 |
| Santa Isabel | 16.4612 | 0.0016 | 12 |
| Ponce | 10.6617 | 0.0011 | 13 |

| | | | |
|---------------|------------|--------|----|
| Gurabo | 8.8239 | 0.0009 | 14 |
| Arecibo | 10600.2290 | 1.0000 | 1 |
| Aguada | 6319.3482 | 0.5962 | 2 |
| Yabucoa | 5246.1390 | 0.4949 | 3 |
| Toa Baja | 3463.8499 | 0.3268 | 4 |
| Barceloneta | 2259.5702 | 0.2132 | 5 |
| Loiza | 2157.0581 | 0.2035 | 6 |
| Vega Baja | 2060.0229 | 0.1943 | 7 |
| Maunabo | 1661.9379 | 0.1568 | 8 |
| Dorado | 1507.9439 | 0.1423 | 9 |
| Manati | 1388.1414 | 0.1310 | 10 |
| Aguadilla | 1236.0180 | 0.1166 | 11 |
| Rincon | 912.9101 | 0.0861 | 12 |
| Isabela | 743.8760 | 0.0702 | 13 |
| San Juan | 626.1003 | 0.0591 | 14 |
| Carolina | 558.5183 | 0.0527 | 15 |
| Anasco | 539.9570 | 0.0509 | 16 |
| Juana Diaz | 487.4644 | 0.0460 | 17 |
| Cabo Rojo | 482.8511 | 0.0456 | 18 |
| Ceiba | 478.5784 | 0.0451 | 19 |
| Mayaguez | 473.5342 | 0.0447 | 20 |
| Rio Grande | 473.0351 | 0.0446 | 21 |
| Ponce | 410.1782 | 0.0387 | 22 |
| Guayama | 393.7207 | 0.0371 | 23 |
| Salinas | 354.1422 | 0.0334 | 24 |
| Bayamon | 292.8483 | 0.0276 | 25 |
| Catano | 291.9054 | 0.0275 | 26 |
| San Sebastian | 258.2230 | 0.0244 | 27 |
| Moca | 239.0914 | 0.0226 | 28 |
| Humacao | 238.8467 | 0.0225 | 29 |
| San German | 233.7365 | 0.0221 | 30 |
| Hormigueros | 226.0768 | 0.0213 | 31 |
| Vega Alta | 159.5495 | 0.0151 | 32 |
| Patillas | 150.3974 | 0.0142 | 33 |
| Santa Isabel | 125.3396 | 0.0118 | 34 |
| Lares | 101.9350 | 0.0096 | 35 |
| Fajardo | 100.0624 | 0.0094 | 36 |
| Canovanas | 89.9216 | 0.0085 | 37 |
| Guanica | 57.7384 | 0.0054 | 38 |
| Naguabo | 55.2757 | 0.0052 | 39 |
| Luquillo | 50.3899 | 0.0048 | 40 |
| Guaynabo | 48.1174 | 0.0045 | 41 |

| | | | |
|---------------|---------|--------|----|
| Villalba | 43.2184 | 0.0041 | 42 |
| Arroyo | 39.6616 | 0.0037 | 43 |
| Hatillo | 37.5852 | 0.0035 | 44 |
| Toa Alta | 32.5591 | 0.0031 | 45 |
| Penuelas | 27.1494 | 0.0026 | 46 |
| Lajas | 26.5149 | 0.0025 | 47 |
| Sabana Grande | 23.9911 | 0.0023 | 48 |
| Ciales | 20.6870 | 0.0020 | 49 |
| Guayanilla | 16.7617 | 0.0016 | 50 |
| Trujillo Alto | 15.4608 | 0.0015 | 51 |
| Camuy | 14.8311 | 0.0014 | 52 |
| Comerio | 14.5382 | 0.0014 | 52 |
| Corozal | 15.0579 | 0.0014 | 52 |
| Aguas Buenas | 11.0653 | 0.0010 | 55 |
| Jayuya | 10.5912 | 0.0010 | 55 |
| Morovis | 10.2715 | 0.0010 | 55 |
| Quebradillas | 7.3716 | 0.0007 | 58 |
| Cayey | 6.0740 | 0.0006 | 59 |
| Caguas | 5.7316 | 0.0005 | 60 |
| Yauco | 4.9190 | 0.0005 | 60 |
| Utua | 3.9429 | 0.0004 | 62 |
| Coamo | 2.9327 | 0.0003 | 63 |
| Florida | 2.7865 | 0.0003 | 63 |

Lightning

Hazard Overview

All thunderstorms produce lightning, a spark of static electricity and results from the buildup of electrical energy between positively and negatively charged areas. Whenever thunder is audible, there is the risk of a lightning strike. The only safe place during a thunderstorm is inside. Lightning has also occurred in volcanic eruptions, intense forest fires, surface nuclear detonations, heavy snowstorms, and in large hurricanes. There are four types of lightning: cloud to ground, intra-cloud, cloud-to-cloud, and cloud to air. The term “heat lightning” is a misnomer and is not related to high temperatures. Heat lightning is lightning that is simply too far away for the thunder to be audible. Cloud-to-ground lightning is responsible for most fatalities, injuries, and property damage.

Data and Methods

The lightning data (2010-2019), obtained from the World Wide Lightning Location Network⁴⁰ provide locations in latitude and longitude (decimal degree) of cloud-to-ground lightning strikes. These strike locations were plotted as points, overlaid by the .5-mile hex grid and a count of strikes was generated for each hex grid. Annual lightning frequency, calculated as the number of lightning points that are intercepted with each hexagon divided by the total number of years in record, provides a spatial representation of lightning hazard across Puerto Rico.

Hazard Frequency Analysis Results

Although lightning can occur anywhere in Puerto Rico, western portions of the main island have a higher lightning strike frequency than other areas (Figure 28). Table 84 provides an overview of land area in each municipio by lightning hazard frequency zones. Table 85 and Table 86 summarize percent land area by municipio and compared to total island-wide area respectively. Table 87 shows the total lightning hazard score, standardized score, rank for each municipio.

⁴⁰ <http://wwlln.net/>

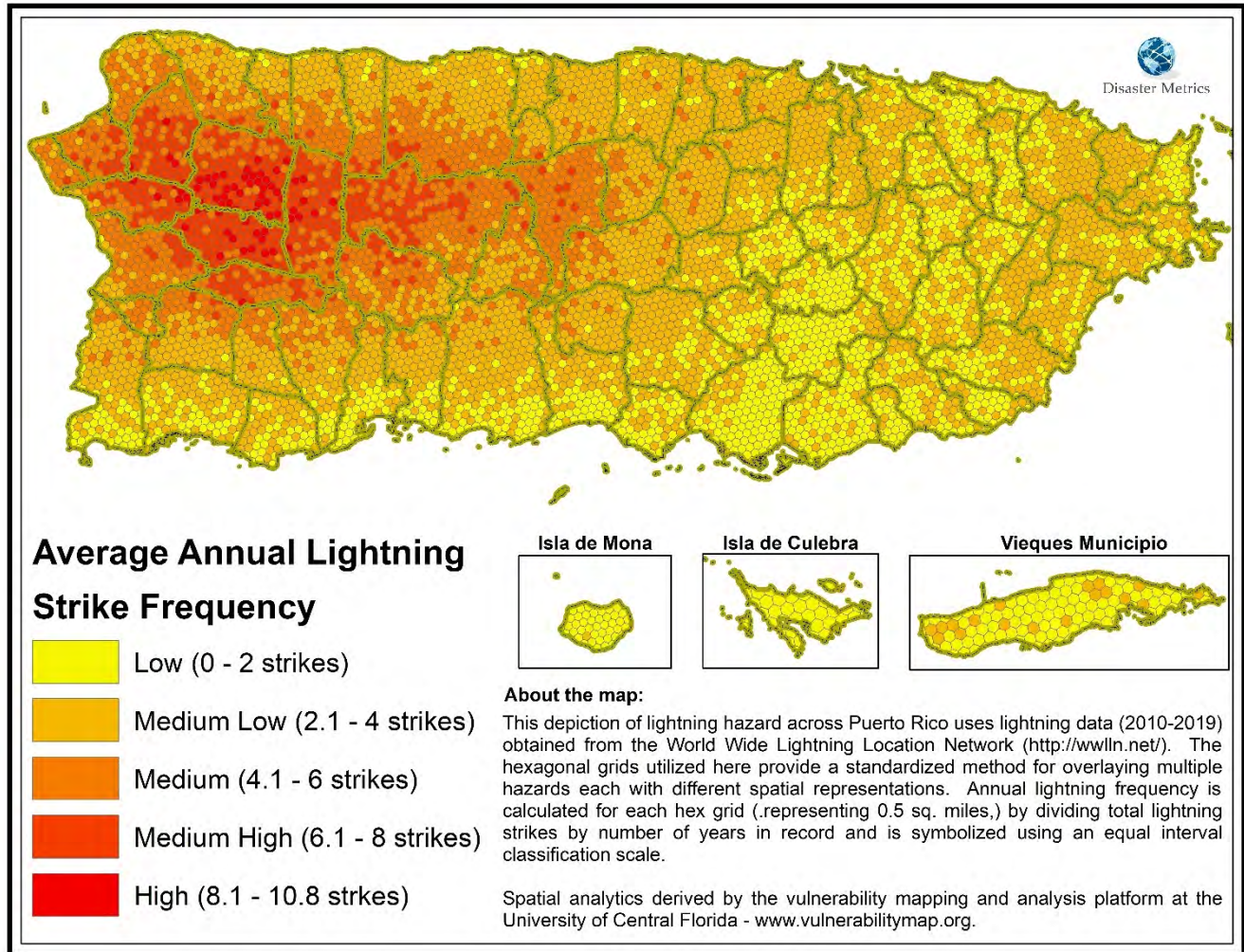


Figure 28: Lightning Hazard Areas

Table 84: Lightning Hazard by Municipio and Areal Extent

| Municipio | HEX GRID Area by Annual Lightning Hazard Frequency (Sq. miles) | | | | |
|--------------|--|------------------------------|--------------------------|-------------------------------|-------------------------|
| | Low (0 – 2 strikes) | Medium Low (2.1 – 4 strikes) | Medium (4.1 – 6 strikes) | Medium High (6.1 – 8 strikes) | High (8.1 – 10 strikes) |
| Adjuntas | 0.10 | 21.57 | 37.53 | 7.90 | |
| Aguada | 0.56 | 1.69 | 19.36 | 9.24 | 0.07 |
| Aguadilla | 1.17 | 14.34 | 20.33 | 0.77 | |
| Aguas Buenas | 14.21 | 15.88 | | | |
| Aibonito | 15.89 | 15.44 | | | |
| Anasco | 0.21 | 2.14 | 14.05 | 19.98 | 3.18 |
| Arecibo | 5.21 | 65.53 | 50.42 | 5.81 | |
| Arroyo | 11.18 | 3.87 | | | |
| Barceloneta | 2.40 | 16.02 | 0.34 | | |
| Barranquitas | 7.15 | 27.13 | | | |
| Bayamon | 9.84 | 34.23 | 0.45 | | |

| | | | | | |
|-------------|-------|-------|-------|-------|------|
| Cabo Rojo | 24.12 | 41.76 | 7.24 | | |
| Caguas | 28.16 | 30.90 | | | |
| Camuy | 1.45 | 23.36 | 20.08 | 1.49 | |
| Canovanas | 19.05 | 13.95 | | | |
| Cantano | 29.55 | 17.75 | | | |
| Carolina | 1.34 | 3.75 | | | |
| Cayey | 40.95 | 11.01 | | | |
| Ceiba | 12.60 | 17.37 | 0.40 | | |
| Ciales | | 7.55 | 55.15 | 4.00 | |
| Cidra | 29.04 | 7.42 | | | |
| Coamo | 18.43 | 59.60 | | | |
| Comerio | 17.94 | 10.58 | | | |
| Corozal | 0.29 | 37.79 | 4.50 | | |
| Culebra | 13.31 | | | | |
| Dorado | 2.29 | 20.13 | 1.00 | | |
| Fajardo | 16.96 | 13.55 | | | |
| Florida | | 9.77 | 4.95 | 0.50 | |
| Guanica | 17.07 | 21.94 | | | |
| Guayama | 52.34 | 13.52 | | | |
| Guayanilla | 17.51 | 23.17 | 2.31 | | |
| Guaynabo | 4.52 | 23.25 | | | |
| Gurabo | 15.56 | 12.75 | | | |
| Hatillo | 2.82 | 21.12 | 14.68 | 3.22 | |
| Hormigueros | | 4.13 | 7.22 | | |
| Humacao | 13.71 | 31.40 | | | |
| Isabela | 3.42 | 28.27 | 20.79 | 2.92 | |
| Jayuya | | 20.28 | 23.42 | 0.84 | |
| Juana Diaz | 23.93 | 34.73 | 2.07 | | |
| Juncos | 13.49 | 13.13 | | | |
| Lajas | 23.62 | 37.58 | 0.16 | | |
| Lares | | 0.92 | 18.73 | 37.39 | 4.59 |
| Las Marias | | | 3.24 | 34.84 | 8.43 |
| Las Piedras | 7.84 | 26.05 | | | |
| Loiza | 15.18 | 5.35 | | | |
| Luquillo | 3.59 | 22.27 | | | |
| Manati | 1.57 | 41.61 | 3.65 | | |
| Maricao | | 0.03 | 18.32 | 17.65 | 0.63 |
| Maunabo | 14.53 | 6.56 | | | |
| Mayaguez | 23.39 | 9.87 | 35.98 | 8.74 | |
| Moca | | 1.36 | 21.12 | 25.44 | 2.45 |
| Morovis | | 26.48 | 12.45 | | |
| Naguabo | 11.14 | 40.64 | 0.10 | | |

| | | | | | |
|---------------|--------|---------|--------|--------|-------|
| Naranjito | 6.49 | 21.26 | | | |
| Orocovis | 0.50 | 47.35 | 15.43 | 0.50 | |
| Patillas | 24.68 | 22.53 | | | |
| Penuelas | 11.02 | 29.18 | 4.56 | | |
| Ponce | 31.58 | 77.16 | 8.25 | | |
| Quebradillas | 1.78 | 14.07 | 6.42 | 0.87 | |
| Rio Grande | 0.42 | 4.47 | 8.47 | 1.04 | |
| Rincon | 16.55 | 43.76 | 0.50 | | |
| Sabana Grande | 1.42 | 24.11 | 9.98 | 0.33 | 0.00 |
| Salinas | 55.49 | 14.57 | | | |
| San German | 0.89 | 29.92 | 21.41 | 2.29 | |
| San Juan | 15.52 | 34.01 | | | |
| San Lorenzo | 28.14 | 25.07 | | | |
| San Sebastian | | 0.26 | 15.80 | 37.02 | 18.14 |
| Santa Isabel | 21.89 | 12.69 | | | |
| Toa Alta | 1.16 | 25.19 | 1.21 | | |
| Toa Baja | 2.47 | 20.49 | 0.84 | | |
| Trujillo Alto | 11.42 | 9.96 | | | |
| Utuado | | 10.11 | 66.70 | 38.26 | |
| Vega Alta | 1.89 | 24.35 | 1.50 | | |
| Vega Baja | 5.92 | 39.23 | 1.50 | | |
| Vieques | 44.33 | 8.86 | | | |
| Villalba | 1.00 | 32.17 | 3.87 | | |
| Yabucoa | 22.03 | 33.38 | | | |
| Yauco | 8.22 | 37.87 | 22.26 | 0.47 | |
| Grand Total | 903.44 | 1652.48 | 608.71 | 261.50 | 37.50 |

Table 85: Percent of (Municipio) Hexagonal Area by Lightning Hazard per Municipio

| Municipio | Annual Lightning Hazard Frequency Percent Area by Total (Municipio) Land Area | | | | |
|--------------|---|------------------------------------|--------------------------------|-------------------------------------|-------------------------------|
| | Low (0 – 2 strikes) | Medium Low (2.1 – 4 strikes) | Medium (4.1 – 6 strikes) | Medium High (6.1 – 8 strikes) | High (8.1 – 10 strikes) |
| Adjuntas | 0.15% | 32.15% | 55.93% | 11.77% | 0.00% |
| Aguada | 1.81% | 5.48% | 62.60% | 29.89% | 0.23% |
| Aguadilla | 3.20% | 39.19% | 55.52% | 2.09% | 0.00% |
| Aguas Buenas | 47.22% | 52.78% | 0.00% | 0.00% | 0.00% |
| Aibonito | 50.72% | 49.28% | 0.00% | 0.00% | 0.00% |
| Anasco | 0.52% | 5.41% | 35.52% | 50.51% | 8.04% |
| Arecibo | 4.11% | 51.61% | 39.71% | 4.57% | 0.00% |
| Arroyo | 74.31% | 25.69% | 0.00% | 0.00% | 0.00% |
| Barceloneta | 12.78% | 85.39% | 1.83% | 0.00% | 0.00% |

| | | | | | |
|--------------|---------|--------|--------|--------|--------|
| Barranquitas | 20.87% | 79.13% | 0.00% | 0.00% | 0.00% |
| Bayamon | 22.10% | 76.89% | 1.01% | 0.00% | 0.00% |
| Cabo Rojo | 32.99% | 57.11% | 9.90% | 0.00% | 0.00% |
| Caguas | 47.68% | 52.32% | 0.00% | 0.00% | 0.00% |
| Camuy | 3.12% | 50.37% | 43.29% | 3.21% | 0.00% |
| Canovanas | 57.73% | 42.27% | 0.00% | 0.00% | 0.00% |
| Carolina | 62.47% | 37.53% | 0.00% | 0.00% | 0.00% |
| Catano | 26.34% | 73.66% | 0.00% | 0.00% | 0.00% |
| Cayey | 78.81% | 21.19% | 0.00% | 0.00% | 0.00% |
| Ceiba | 41.50% | 57.19% | 1.31% | 0.00% | 0.00% |
| Ciales | 0.00% | 11.32% | 82.68% | 6.00% | 0.00% |
| Cidra | 79.66% | 20.34% | 0.00% | 0.00% | 0.00% |
| Coamo | 23.61% | 76.39% | 0.00% | 0.00% | 0.00% |
| Comerio | 62.90% | 37.10% | 0.00% | 0.00% | 0.00% |
| Corozal | 0.69% | 88.75% | 10.57% | 0.00% | 0.00% |
| Culebra | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Dorado | 9.77% | 85.96% | 4.27% | 0.00% | 0.00% |
| Fajardo | 55.60% | 44.40% | 0.00% | 0.00% | 0.00% |
| Florida | 0.00% | 64.18% | 32.53% | 3.28% | 0.00% |
| Guanica | 43.76% | 56.24% | 0.00% | 0.00% | 0.00% |
| Guayama | 79.47% | 20.53% | 0.00% | 0.00% | 0.00% |
| Guayanilla | 40.72% | 53.90% | 5.38% | 0.00% | 0.00% |
| Guaynabo | 16.26% | 83.74% | 0.00% | 0.00% | 0.00% |
| Gurabo | 54.96% | 45.04% | 0.00% | 0.00% | 0.00% |
| Hatillo | 6.74% | 50.48% | 35.08% | 7.69% | 0.00% |
| Hormigueros | 0.00% | 36.36% | 63.64% | 0.00% | 0.00% |
| Humacao | 30.39% | 69.61% | 0.00% | 0.00% | 0.00% |
| Isabela | 6.18% | 51.02% | 37.53% | 5.28% | 0.00% |
| Jayuya | 0.00% | 45.53% | 52.58% | 1.90% | 0.00% |
| Juana Diaz | 39.40% | 57.18% | 3.42% | 0.00% | 0.00% |
| Juncos | 50.67% | 49.33% | 0.00% | 0.00% | 0.00% |
| Lajas | 38.50% | 61.24% | 0.26% | 0.00% | 0.00% |
| Lares | 0.00% | 1.49% | 30.39% | 60.66% | 7.45% |
| Las Marias | 0.00% | 0.00% | 6.96% | 74.91% | 18.13% |
| Las Piedras | 23.13% | 76.87% | 0.00% | 0.00% | 0.00% |
| Loiza | 73.94% | 26.06% | 0.00% | 0.00% | 0.00% |
| Luquillo | 13.89% | 86.11% | 0.00% | 0.00% | 0.00% |
| Manati | 3.35% | 88.86% | 7.79% | 0.00% | 0.00% |
| Maricao | 0.00% | 0.07% | 50.01% | 48.19% | 1.73% |
| Maunabo | 68.89% | 31.11% | 0.00% | 0.00% | 0.00% |
| Mayaguez | 29.99% | 12.65% | 46.15% | 11.20% | 0.00% |
| Moca | 0.00% | 2.70% | 41.93% | 50.51% | 4.86% |

| | | | | | |
|---------------|--------|--------|--------|--------|--------|
| Morovis | 0.00% | 68.02% | 31.98% | 0.00% | 0.00% |
| Naguabo | 21.47% | 78.33% | 0.20% | 0.00% | 0.00% |
| Naranjito | 23.38% | 76.62% | 0.00% | 0.00% | 0.00% |
| Orocovis | 0.78% | 74.24% | 24.19% | 0.78% | 0.00% |
| Patillas | 52.28% | 47.72% | 0.00% | 0.00% | 0.00% |
| Penuelas | 24.61% | 65.21% | 10.18% | 0.00% | 0.00% |
| Ponce | 26.99% | 65.96% | 7.05% | 0.00% | 0.00% |
| Quebradillas | 7.69% | 60.80% | 27.77% | 3.74% | 0.00% |
| Rincon | 2.90% | 31.07% | 58.83% | 7.20% | 0.00% |
| Rio Grande | 27.22% | 71.96% | 0.82% | 0.00% | 0.00% |
| Sabana Grande | 3.97% | 67.25% | 27.86% | 0.92% | 0.00% |
| Salinas | 79.20% | 20.80% | 0.00% | 0.00% | 0.00% |
| San German | 1.64% | 54.89% | 39.28% | 4.19% | 0.00% |
| San Juan | 31.33% | 68.67% | 0.00% | 0.00% | 0.00% |
| San Lorenzo | 52.88% | 47.12% | 0.00% | 0.00% | 0.00% |
| San Sebastian | 0.00% | 0.36% | 22.18% | 51.98% | 25.47% |
| Santa Isabel | 63.30% | 36.70% | 0.00% | 0.00% | 0.00% |
| Toa Alta | 4.20% | 91.41% | 4.39% | 0.00% | 0.00% |
| Toa Baja | 10.39% | 86.07% | 3.54% | 0.00% | 0.00% |
| Trujillo Alto | 53.41% | 46.59% | 0.00% | 0.00% | 0.00% |
| Utuado | 0.00% | 8.79% | 57.96% | 33.25% | 0.00% |
| Vega Alta | 6.82% | 87.77% | 5.41% | 0.00% | 0.00% |
| Vega Baja | 12.68% | 84.10% | 3.22% | 0.00% | 0.00% |
| Vieques | 83.35% | 16.65% | 0.00% | 0.00% | 0.00% |
| Villalba | 2.70% | 86.86% | 10.44% | 0.00% | 0.00% |
| Yabucoa | 39.76% | 60.24% | 0.00% | 0.00% | 0.00% |
| Yauco | 11.95% | 55.02% | 32.34% | 0.69% | 0.00% |

Table 86: Percent of (Island) Hexagonal Area by Lightning Hazard per Municipio

| Municipio | Annual Lightning Hazard Frequency Percent Area by Total (Island) Land Area | | | | |
|--------------|--|------------------------------------|--------------------------------|-------------------------------------|-------------------------------|
| | Low (0 – 2 strikes) | Medium Low (2.1 – 4 strikes) | Medium (4.1 – 6 strikes) | Medium High (6.1 – 8 strikes) | High (8.1 – 10 strikes) |
| Adjuntas | 0.01% | 1.31% | 6.16% | 3.02% | 0.00% |
| Aguada | 0.06% | 0.10% | 3.18% | 3.53% | 0.19% |
| Aguadilla | 0.13% | 0.87% | 3.34% | 0.29% | 0.00% |
| Aguas Buenas | 1.57% | 0.96% | 0.00% | 0.00% | 0.00% |
| Aibonito | 1.76% | 0.93% | 0.00% | 0.00% | 0.00% |
| Anasco | 0.02% | 0.13% | 2.31% | 7.64% | 8.48% |
| Arecibo | 0.58% | 3.97% | 8.28% | 2.22% | 0.00% |
| Arroyo | 1.24% | 0.23% | 0.00% | 0.00% | 0.00% |
| Barceloneta | 0.27% | 0.97% | 0.06% | 0.00% | 0.00% |

| | | | | | |
|--------------|-------|-------|-------|--------|--------|
| Barranquitas | 0.79% | 1.64% | 0.00% | 0.00% | 0.00% |
| Bayamon | 1.09% | 2.07% | 0.07% | 0.00% | 0.00% |
| Cabo Rojo | 2.67% | 2.53% | 1.19% | 0.00% | 0.00% |
| Caguas | 3.12% | 1.87% | 0.00% | 0.00% | 0.00% |
| Camuy | 0.16% | 1.41% | 3.30% | 0.57% | 0.00% |
| Canovanas | 2.11% | 0.84% | 0.00% | 0.00% | 0.00% |
| Carolina | 3.27% | 1.07% | 0.00% | 0.00% | 0.00% |
| Catano | 0.15% | 0.23% | 0.00% | 0.00% | 0.00% |
| Cayey | 4.53% | 0.67% | 0.00% | 0.00% | 0.00% |
| Ceiba | 1.40% | 1.05% | 0.07% | 0.00% | 0.00% |
| Ciales | 0.00% | 0.46% | 9.06% | 1.53% | 0.00% |
| Cidra | 3.21% | 0.45% | 0.00% | 0.00% | 0.00% |
| Coamo | 2.04% | 3.61% | 0.00% | 0.00% | 0.00% |
| Comerio | 1.99% | 0.64% | 0.00% | 0.00% | 0.00% |
| Corozal | 0.03% | 2.29% | 0.74% | 0.00% | 0.00% |
| Culebra | 1.47% | 0.00% | 0.00% | 0.00% | 0.00% |
| Dorado | 0.25% | 1.22% | 0.16% | 0.00% | 0.00% |
| Fajardo | 1.88% | 0.82% | 0.00% | 0.00% | 0.00% |
| Florida | 0.00% | 0.59% | 0.81% | 0.19% | 0.00% |
| Guanica | 1.89% | 1.33% | 0.00% | 0.00% | 0.00% |
| Guayama | 5.79% | 0.82% | 0.00% | 0.00% | 0.00% |
| Guayanilla | 1.94% | 1.40% | 0.38% | 0.00% | 0.00% |
| Guaynabo | 0.50% | 1.41% | 0.00% | 0.00% | 0.00% |
| Gurabo | 1.72% | 0.77% | 0.00% | 0.00% | 0.00% |
| Hatillo | 0.31% | 1.28% | 2.41% | 1.23% | 0.00% |
| Hormigueros | 0.00% | 0.25% | 1.19% | 0.00% | 0.00% |
| Humacao | 1.52% | 1.90% | 0.00% | 0.00% | 0.00% |
| Isabela | 0.38% | 1.71% | 3.42% | 1.12% | 0.00% |
| Jayuya | 0.00% | 1.23% | 3.85% | 0.32% | 0.00% |
| Juana Diaz | 2.65% | 2.10% | 0.34% | 0.00% | 0.00% |
| Juncos | 1.49% | 0.79% | 0.00% | 0.00% | 0.00% |
| Lajas | 2.61% | 2.27% | 0.03% | 0.00% | 0.00% |
| Lares | 0.00% | 0.06% | 3.08% | 14.30% | 12.25% |
| Las Marias | 0.00% | 0.00% | 0.53% | 13.32% | 22.49% |
| Las Piedras | 0.87% | 1.58% | 0.00% | 0.00% | 0.00% |
| Loiza | 1.68% | 0.32% | 0.00% | 0.00% | 0.00% |
| Luquillo | 0.40% | 1.35% | 0.00% | 0.00% | 0.00% |
| Manati | 0.17% | 2.52% | 0.60% | 0.00% | 0.00% |
| Maricao | 0.00% | 0.00% | 3.01% | 6.75% | 1.69% |
| Maunabo | 1.61% | 0.40% | 0.00% | 0.00% | 0.00% |
| Mayaguez | 2.59% | 0.60% | 5.91% | 3.34% | 0.00% |
| Moca | 0.00% | 0.08% | 3.47% | 9.73% | 6.53% |

| | | | | | |
|---------------|-------|-------|--------|--------|--------|
| Morovis | 0.00% | 1.60% | 2.04% | 0.00% | 0.00% |
| Naguabo | 1.23% | 2.46% | 0.02% | 0.00% | 0.00% |
| Naranjito | 0.72% | 1.29% | 0.00% | 0.00% | 0.00% |
| Orocovis | 0.06% | 2.87% | 2.53% | 0.19% | 0.00% |
| Patillas | 2.73% | 1.36% | 0.00% | 0.00% | 0.00% |
| Penuelas | 1.22% | 1.77% | 0.75% | 0.00% | 0.00% |
| Ponce | 3.50% | 4.67% | 1.35% | 0.00% | 0.00% |
| Quebradillas | 0.20% | 0.85% | 1.06% | 0.33% | 0.00% |
| Rincon | 0.05% | 0.27% | 1.39% | 0.40% | 0.00% |
| Rio Grande | 1.83% | 2.65% | 0.08% | 0.00% | 0.00% |
| Sabana Grande | 0.16% | 1.46% | 1.64% | 0.13% | 0.00% |
| Salinas | 6.14% | 0.88% | 0.00% | 0.00% | 0.00% |
| San German | 0.10% | 1.81% | 3.52% | 0.87% | 0.00% |
| San Juan | 1.72% | 2.06% | 0.00% | 0.00% | 0.00% |
| San Lorenzo | 3.11% | 1.52% | 0.00% | 0.00% | 0.00% |
| San Sebastian | 0.00% | 0.02% | 2.60% | 14.16% | 48.38% |
| Santa Isabel | 2.42% | 0.77% | 0.00% | 0.00% | 0.00% |
| Toa Alta | 0.13% | 1.52% | 0.20% | 0.00% | 0.00% |
| Toa Baja | 0.27% | 1.24% | 0.14% | 0.00% | 0.00% |
| Trujillo Alto | 1.26% | 0.60% | 0.00% | 0.00% | 0.00% |
| Utua | 0.00% | 0.61% | 10.96% | 14.63% | 0.00% |
| Vega Alta | 0.21% | 1.47% | 0.25% | 0.00% | 0.00% |
| Vega Baja | 0.65% | 2.37% | 0.25% | 0.00% | 0.00% |
| Vieques | 4.91% | 0.54% | 0.00% | 0.00% | 0.00% |
| Villalba | 0.11% | 1.95% | 0.64% | 0.00% | 0.00% |
| Yabucoa | 2.44% | 2.02% | 0.00% | 0.00% | 0.00% |
| Yauco | 0.91% | 2.29% | 3.66% | 0.18% | 0.00% |

Table 87: Lightning Hazard Scores and Ranks by Municipio

| Municipio | Annual Lightning Hazard Frequency Score (Log Multiplied) | | |
|---------------|--|--------------------------|----------------------|
| | Total Score | Standardized Score (0-1) | Rank of Score (1-78) |
| San Sebastian | 10,000.0336 | 1.0000 | 1 |
| Las Marias | 4,647.6530 | 0.4648 | 2 |
| Lares | 2,531.2702 | 0.2531 | 3 |
| Anasco | 1,753.2798 | 0.1753 | 4 |
| Moca | 1,349.8289 | 0.1350 | 5 |
| Maricao | 349.7474 | 0.0350 | 6 |
| Aguada | 38.6168 | 0.0038 | 7 |
| Ponce | 10.5691 | 0.0010 | 8 |
| Arecibo | 8.5872 | 0.0008 | 9 |
| Coamo | 8.0568 | 0.0008 | 9 |

| | | | |
|---------------|--------|--------|----|
| Cabo Rojo | 5.8465 | 0.0006 | 11 |
| Orocovis | 6.1454 | 0.0006 | 11 |
| Rincon | 5.9702 | 0.0006 | 11 |
| Corozal | 4.9027 | 0.0005 | 14 |
| Juana Diaz | 4.9321 | 0.0005 | 14 |
| Lajas | 5.2962 | 0.0005 | 14 |
| Manati | 5.4207 | 0.0005 | 14 |
| Naguabo | 5.4676 | 0.0005 | 14 |
| Vega Baja | 5.1914 | 0.0005 | 14 |
| Yauco | 5.0559 | 0.0005 | 14 |
| Bayamon | 4.6135 | 0.0004 | 21 |
| Caguas | 4.5129 | 0.0004 | 21 |
| Humacao | 4.3164 | 0.0004 | 21 |
| Penuelas | 3.9810 | 0.0004 | 21 |
| San German | 3.8940 | 0.0004 | 21 |
| San Juan | 4.6876 | 0.0004 | 21 |
| San Lorenzo | 3.7563 | 0.0004 | 21 |
| Villalba | 4.1873 | 0.0004 | 21 |
| Yabucoa | 4.7231 | 0.0004 | 21 |
| Adjuntas | 2.7973 | 0.0003 | 30 |
| Barranquitas | 3.6449 | 0.0003 | 30 |
| Camuy | 3.0536 | 0.0003 | 30 |
| Cantano | 2.8333 | 0.0003 | 30 |
| Guanica | 3.1513 | 0.0003 | 30 |
| Guayanilla | 3.3186 | 0.0003 | 30 |
| Guaynabo | 3.0946 | 0.0003 | 30 |
| Hatillo | 2.7883 | 0.0003 | 30 |
| Isabela | 3.7253 | 0.0003 | 30 |
| Las Piedras | 3.5177 | 0.0003 | 30 |
| Luquillo | 2.9508 | 0.0003 | 30 |
| Morovis | 3.4316 | 0.0003 | 30 |
| Naranjito | 2.8723 | 0.0003 | 30 |
| Patillas | 3.3649 | 0.0003 | 30 |
| Sabana Grande | 3.1641 | 0.0003 | 30 |
| Salinas | 2.8882 | 0.0003 | 30 |
| Toa Alta | 3.2859 | 0.0003 | 30 |
| Vega Alta | 3.1897 | 0.0003 | 30 |
| Aguadilla | 1.8801 | 0.0002 | 48 |
| Aguas Buenas | 2.3147 | 0.0002 | 48 |
| Aibonito | 2.2881 | 0.0002 | 48 |
| Barceloneta | 2.1192 | 0.0002 | 48 |
| Canovanas | 2.1515 | 0.0002 | 48 |

| | | | |
|---------------|--------|--------|----|
| Cayey | 2.1648 | 0.0002 | 48 |
| Ceiba | 2.4785 | 0.0002 | 48 |
| Dorado | 2.6502 | 0.0002 | 48 |
| Fajardo | 2.0615 | 0.0002 | 48 |
| Guayama | 2.6962 | 0.0002 | 48 |
| Gurabo | 1.9332 | 0.0002 | 48 |
| Jayuya | 2.6278 | 0.0002 | 48 |
| Juncos | 1.9447 | 0.0002 | 48 |
| Quebradillas | 1.8555 | 0.0002 | 48 |
| Santa Isabel | 2.0388 | 0.0002 | 48 |
| Toa Baja | 2.6999 | 0.0002 | 48 |
| Vieques | 1.9467 | 0.0002 | 48 |
| Ciales | 0.9788 | 0.0001 | 65 |
| Cidra | 1.4845 | 0.0001 | 65 |
| Comerio | 1.6947 | 0.0001 | 65 |
| Florida | 1.2662 | 0.0001 | 65 |
| Loiza | 0.9673 | 0.0001 | 65 |
| Maunabo | 1.1121 | 0.0001 | 65 |
| Mayaguez | 1.7001 | 0.0001 | 65 |
| Trujillo Alto | 1.4969 | 0.0001 | 65 |
| Utuado | 1.3108 | 0.0001 | 65 |
| Arroyo | 0.7025 | 0.0000 | 74 |
| Carolina | 0.5095 | 0.0000 | 74 |
| Culebra | 0.2398 | 0.0000 | 74 |
| Hormigueros | 0.5346 | 0.0000 | 74 |
| Rjo Grande | 0.5869 | 0.0000 | 74 |

Sea Level Rise

Hazard Overview

Sea level rise is an increase in the level of the world's oceans due to the effects of global warming and land subsidence. As ocean water becomes warmer, it expands. This results in ocean levels rising worldwide.⁴¹ Global sea level has been rising over the past century, and the rate has increased in recent decades. In 2014, global sea level was 2.6 inches above the 1993 average—the highest annual average in the satellite record (1993-present). Sea level continues to rise at a rate of about one-eighth of an inch per year.⁴² Sea level rise poses significant threat to people living and working in coastal areas.

Data and Methods

Three scenarios of future sea-level rise, created by NOAA⁴³, were utilized in this assessment: A low scenario (1 foot), A moderate scenario (4 feet), and a high scenario (10 feet) of sea level rise above Mean Higher High water levels.⁴⁴ Like flooding hazard, percentage of land area spatially inside NOAA SLR zones was calculated for each .5-mile hex grid across Puerto Rico. These were classified using an equal interval classifications scheme allowing users to clearly see where sea-level rise threatens the coastline.

Hazard Frequency Analysis Results

Like hurricane storm surges, sea level rise impacts are largely a coastal phenomena with the main island's northern shore northern shore seeing the heaviest potential impacts . However, impacts on all coastal Puerto Rico are clearly evident across all three scenarios with the 10 foot inundation creating the largest spatial impact (Figure 29, Figure 30, Figure 31). For each sea level rise scenario, the NOAA model indicates a differing amount of land area inundated in each municipio (Table 88, Table 92, Table 96). As a result, the percentage of each municipio's land area changes for each scenario (Table 89, Table 93, Table 97). The percent of each municipio's total island-wide land area also changes for different sea level rise scenarios (Table 90, Table 94, Table 98). Finally, a table showing municipio scores and ranks for each scenario provides perspective on which areas of the island are more highly threatened by potential sea level rise conditions (Table 91, Table 95, Table 99).

⁴¹ <https://www.nationalgeographic.org/encyclopedia/sea-level-rise/>

⁴² <https://oceanservice.noaa.gov/facts/sealevel.html>

⁴³ <https://coast.noaa.gov/slrdata/>

⁴⁴ https://tidesandcurrents.noaa.gov/datum_options.html

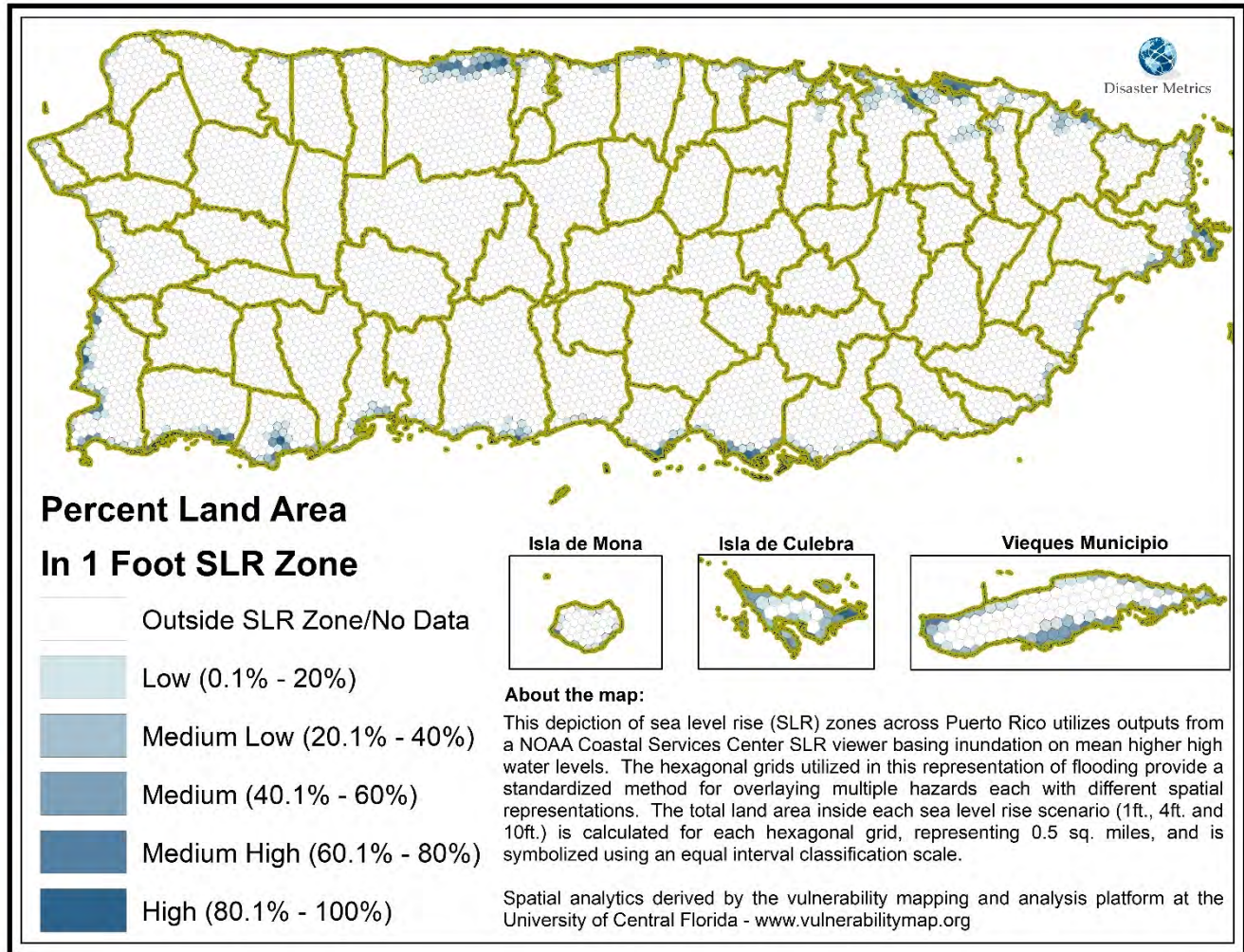


Figure 29: Sea Level Rise (1 foot) Hazard Areas

Table 88: Sea Level Rise (1 foot) by Municipio and Areal Extent

| Municipio | Hex Grid Area in Sea Level Rise (1 Foot) Zones (Sq. miles) | | | | | |
|--------------|--|-------------|--------------------------|----------------------|---------------------------|---------------------|
| | No SLR/No Data | Low (< 20%) | Medium Low (20.1% - 40%) | Medium (40.1% - 60%) | Medium High (60.1% - 80%) | High (80.1% - 100%) |
| Adjuntas | 67.10 | | | | | |
| Aguada | 28.57 | 1.11 | 0.68 | | 0.43 | 0.13 |
| Aguadilla | 32.16 | 2.27 | 1.06 | 0.31 | 0.67 | 0.14 |
| Aguas Buenas | 30.10 | | | | | |
| Aibonito | 31.34 | | | | | |
| Anasco | 37.32 | 1.41 | 0.32 | 0.45 | | 0.06 |
| Arecibo | 107.06 | 9.44 | 3.47 | 2.88 | 2.73 | 1.39 |
| Arroyo | 13.41 | 0.48 | 0.68 | 0.26 | 0.15 | 0.06 |
| Barceloneta | 13.53 | 3.42 | 1.25 | | 0.52 | 0.03 |
| Barranquitas | 34.28 | | | | | |
| Bayamon | 42.59 | 1.92 | | | | |

| | | | | | | |
|--------------------|-------|------|------|------|------|------|
| Cabo Rojo | 54.95 | 6.55 | 3.27 | 2.84 | 3.76 | 1.75 |
| Caguas | 59.07 | | | | | |
| Camuy | 44.60 | 0.29 | 1.18 | 0.22 | | 0.08 |
| Canovanas | 30.05 | 2.96 | | | | |
| Cantano | 34.64 | 8.61 | 0.45 | 0.80 | 1.86 | 0.94 |
| Carolina | 1.99 | 2.24 | 0.43 | 0.32 | 0.06 | 0.04 |
| Cayey | 51.96 | | | | | |
| Ceiba | 20.30 | 2.99 | 0.46 | 3.05 | 1.35 | 2.22 |
| Ciales | 66.71 | | | | | |
| Cidra | 36.46 | | | | | |
| Coamo | 78.03 | | | | | |
| Comerio | 28.52 | | | | | |
| Corozal | 42.58 | | | | | |
| Culebra | 3.00 | 1.90 | 2.25 | 3.31 | 1.48 | 1.37 |
| Dorado | 18.38 | 2.35 | 1.60 | 0.71 | 0.12 | 0.25 |
| Fajardo | 24.46 | 1.93 | 1.36 | 1.26 | 0.89 | 0.61 |
| Florida | 15.22 | | | | | |
| Guanica | 28.76 | 4.09 | 2.71 | 1.32 | 1.27 | 0.85 |
| Guayama | 58.00 | 3.84 | 0.34 | 1.05 | 0.79 | 1.85 |
| Guayanilla | 36.52 | 2.44 | 1.69 | 0.90 | 0.96 | 0.49 |
| Guaynabo | 26.85 | 0.61 | | 0.22 | 0.08 | |
| Gurabo | 28.31 | | | | | |
| Hatillo | 39.75 | 0.88 | | 1.05 | 0.15 | 0.01 |
| Hormigueros | 11.34 | | | | | |
| Humacao | 40.81 | 1.60 | 1.24 | 1.03 | 0.21 | 0.21 |
| Isabela | 52.06 | 1.71 | 0.66 | 0.43 | 0.18 | 0.37 |
| Jayuya | 44.53 | | | | | |
| Juana Diaz | 57.48 | 1.89 | 0.41 | 0.27 | 0.39 | 0.30 |
| Juncos | 26.62 | | | | | |
| Lajas | 53.57 | 3.22 | | 1.87 | 1.79 | 0.92 |
| Lares | 61.64 | | | | | |
| Las Marias | 46.51 | | | | | |
| Las Piedras | 33.89 | | | | | |
| Loiza | 12.04 | 2.99 | 0.76 | 1.11 | 2.66 | 0.96 |
| Luquillo | 22.60 | 2.28 | 0.46 | 0.04 | 0.19 | 0.29 |
| Manati | 41.67 | 2.97 | 0.84 | 0.29 | 0.59 | 0.46 |
| Maricao | 36.63 | | | | | |
| Maunabo | 19.14 | 0.48 | 0.68 | 0.61 | 0.09 | 0.07 |
| Mayaguez | 64.16 | 9.54 | 0.35 | 0.33 | 2.72 | 0.87 |
| Moca | 50.37 | | | | | |
| Morovis | 38.93 | | | | | |
| Naguabo | 47.83 | 1.30 | 0.41 | 1.96 | 0.14 | 0.25 |

| | | | | | | |
|--------------------|----------------|---------------|--------------|--------------|--------------|--------------|
| Naranjito | 27.75 | | | | | |
| Orocovis | 63.78 | | | | | |
| Patillas | 44.14 | 1.37 | 0.36 | 0.41 | 0.85 | 0.09 |
| Penuelas | 41.97 | 1.33 | 0.64 | | 0.56 | 0.25 |
| Ponce | 107.43 | 4.78 | 2.63 | 0.74 | 0.27 | 1.14 |
| Quebradillas | 21.42 | 0.94 | 0.25 | 0.21 | 0.32 | 0.00 |
| Rio Grande | 11.01 | 1.42 | 0.75 | 0.79 | 0.17 | 0.25 |
| Rincon | 52.65 | 3.99 | 2.38 | 0.25 | 1.11 | 0.44 |
| Sabana Grande | 35.84 | | | | | |
| Salinas | 61.14 | 2.86 | 1.03 | 1.57 | 1.01 | 2.45 |
| San German | 54.51 | | | | | |
| San Juan | 37.18 | 7.15 | 2.10 | 1.28 | 1.40 | 0.42 |
| San Lorenzo | 53.21 | | | | | |
| San Sebastian | 71.22 | | | | | |
| Santa Isabel | 29.32 | 1.47 | 1.23 | | 1.50 | 1.07 |
| Toa Alta | 27.56 | | | | | |
| Toa Baja | 19.97 | 2.29 | 0.67 | 0.35 | 0.10 | 0.42 |
| Trujillo Alto | 21.38 | | | | | |
| Utuado | 115.07 | | | | | |
| Vega Alta | 26.83 | 0.19 | 0.32 | 0.30 | | 0.09 |
| Vega Baja | 42.70 | 2.21 | 0.75 | 0.71 | 0.16 | 0.12 |
| Vieques | 30.00 | 7.17 | 5.08 | 6.91 | 3.12 | 0.90 |
| Villalba | 37.04 | | | | | |
| Yabucoa | 51.64 | 1.90 | 1.02 | 0.22 | 0.61 | 0.02 |
| Yauco | 68.37 | | 0.43 | | | 0.02 |
| Grand Total | 3181.48 | 128.80 | 48.66 | 42.62 | 37.43 | 24.64 |

Table 89: Percent of (Municipio) Hexagonal Area by Sea Level Rise (1 foot) per Municipio

| Municipio | Sea Level Rise (1 Foot) Percent Area by Total (Municipio) Land Area | | | | | |
|--------------|---|-------------|--------------------------|----------------------|---------------------------|---------------------|
| | No SLR/No Data | Low (< 20%) | Medium Low (20.1% - 40%) | Medium (40.1% - 60%) | Medium High (60.1% - 80%) | High (80.1% - 100%) |
| Adjuntas | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Aguada | 92.39% | 3.58% | 2.21% | 0.00% | 1.39% | 0.42% |
| Aguadilla | 87.86% | 6.21% | 2.90% | 0.84% | 1.82% | 0.37% |
| Aguas Buenas | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Aibonito | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Anasco | 94.35% | 3.56% | 0.82% | 1.13% | 0.00% | 0.14% |
| Arecibo | 84.31% | 7.44% | 2.73% | 2.27% | 2.15% | 1.09% |
| Arroyo | 89.12% | 3.19% | 4.52% | 1.74% | 1.01% | 0.43% |
| Barceloneta | 72.14% | 18.25% | 6.68% | 0.00% | 2.78% | 0.15% |
| Barranquitas | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |

| | | | | | | |
|--------------------|---------|--------|--------|--------|--------|--------|
| Bayamon | 95.68% | 4.32% | 0.00% | 0.00% | 0.00% | 0.00% |
| Cabo Rojo | 75.15% | 8.96% | 4.47% | 3.88% | 5.15% | 2.39% |
| Caguas | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Camuy | 96.17% | 0.63% | 2.55% | 0.48% | 0.00% | 0.17% |
| Canovanas | 91.03% | 8.97% | 0.00% | 0.00% | 0.00% | 0.00% |
| Cantano | 73.23% | 18.20% | 0.95% | 1.70% | 3.94% | 1.99% |
| Carolina | 39.17% | 44.09% | 8.42% | 6.34% | 1.17% | 0.80% |
| Cayey | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Ceiba | 66.83% | 9.86% | 1.51% | 10.05% | 4.45% | 7.31% |
| Ciales | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Cidra | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Coamo | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Comerio | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Corozal | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Culebra | 22.54% | 14.28% | 16.90% | 24.89% | 11.11% | 10.28% |
| Dorado | 78.50% | 10.02% | 6.84% | 3.03% | 0.53% | 1.09% |
| Fajardo | 80.17% | 6.34% | 4.44% | 4.13% | 2.93% | 1.99% |
| Florida | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Guanica | 73.72% | 10.49% | 6.95% | 3.39% | 3.27% | 2.18% |
| Guayama | 88.05% | 5.84% | 0.51% | 1.59% | 1.20% | 2.81% |
| Guayanilla | 84.95% | 5.67% | 3.92% | 2.10% | 2.23% | 1.13% |
| Guaynabo | 96.71% | 2.21% | 0.00% | 0.79% | 0.29% | 0.00% |
| Gurabo | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Hatillo | 95.00% | 2.10% | 0.00% | 2.51% | 0.36% | 0.02% |
| Hormigueros | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Humacao | 90.48% | 3.54% | 2.76% | 2.28% | 0.47% | 0.47% |
| Isabela | 93.95% | 3.09% | 1.19% | 0.77% | 0.32% | 0.67% |
| Jayuya | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Juana Diaz | 94.64% | 3.11% | 0.68% | 0.45% | 0.64% | 0.49% |
| Juncos | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Lajas | 87.30% | 5.24% | 0.00% | 3.05% | 2.92% | 1.49% |
| Lares | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Las Marias | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Las Piedras | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Loiza | 58.66% | 14.58% | 3.72% | 5.43% | 12.94% | 4.68% |
| Luquillo | 87.38% | 8.82% | 1.80% | 0.14% | 0.74% | 1.12% |
| Manati | 89.00% | 6.33% | 1.80% | 0.62% | 1.26% | 0.98% |
| Maricao | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Maunabo | 90.78% | 2.30% | 3.23% | 2.91% | 0.45% | 0.34% |
| Mayaguez | 82.29% | 12.23% | 0.45% | 0.42% | 3.49% | 1.12% |
| Moca | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Morovis | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |

| | | | | | | |
|----------------------|---------|--------|-------|--------|-------|-------|
| Naguabo | 92.19% | 2.50% | 0.78% | 3.78% | 0.27% | 0.49% |
| Naranjito | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Orocovis | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Patillas | 93.49% | 2.89% | 0.76% | 0.87% | 1.79% | 0.20% |
| Penuelas | 93.78% | 2.98% | 1.43% | 0.00% | 1.25% | 0.56% |
| Ponce | 91.84% | 4.09% | 2.24% | 0.63% | 0.23% | 0.97% |
| Quebradillas | 92.58% | 4.06% | 1.07% | 0.89% | 1.40% | 0.01% |
| Rio Grande | 76.53% | 9.86% | 5.22% | 5.50% | 1.18% | 1.71% |
| Rincon | 86.57% | 6.56% | 3.91% | 0.41% | 1.82% | 0.73% |
| Sabana Grande | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Salinas | 87.27% | 4.09% | 1.47% | 2.24% | 1.45% | 3.49% |
| San German | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| San Juan | 75.07% | 14.44% | 4.24% | 2.59% | 2.83% | 0.85% |
| San Lorenzo | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| San Sebastian | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Santa Isabel | 84.80% | 4.25% | 3.55% | 0.00% | 4.33% | 3.08% |
| Toa Alta | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Toa Baja | 83.90% | 9.61% | 2.83% | 1.48% | 0.41% | 1.78% |
| Trujillo Alto | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Utua | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Vega Alta | 96.72% | 0.70% | 1.16% | 1.08% | 0.00% | 0.34% |
| Vega Baja | 91.54% | 4.74% | 1.60% | 1.51% | 0.35% | 0.26% |
| Vieques | 56.41% | 13.48% | 9.56% | 13.00% | 5.87% | 1.69% |
| Villalba | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Yabucoa | 93.19% | 3.44% | 1.84% | 0.39% | 1.11% | 0.03% |
| Yauco | 99.35% | 0.00% | 0.63% | 0.00% | 0.00% | 0.02% |

Table 90: Percent of (Island) Hexagonal Area by Sea Level Rise (1 foot) per Municipio

| Municipio | Sea Level Rise (1 Foot) Percent Area by Total (Island) Land Area | | | | | |
|---------------------|--|-------------|--------------------------|----------------------|---------------------------|---------------------|
| | No SLR/No Data | Low (< 20%) | Medium Low (20.1% - 40%) | Medium (40.1% - 60%) | Medium High (60.1% - 80%) | High (80.1% - 100%) |
| Adjuntas | 2.11% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Aguada | 0.90% | 0.86% | 1.41% | 0.00% | 1.15% | 0.52% |
| Aguadilla | 1.01% | 1.77% | 2.18% | 0.72% | 1.78% | 0.55% |
| Agua Buenas | 0.95% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Aibonito | 0.99% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Anasco | 1.17% | 1.09% | 0.67% | 1.05% | 0.00% | 0.23% |
| Arecibo | 3.36% | 7.33% | 7.14% | 6.76% | 7.30% | 5.64% |
| Arroyo | 0.42% | 0.37% | 1.40% | 0.61% | 0.41% | 0.26% |
| Barceloneta | 0.43% | 2.66% | 2.57% | 0.00% | 1.40% | 0.11% |
| Barranquitas | 1.08% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |

| | | | | | | |
|--------------------|-------|-------|-------|-------|--------|-------|
| Bayamon | 1.34% | 1.49% | 0.00% | 0.00% | 0.00% | 0.00% |
| Cabo Rojo | 1.73% | 5.09% | 6.72% | 6.65% | 10.06% | 7.11% |
| Caguas | 1.86% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Camuy | 1.40% | 0.23% | 2.43% | 0.52% | 0.00% | 0.33% |
| Canovanas | 0.94% | 2.30% | 0.00% | 0.00% | 0.00% | 0.00% |
| Cantano | 1.09% | 6.68% | 0.92% | 1.88% | 4.98% | 3.81% |
| Carolina | 0.06% | 1.74% | 0.88% | 0.76% | 0.16% | 0.16% |
| Cayey | 1.63% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Ceiba | 0.64% | 2.33% | 0.94% | 7.16% | 3.61% | 9.01% |
| Ciales | 2.10% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Cidra | 1.15% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Coamo | 2.45% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Comerio | 0.90% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Corozal | 1.34% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Culebra | 0.09% | 1.47% | 4.62% | 7.77% | 3.95% | 5.55% |
| Dorado | 0.58% | 1.82% | 3.29% | 1.66% | 0.33% | 1.03% |
| Fajardo | 0.77% | 1.50% | 2.79% | 2.96% | 2.39% | 2.47% |
| Florida | 0.48% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Guanica | 0.90% | 3.18% | 5.57% | 3.10% | 3.41% | 3.45% |
| Guayama | 1.82% | 2.98% | 0.69% | 2.46% | 2.11% | 7.51% |
| Guayanilla | 1.15% | 1.89% | 3.47% | 2.11% | 2.56% | 1.97% |
| Guaynabo | 0.84% | 0.48% | 0.00% | 0.52% | 0.22% | 0.00% |
| Gurabo | 0.89% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Hatillo | 1.25% | 0.68% | 0.00% | 2.47% | 0.41% | 0.04% |
| Hormigueros | 0.36% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Humacao | 1.28% | 1.24% | 2.55% | 2.41% | 0.57% | 0.86% |
| Isabela | 1.64% | 1.33% | 1.36% | 1.01% | 0.47% | 1.51% |
| Jayuya | 1.40% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Juana Diaz | 1.81% | 1.46% | 0.85% | 0.64% | 1.03% | 1.22% |
| Juncos | 0.84% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Lajas | 1.68% | 2.50% | 0.00% | 4.39% | 4.78% | 3.72% |
| Lares | 1.94% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Las Marias | 1.46% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Las Piedras | 1.07% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Loiza | 0.38% | 2.32% | 1.57% | 2.61% | 7.10% | 3.90% |
| Luquillo | 0.71% | 1.77% | 0.95% | 0.09% | 0.51% | 1.18% |
| Manati | 1.31% | 2.30% | 1.73% | 0.68% | 1.58% | 1.86% |
| Maricao | 1.15% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Maunabo | 0.60% | 0.38% | 1.40% | 1.44% | 0.25% | 0.29% |
| Mayaguez | 2.02% | 7.41% | 0.73% | 0.77% | 7.27% | 3.54% |
| Moca | 1.58% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Morovis | 1.22% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |

| | | | | | | |
|----------------------|-------|-------|--------|--------|-------|-------|
| Naguabo | 1.50% | 1.01% | 0.84% | 4.60% | 0.37% | 1.02% |
| Naranjito | 0.87% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Orocovis | 2.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Patillas | 1.39% | 1.06% | 0.73% | 0.96% | 2.26% | 0.38% |
| Penuelas | 1.32% | 1.03% | 1.32% | 0.00% | 1.49% | 1.03% |
| Ponce | 3.38% | 3.71% | 5.39% | 1.73% | 0.72% | 4.63% |
| Quebradillas | 0.67% | 0.73% | 0.51% | 0.48% | 0.86% | 0.01% |
| Rio Grande | 0.35% | 1.10% | 1.54% | 1.86% | 0.45% | 1.00% |
| Rincon | 1.65% | 3.10% | 4.89% | 0.58% | 2.96% | 1.79% |
| Sabana Grande | 1.13% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Salinas | 1.92% | 2.22% | 2.11% | 3.68% | 2.71% | 9.93% |
| San German | 1.71% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| San Juan | 1.17% | 5.55% | 4.31% | 3.00% | 3.74% | 1.71% |
| San Lorenzo | 1.67% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| San Sebastian | 2.24% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Santa Isabel | 0.92% | 1.14% | 2.52% | 0.00% | 4.00% | 4.32% |
| Toa Alta | 0.87% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Toa Baja | 0.63% | 1.78% | 1.38% | 0.83% | 0.26% | 1.72% |
| Trujillo Alto | 0.67% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Utua | 3.62% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Vega Alta | 0.84% | 0.15% | 0.66% | 0.70% | 0.00% | 0.38% |
| Vega Baja | 1.34% | 1.72% | 1.53% | 1.66% | 0.43% | 0.49% |
| Vieques | 0.94% | 5.57% | 10.45% | 16.22% | 8.33% | 3.64% |
| Villalba | 1.16% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Yabucoa | 1.62% | 1.48% | 2.10% | 0.51% | 1.64% | 0.07% |
| Yauco | 2.15% | 0.00% | 0.89% | 0.00% | 0.00% | 0.06% |

Table 91: Sea Level Rise (1 foot) Hazard Scores and Ranks by Municipio

| Municipio | Sea Level Rise (1 Foot) Hazard Score (Log Multiplied) | | |
|--------------|---|--------------------------|------------------------|
| | Total Score | Standardized Score (0-1) | Rank of Score (1 – 78) |
| Salinas | 10294.4028 | 1.0000 | 1 |
| Ceiba | 9477.9994 | 0.9207 | 2 |
| Cabo Rojo | 8208.1394 | 0.7973 | 3 |
| Guayama | 7789.1656 | 0.7566 | 4 |
| Arecibo | 6459.5595 | 0.6275 | 5 |
| Culebra | 6039.1213 | 0.5866 | 6 |
| Santa Isabel | 4756.6444 | 0.4621 | 7 |
| Ponce | 4750.1998 | 0.4614 | 8 |
| Loiza | 4651.3864 | 0.4518 | 9 |
| Vieques | 4609.7075 | 0.4478 | 10 |
| Carolina | 4350.4366 | 0.4226 | 11 |

| | | | |
|--------------|-----------|--------|----|
| Mayaguez | 4291.4889 | 0.4169 | 12 |
| Lajas | 4253.4350 | 0.4132 | 13 |
| Guanica | 3834.5888 | 0.3725 | 14 |
| Fajardo | 2742.4092 | 0.2664 | 15 |
| Guayanilla | 2255.8893 | 0.2191 | 16 |
| San Juan | 2115.4358 | 0.2055 | 17 |
| Rio Grande | 2107.5262 | 0.2047 | 18 |
| Manati | 2037.6867 | 0.1979 | 19 |
| Toa Baja | 1761.5795 | 0.1711 | 20 |
| Isabela | 1575.1355 | 0.1530 | 21 |
| Juana Diaz | 1334.1222 | 0.1296 | 22 |
| Luquillo | 1240.0682 | 0.1205 | 23 |
| Penuelas | 1182.3569 | 0.1149 | 24 |
| Naguabo | 1096.6388 | 0.1065 | 25 |
| Dorado | 1087.9311 | 0.1057 | 26 |
| Rincon | 1065.7416 | 0.1035 | 27 |
| Humacao | 940.8153 | 0.0914 | 28 |
| Aguadilla | 738.6460 | 0.0718 | 29 |
| Aguada | 642.0512 | 0.0624 | 30 |
| Patillas | 610.4918 | 0.0593 | 31 |
| Vega Baja | 549.3412 | 0.0534 | 32 |
| Vega Alta | 388.2917 | 0.0377 | 33 |
| Camuy | 334.8779 | 0.0325 | 34 |
| Maunabo | 325.3957 | 0.0316 | 35 |
| Arroyo | 309.8169 | 0.0301 | 36 |
| Barceloneta | 254.7122 | 0.0247 | 37 |
| Yabucoa | 242.7397 | 0.0236 | 38 |
| Anasco | 235.6831 | 0.0229 | 39 |
| Catano | 187.0706 | 0.0182 | 40 |
| Quebradillas | 100.0748 | 0.0097 | 41 |
| Hatillo | 97.1815 | 0.0094 | 42 |
| Yauco | 66.0656 | 0.0064 | 43 |
| Guaynabo | 24.9213 | 0.0024 | 44 |
| Adjuntas | 0.0000 | 0.0000 | 45 |
| Aguas Buenas | 0.0000 | 0.0000 | 45 |
| Aibonito | 0.0000 | 0.0000 | 45 |
| Barranquitas | 0.0000 | 0.0000 | 45 |
| Bayamon | 0.2015 | 0.0000 | 45 |
| Caguas | 0.0000 | 0.0000 | 45 |
| Canovanas | 0.3102 | 0.0000 | 45 |
| Cayey | 0.0000 | 0.0000 | 45 |
| Ciales | 0.0000 | 0.0000 | 45 |

| | | | |
|---------------|--------|--------|----|
| Cidra | 0.0000 | 0.0000 | 45 |
| Coamo | 0.0000 | 0.0000 | 45 |
| Comerio | 0.0000 | 0.0000 | 45 |
| Corozal | 0.0000 | 0.0000 | 45 |
| Florida | 0.0000 | 0.0000 | 45 |
| Gurabo | 0.0000 | 0.0000 | 45 |
| Hormigueros | 0.0000 | 0.0000 | 45 |
| Jayuya | 0.0000 | 0.0000 | 45 |
| Juncos | 0.0000 | 0.0000 | 45 |
| Lares | 0.0000 | 0.0000 | 45 |
| Las Marias | 0.0000 | 0.0000 | 45 |
| Las Piedras | 0.0000 | 0.0000 | 45 |
| Maricao | 0.0000 | 0.0000 | 45 |
| Moca | 0.0000 | 0.0000 | 45 |
| Morovis | 0.0000 | 0.0000 | 45 |
| Naranjito | 0.0000 | 0.0000 | 45 |
| Orocovis | 0.0000 | 0.0000 | 45 |
| Sabana Grande | 0.0000 | 0.0000 | 45 |
| San German | 0.0000 | 0.0000 | 45 |
| San Lorenzo | 0.0000 | 0.0000 | 45 |
| San Sebastian | 0.0000 | 0.0000 | 45 |
| Toa Alta | 0.0000 | 0.0000 | 45 |
| Trujillo Alto | 0.0000 | 0.0000 | 45 |
| Utado | 0.0000 | 0.0000 | 45 |
| Villalba | 0.0000 | 0.0000 | 45 |

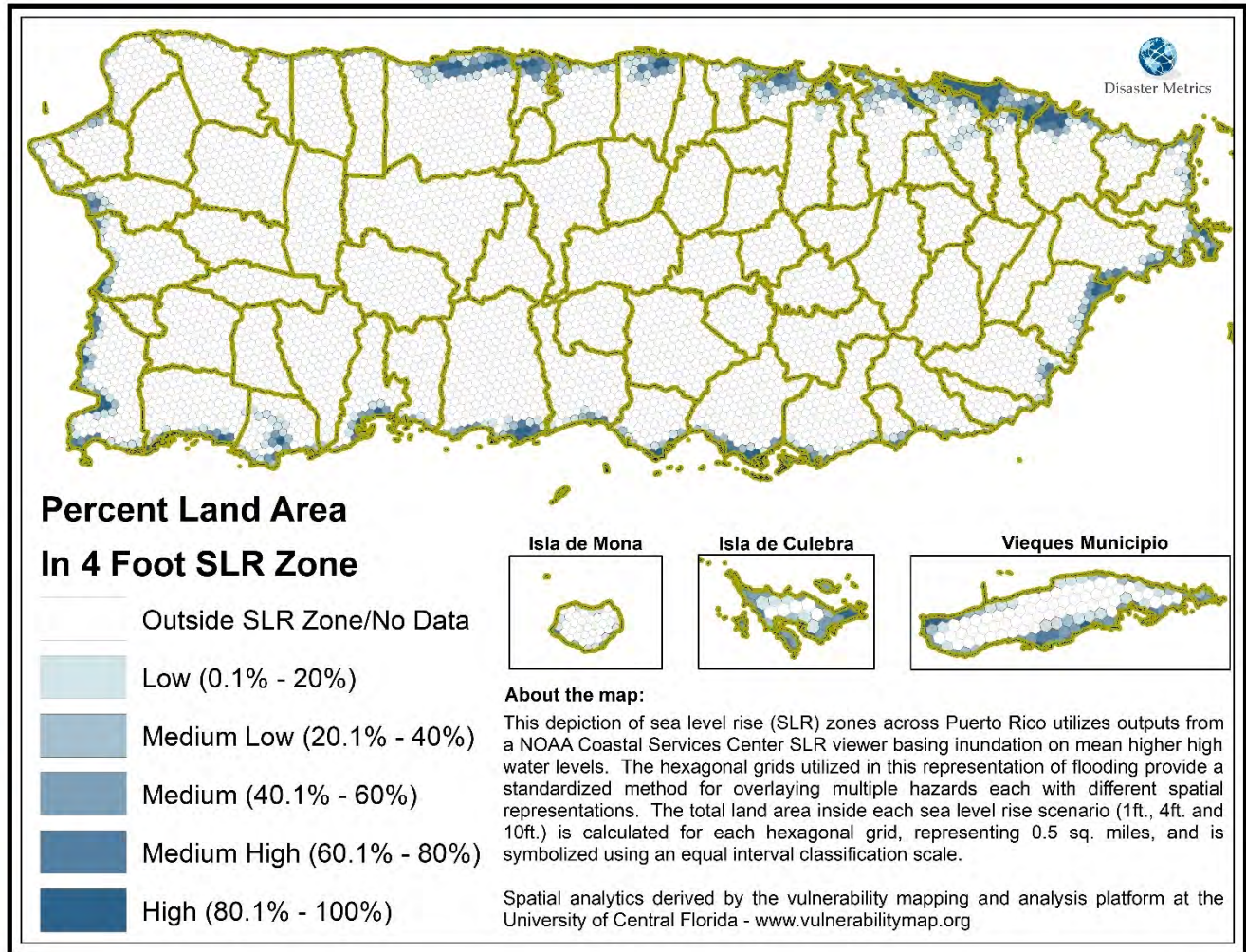


Figure 30: Sea Level Rise (4 feet) Hazard Areas

Table 92: Sea Level Rise (4 feet) by Municipio and Areal Extent

| Municipio | Hex Grid Area in Sea Level Rise (4 Feet) Zones (Sq. miles) | | | | | |
|--------------|--|-------------|--------------------------|----------------------|---------------------------|---------------------|
| | No SLR/No Date | Low (< 20%) | Medium Low (20.1% - 40%) | Medium (40.1% - 60%) | Medium High (60.1% - 80%) | High (80.1% - 100%) |
| Adjuntas | 67.10 | | | | | |
| Aguada | 27.07 | 1.13 | 1.80 | 0.36 | 0.33 | 0.23 |
| Aguadilla | 31.66 | 2.77 | 1.06 | 0.31 | 0.64 | 0.16 |
| Aguas Buenas | 30.10 | | | | | |
| Aibonito | 31.34 | | | | | |
| Anasco | 33.83 | 2.92 | 0.50 | 0.86 | 1.25 | 0.21 |
| Arecibo | 105.56 | 8.01 | 3.69 | 1.95 | 4.14 | 3.62 |
| Arroyo | 12.03 | 1.36 | 0.50 | 0.31 | 0.67 | 0.17 |
| Barceloneta | 9.48 | 2.84 | 1.31 | 2.08 | 1.65 | 1.40 |
| Barranquitas | 34.28 | | | | | |
| Bayamon | 41.96 | 2.56 | | | | |

| | | | | | | |
|--------------------|-------|-------|------|------|------|-------|
| Cabo Rojo | 49.90 | 9.08 | 2.24 | 2.77 | 3.66 | 5.46 |
| Caguas | 59.07 | | | | | |
| Camuy | 44.49 | 0.10 | 1.47 | 0.22 | | 0.08 |
| Canovanas | 28.16 | 3.30 | 0.66 | | 0.52 | 0.37 |
| Cantano | 28.65 | 10.91 | 2.35 | 0.97 | 1.62 | 2.79 |
| Carolina | | 2.86 | 0.11 | 0.70 | 0.66 | 0.76 |
| Cayey | 51.96 | | | | | |
| Ceiba | 19.46 | 2.83 | 1.00 | 2.16 | 1.41 | 3.51 |
| Ciales | 66.71 | | | | | |
| Cidra | 36.46 | | | | | |
| Coamo | 78.03 | | | | | |
| Comerio | 28.52 | | | | | |
| Corozal | 42.58 | | | | | |
| Culebra | 2.50 | 2.40 | 1.05 | 4.26 | 1.73 | 1.37 |
| Dorado | 16.93 | 3.01 | 1.37 | 1.45 | 0.26 | 0.40 |
| Fajardo | 21.96 | 3.45 | 1.15 | 1.17 | 1.56 | 1.22 |
| Florida | 15.22 | | | | | |
| Guanica | 25.21 | 7.14 | 1.51 | 3.03 | 1.20 | 0.92 |
| Guayama | 57.50 | 2.94 | 0.50 | 1.18 | 1.49 | 2.26 |
| Guayanilla | 35.02 | 2.03 | 0.86 | 2.06 | 1.04 | 1.98 |
| Guaynabo | 26.48 | 0.90 | | 0.08 | 0.30 | |
| Gurabo | 28.31 | | | | | |
| Hatillo | 39.35 | 1.17 | 0.11 | 1.05 | 0.15 | 0.01 |
| Hormigueros | 11.34 | | | | | |
| Humacao | 34.09 | 3.49 | 1.52 | 2.03 | 1.92 | 2.06 |
| Isabela | 51.21 | 2.16 | 1.05 | 0.24 | 0.37 | 0.37 |
| Jayuya | 44.53 | | | | | |
| Juana Diaz | 55.45 | 2.52 | 0.50 | 0.50 | 1.02 | 0.75 |
| Juncos | 26.62 | | | | | |
| Lajas | 52.66 | 3.21 | 0.92 | 1.21 | 1.36 | 2.00 |
| Lares | 61.64 | | | | | |
| Las Marias | 46.51 | | | | | |
| Las Piedras | 33.89 | | | | | |
| Loiza | 1.12 | 1.68 | 2.25 | 2.90 | 2.44 | 10.15 |
| Luquillo | 21.60 | 3.28 | 0.35 | | 0.34 | 0.29 |
| Manati | 39.23 | 4.13 | 1.81 | 0.61 | 0.59 | 0.46 |
| Maricao | 36.63 | | | | | |
| Maunabo | 19.14 | 0.48 | 0.68 | 0.61 | 0.09 | 0.07 |
| Mayaguez | 61.66 | 9.01 | 1.74 | 0.64 | 3.05 | 1.87 |
| Moca | 50.37 | | | | | |
| Morovis | 38.93 | | | | | |
| Naguabo | 44.88 | 1.17 | 0.93 | 1.31 | 2.58 | 1.02 |

| | | | | | | |
|--------------------|----------------|---------------|--------------|--------------|--------------|--------------|
| Naranjito | 27.75 | | | | | |
| Orocovis | 63.78 | | | | | |
| Patillas | 44.02 | 0.63 | 0.77 | 0.64 | 0.74 | 0.41 |
| Penuelas | 41.47 | 0.97 | 0.74 | 0.77 | 0.56 | 0.25 |
| Ponce | 104.43 | 3.47 | 2.23 | 0.89 | 3.15 | 2.81 |
| Quebradillas | 21.27 | 1.09 | 0.25 | 0.21 | 0.32 | 0.00 |
| Rio Grande | 11.01 | 1.42 | 0.75 | 0.79 | 0.17 | 0.25 |
| Rincon | 48.24 | 2.06 | 1.93 | 1.46 | 2.43 | 4.69 |
| Sabana Grande | 35.84 | | | | | |
| Salinas | 60.64 | 1.46 | 2.02 | 1.19 | 1.28 | 3.46 |
| San German | 54.51 | | | | | |
| San Juan | 35.67 | 5.74 | 3.59 | 2.33 | 0.86 | 1.33 |
| San Lorenzo | 53.21 | | | | | |
| San Sebastian | 71.22 | | | | | |
| Santa Isabel | 27.36 | 2.43 | 2.12 | | 0.26 | 2.41 |
| Toa Alta | 27.56 | | | | | |
| Toa Baja | 11.43 | 5.62 | 1.61 | 2.21 | 1.96 | 0.98 |
| Trujillo Alto | 20.09 | 1.29 | | | | |
| Utua | 115.07 | | | | | |
| Vega Alta | 26.83 | 0.19 | 0.32 | 0.30 | | 0.09 |
| Vega Baja | 35.20 | 4.71 | 2.25 | 2.29 | 0.66 | 1.53 |
| Vieques | 28.50 | 8.25 | 4.01 | 6.29 | 3.95 | 2.19 |
| Villalba | 37.04 | | | | | |
| Yabucoa | 50.14 | 2.40 | 1.04 | 0.70 | 1.02 | 0.11 |
| Yauco | 68.37 | | 0.43 | | | 0.02 |
| Grand Total | 3078.99 | 146.57 | 59.04 | 57.12 | 55.42 | 66.50 |

Table 93: Percent of (Municipio) Hexagonal Area by Sea Level Rise (4 feet) per Municipio

| Municipio | Sea Level Rise (4 Feet) Percent Area by Total (Municipio) Land Area | | | | | |
|--------------|---|-------------|--------------------------|----------------------|---------------------------|---------------------|
| | No SLR/No Data | Low (< 20%) | Medium Low (20.1% - 40%) | Medium (40.1% - 60%) | Medium High (60.1% - 80%) | High (80.1% - 100%) |
| Adjuntas | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Aguada | 87.54% | 3.66% | 5.81% | 1.18% | 1.07% | 0.74% |
| Aguadilla | 86.50% | 7.57% | 2.90% | 0.84% | 1.76% | 0.43% |
| Agua Buenas | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Aibonito | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Anasco | 85.51% | 7.38% | 1.26% | 2.17% | 3.16% | 0.52% |
| Arecibo | 83.13% | 6.31% | 2.90% | 1.54% | 3.26% | 2.85% |
| Arroyo | 79.97% | 9.02% | 3.32% | 2.08% | 4.46% | 1.15% |
| Barceloneta | 50.54% | 15.12% | 6.98% | 11.09% | 8.78% | 7.48% |
| Barranquitas | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |

| | | | | | | |
|--------------------|---------|--------|--------|--------|--------|--------|
| Bayamon | 94.26% | 5.74% | 0.00% | 0.00% | 0.00% | 0.00% |
| Cabo Rojo | 68.25% | 12.42% | 3.06% | 3.79% | 5.00% | 7.47% |
| Caguas | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Camuy | 95.95% | 0.22% | 3.17% | 0.48% | 0.00% | 0.17% |
| Canovanas | 85.32% | 9.99% | 2.00% | 0.00% | 1.57% | 1.12% |
| Cantano | 60.57% | 23.07% | 4.98% | 2.06% | 3.43% | 5.89% |
| Carolina | 0.00% | 56.17% | 2.16% | 13.69% | 12.96% | 15.02% |
| Cayey | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Ceiba | 64.07% | 9.32% | 3.29% | 7.10% | 4.65% | 11.55% |
| Ciales | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Cidra | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Coamo | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Comerio | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Corozal | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Culebra | 18.79% | 18.03% | 7.90% | 32.01% | 12.99% | 10.28% |
| Dorado | 72.29% | 12.85% | 5.84% | 6.21% | 1.11% | 1.70% |
| Fajardo | 71.97% | 11.32% | 3.76% | 3.84% | 5.10% | 4.01% |
| Florida | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Guanica | 64.63% | 18.30% | 3.86% | 7.76% | 3.08% | 2.37% |
| Guayama | 87.29% | 4.46% | 0.76% | 1.79% | 2.27% | 3.43% |
| Guayanilla | 81.46% | 4.72% | 2.01% | 4.79% | 2.41% | 4.61% |
| Guaynabo | 95.36% | 3.26% | 0.00% | 0.30% | 1.09% | 0.00% |
| Gurabo | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Hatillo | 94.05% | 2.79% | 0.26% | 2.51% | 0.36% | 0.02% |
| Hormigueros | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Humacao | 75.59% | 7.74% | 3.36% | 4.50% | 4.26% | 4.56% |
| Isabela | 92.43% | 3.90% | 1.90% | 0.43% | 0.66% | 0.67% |
| Jayuya | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Juana Diaz | 91.30% | 4.14% | 0.82% | 0.82% | 1.69% | 1.23% |
| Juncos | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Lajas | 85.82% | 5.23% | 1.49% | 1.97% | 2.22% | 3.27% |
| Lares | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Las Marias | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Las Piedras | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Loiza | 5.45% | 8.17% | 10.95% | 14.14% | 11.88% | 49.41% |
| Luquillo | 83.51% | 12.69% | 1.35% | 0.00% | 1.32% | 1.12% |
| Manati | 83.78% | 8.82% | 3.86% | 1.30% | 1.26% | 0.98% |
| Maricao | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Maunabo | 90.78% | 2.30% | 3.23% | 2.91% | 0.45% | 0.34% |
| Mayaguez | 79.08% | 11.56% | 2.23% | 0.82% | 3.91% | 2.40% |
| Moca | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Morovis | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |

| | | | | | | |
|----------------------|---------|--------|-------|--------|-------|-------|
| Naguabo | 86.51% | 2.25% | 1.79% | 2.53% | 4.97% | 1.96% |
| Naranjito | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Orocovis | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Patillas | 93.23% | 1.34% | 1.63% | 1.36% | 1.57% | 0.87% |
| Penuelas | 92.66% | 2.16% | 1.65% | 1.72% | 1.25% | 0.56% |
| Ponce | 89.27% | 2.96% | 1.91% | 0.76% | 2.69% | 2.40% |
| Quebradillas | 91.90% | 4.73% | 1.08% | 0.89% | 1.40% | 0.01% |
| Rio Grande | 76.53% | 9.86% | 5.22% | 5.50% | 1.18% | 1.71% |
| Rincon | 79.32% | 3.38% | 3.18% | 2.40% | 3.99% | 7.72% |
| Sabana Grande | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Salinas | 86.56% | 2.09% | 2.88% | 1.70% | 1.83% | 4.94% |
| San German | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| San Juan | 72.03% | 11.58% | 7.25% | 4.70% | 1.74% | 2.69% |
| San Lorenzo | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| San Sebastian | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Santa Isabel | 79.14% | 7.02% | 6.14% | 0.00% | 0.75% | 6.96% |
| Toa Alta | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Toa Baja | 48.00% | 23.63% | 6.76% | 9.28% | 8.23% | 4.10% |
| Trujillo Alto | 93.98% | 6.02% | 0.00% | 0.00% | 0.00% | 0.00% |
| Utua | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Vega Alta | 96.72% | 0.70% | 1.16% | 1.08% | 0.00% | 0.34% |
| Vega Baja | 75.46% | 10.10% | 4.82% | 4.91% | 1.42% | 3.29% |
| Vieques | 53.59% | 15.51% | 7.54% | 11.84% | 7.42% | 4.11% |
| Villalba | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Yabucoa | 90.49% | 4.34% | 1.88% | 1.25% | 1.84% | 0.21% |
| Yauco | 99.35% | 0.00% | 0.63% | 0.00% | 0.00% | 0.02% |

Table 94: Percent of (Island) Hexagonal Area by Sea Level Rise (4 feet) per Municipio

| Municipio | Sea Level Rise (4 Feet) Percent Area by Total (Island) Land Area | | | | | |
|---------------------|--|-------------|--------------------------|----------------------|---------------------------|---------------------|
| | No SLR/No Data | Low (< 20%) | Medium Low (20.1% - 40%) | Medium (40.1% - 60%) | Medium High (60.1% - 80%) | High (80.1% - 100%) |
| Adjuntas | 2.18% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Aguada | 0.88% | 0.77% | 3.04% | 0.64% | 0.60% | 0.34% |
| Aguadilla | 1.03% | 1.89% | 1.80% | 0.54% | 1.16% | 0.24% |
| Aguas Buenas | 0.98% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Aibonito | 1.02% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Anasco | 1.10% | 1.99% | 0.85% | 1.50% | 2.26% | 0.31% |
| Arecibo | 3.43% | 5.47% | 6.24% | 3.42% | 7.48% | 5.45% |
| Arroyo | 0.39% | 0.93% | 0.85% | 0.55% | 1.21% | 0.26% |
| Barceloneta | 0.31% | 1.94% | 2.22% | 3.64% | 2.97% | 2.11% |
| Barranquitas | 1.11% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |

| | | | | | | |
|--------------------|-------|-------|-------|-------|-------|--------|
| Bayamon | 1.36% | 1.74% | 0.00% | 0.00% | 0.00% | 0.00% |
| Cabo Rojo | 1.62% | 6.20% | 3.79% | 4.85% | 6.60% | 8.21% |
| Caguas | 1.92% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Camuy | 1.45% | 0.07% | 2.49% | 0.39% | 0.00% | 0.12% |
| Canovanas | 0.91% | 2.25% | 1.12% | 0.00% | 0.93% | 0.56% |
| Cantano | 0.93% | 7.45% | 3.99% | 1.71% | 2.93% | 4.19% |
| Carolina | 0.00% | 1.95% | 0.19% | 1.22% | 1.19% | 1.15% |
| Cayey | 1.69% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Ceiba | 0.63% | 1.93% | 1.69% | 3.78% | 2.55% | 5.28% |
| Ciales | 2.17% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Cidra | 1.18% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Coamo | 2.53% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Comerio | 0.93% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Corozal | 1.38% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Culebra | 0.08% | 1.64% | 1.78% | 7.46% | 3.12% | 2.06% |
| Dorado | 0.55% | 2.05% | 2.32% | 2.54% | 0.47% | 0.60% |
| Fajardo | 0.71% | 2.36% | 1.95% | 2.05% | 2.81% | 1.84% |
| Florida | 0.49% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Guanica | 0.82% | 4.87% | 2.55% | 5.30% | 2.17% | 1.39% |
| Guayama | 1.87% | 2.00% | 0.85% | 2.06% | 2.69% | 3.40% |
| Guayanilla | 1.14% | 1.38% | 1.46% | 3.61% | 1.87% | 2.98% |
| Guaynabo | 0.86% | 0.62% | 0.00% | 0.15% | 0.54% | 0.00% |
| Gurabo | 0.92% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Hatillo | 1.28% | 0.80% | 0.18% | 1.84% | 0.27% | 0.02% |
| Hormigueros | 0.37% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Humacao | 1.11% | 2.38% | 2.57% | 3.55% | 3.47% | 3.09% |
| Isabela | 1.66% | 1.48% | 1.79% | 0.42% | 0.66% | 0.56% |
| Jayuya | 1.45% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Juana Diaz | 1.80% | 1.72% | 0.84% | 0.88% | 1.85% | 1.13% |
| Juncos | 0.86% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Lajas | 1.71% | 2.19% | 1.55% | 2.11% | 2.46% | 3.01% |
| Lares | 2.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Las Marias | 1.51% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Las Piedras | 1.10% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Loiza | 0.04% | 1.14% | 3.81% | 5.08% | 4.40% | 15.26% |
| Luquillo | 0.70% | 2.24% | 0.59% | 0.00% | 0.62% | 0.44% |
| Manati | 1.27% | 2.82% | 3.06% | 1.06% | 1.07% | 0.69% |
| Maricao | 1.19% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Maunabo | 0.62% | 0.33% | 1.16% | 1.07% | 0.17% | 0.11% |
| Mayaguez | 2.00% | 6.15% | 2.94% | 1.13% | 5.50% | 2.82% |
| Moca | 1.64% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Morovis | 1.26% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |

| | | | | | | |
|----------------------|-------|-------|-------|--------|-------|-------|
| Naguabo | 1.46% | 0.80% | 1.57% | 2.29% | 4.65% | 1.53% |
| Naranjito | 0.90% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Orocovis | 2.07% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Patillas | 1.43% | 0.43% | 1.30% | 1.13% | 1.33% | 0.62% |
| Penuelas | 1.35% | 0.66% | 1.25% | 1.35% | 1.01% | 0.38% |
| Ponce | 3.39% | 2.37% | 3.78% | 1.56% | 5.69% | 4.23% |
| Quebradillas | 0.69% | 0.75% | 0.42% | 0.36% | 0.58% | 0.00% |
| Rio Grande | 0.36% | 0.97% | 1.27% | 1.39% | 0.31% | 0.37% |
| Rincon | 1.57% | 1.40% | 3.28% | 2.56% | 4.38% | 7.06% |
| Sabana Grande | 1.16% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Salinas | 1.97% | 1.00% | 3.42% | 2.09% | 2.31% | 5.20% |
| San German | 1.77% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| San Juan | 1.16% | 3.91% | 6.08% | 4.08% | 1.56% | 2.00% |
| San Lorenzo | 1.73% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| San Sebastian | 2.31% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Santa Isabel | 0.89% | 1.66% | 3.59% | 0.00% | 0.47% | 3.62% |
| Toa Alta | 0.90% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Toa Baja | 0.37% | 3.84% | 2.73% | 3.87% | 3.53% | 1.47% |
| Trujillo Alto | 0.65% | 0.88% | 0.00% | 0.00% | 0.00% | 0.00% |
| Utua | 3.74% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Vega Alta | 0.87% | 0.13% | 0.55% | 0.53% | 0.00% | 0.14% |
| Vega Baja | 1.14% | 3.22% | 3.81% | 4.01% | 1.19% | 2.31% |
| Vieques | 0.93% | 5.63% | 6.79% | 11.02% | 7.12% | 3.29% |
| Villalba | 1.20% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Yabucoa | 1.63% | 1.64% | 1.76% | 1.22% | 1.83% | 0.17% |
| Yauco | 2.22% | 0.00% | 0.74% | 0.00% | 0.00% | 0.02% |

Table 95: Sea Level Rise (4 feet) Hazard Scores and Ranks by Municipio

| Municipio | Sea Level Rise (4 Foot) Hazard Score (Log Multiplied) | | |
|------------|---|--------------------------|------------------------|
| | Total Score | Standardized Score (0-1) | Rank of Score (1 – 78) |
| Loiza | 10640.7603 | 1.0000 | 1 |
| Cabo Rojo | 6317.5315 | 0.5937 | 2 |
| Rio Grande | 5240.4192 | 0.4925 | 3 |
| Arecibo | 4612.8528 | 0.4335 | 4 |
| Ceiba | 3836.8624 | 0.3606 | 5 |
| Salinas | 3743.8345 | 0.3518 | 6 |
| Ponce | 3550.8608 | 0.3337 | 7 |
| Vieques | 3217.7516 | 0.3024 | 8 |
| Carolina | 3160.8783 | 0.2971 | 9 |
| Guayama | 2610.2988 | 0.2453 | 10 |
| Mayaguez | 2599.0903 | 0.2443 | 11 |

| | | | |
|--------------|-----------|--------|----|
| Humacao | 2527.1449 | 0.2375 | 12 |
| Santa Isabel | 2439.1991 | 0.2292 | 13 |
| Lajas | 2326.9730 | 0.2187 | 14 |
| Guayanilla | 2239.1538 | 0.2104 | 15 |
| Culebra | 1836.1956 | 0.1726 | 16 |
| Barceloneta | 1817.1918 | 0.1708 | 17 |
| Vega Baja | 1714.1996 | 0.1611 | 18 |
| Naguabo | 1646.0038 | 0.1547 | 19 |
| Fajardo | 1601.9426 | 0.1505 | 20 |
| San Juan | 1566.4986 | 0.1472 | 21 |
| Toa Baja | 1473.7894 | 0.1385 | 22 |
| Guanica | 1252.0370 | 0.1177 | 23 |
| Juana Diaz | 995.2300 | 0.0935 | 24 |
| Catano | 923.4687 | 0.0868 | 25 |
| Manati | 609.0366 | 0.0572 | 26 |
| Patillas | 595.4255 | 0.0560 | 27 |
| Anasco | 519.4689 | 0.0488 | 28 |
| Canovanas | 491.0325 | 0.0461 | 29 |
| Dorado | 481.1374 | 0.0452 | 30 |
| Isabela | 461.7664 | 0.0434 | 31 |
| Penuelas | 397.7163 | 0.0374 | 32 |
| Yabucoa | 371.4965 | 0.0349 | 33 |
| Luquillo | 369.9933 | 0.0348 | 34 |
| Arroyo | 338.9773 | 0.0319 | 35 |
| Aguadilla | 318.9439 | 0.03 | 36 |
| Aguada | 314.8094 | 0.0296 | 37 |
| Rincon | 298.5289 | 0.0281 | 38 |
| Maunabo | 104.1538 | 0.0098 | 39 |
| Vega Alta | 97.9899 | 0.0092 | 40 |
| Camuy | 86.6050 | 0.0081 | 41 |
| Quebradillas | 84.5608 | 0.0079 | 42 |
| Guaynabo | 74.1678 | 0.007 | 43 |
| Hatillo | 63.8009 | 0.006 | 44 |
| Yauco | 16.8031 | 0.0016 | 45 |
| Adjuntas | 0.0000 | 0.0000 | 46 |
| Aguas Buenas | 0.0000 | 0.0000 | 46 |
| Aibonito | 0.0000 | 0.0000 | 46 |
| Barranquitas | 0.0000 | 0.0000 | 46 |
| Bayamon | 0.2343 | 0.0000 | 46 |
| Caguas | 0.0000 | 0.0000 | 46 |
| Cayey | 0.0000 | 0.0000 | 46 |
| Ciales | 0.0000 | 0.0000 | 46 |

| | | | |
|---------------|--------|--------|----|
| Cidra | 0.0000 | 0.0000 | 46 |
| Coamo | 0.0000 | 0.0000 | 46 |
| Comerio | 0.0000 | 0.0000 | 46 |
| Corozal | 0.0000 | 0.0000 | 46 |
| Florida | 0.0000 | 0.0000 | 46 |
| Gurabo | 0.0000 | 0.0000 | 46 |
| Hormigueros | 0.0000 | 0.0000 | 46 |
| Jayuya | 0.0000 | 0.0000 | 46 |
| Juncos | 0.0000 | 0.0000 | 46 |
| Lares | 0.0000 | 0.0000 | 46 |
| Las Marias | 0.0000 | 0.0000 | 46 |
| Las Piedras | 0.0000 | 0.0000 | 46 |
| Maricao | 0.0000 | 0.0000 | 46 |
| Moca | 0.0000 | 0.0000 | 46 |
| Morovis | 0.0000 | 0.0000 | 46 |
| Naranjito | 0.0000 | 0.0000 | 46 |
| Orocovis | 0.0000 | 0.0000 | 46 |
| Sabana Grande | 0.0000 | 0.0000 | 46 |
| San German | 0.0000 | 0.0000 | 46 |
| San Lorenzo | 0.0000 | 0.0000 | 46 |
| San Sebastian | 0.0000 | 0.0000 | 46 |
| Toa Alta | 0.0000 | 0.0000 | 46 |
| Trujillo Alto | 0.1180 | 0.0000 | 46 |
| Utado | 0.0000 | 0.0000 | 46 |
| Villalba | 0.0000 | 0.0000 | 46 |

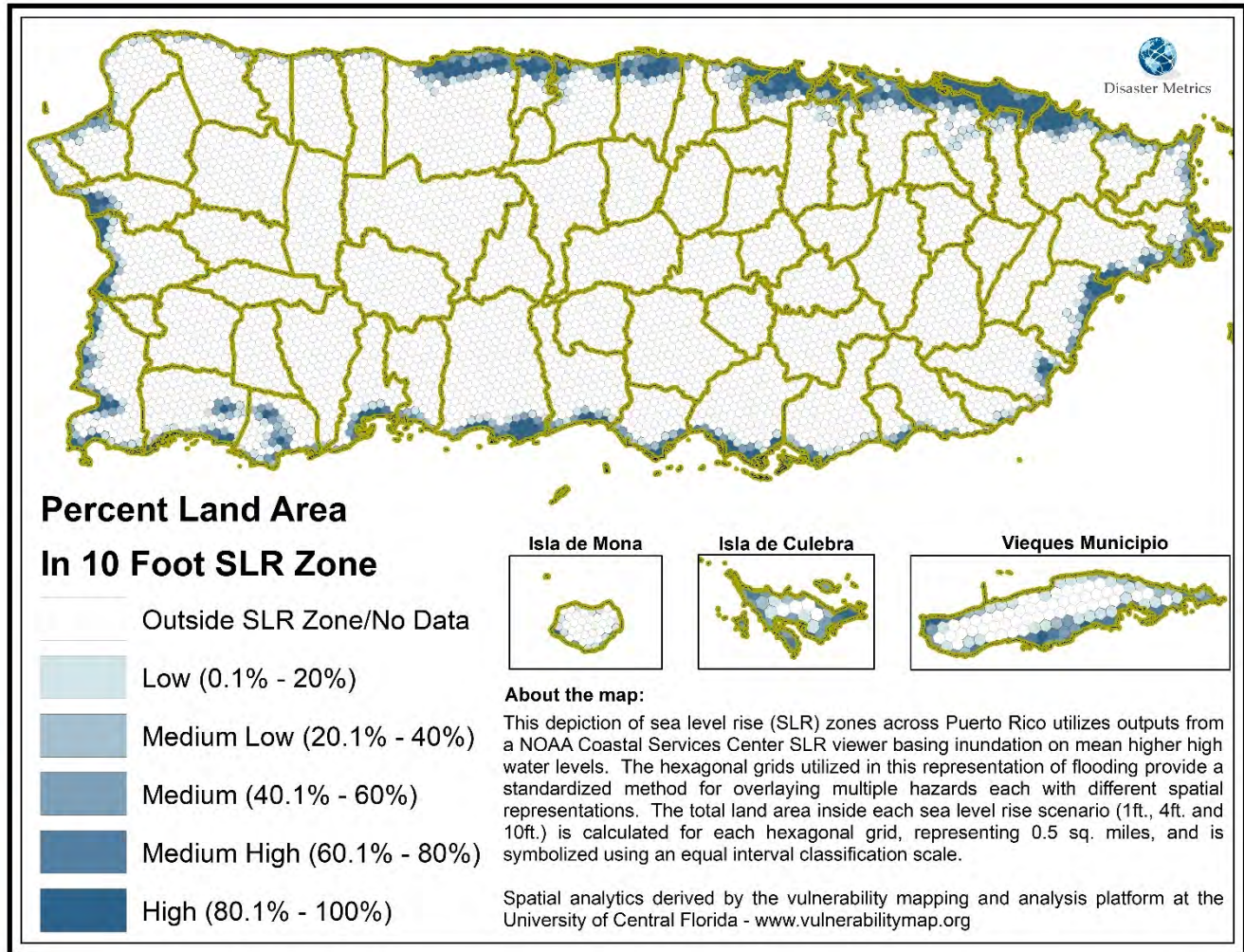


Figure 31: Sea Level Rise (10 feet) Hazard Areas

Table 96: Sea Level Rise (10 feet) by Municipio and Areal Extent

| Municipio | Hex Grid Area in Sea Level Rise (10 Feet) Zones (Sq. miles) | | | | | |
|--------------|---|-------------|--------------------------|----------------------|---------------------------|---------------------|
| | No SLR/No Date | Low (< 20%) | Medium Low (20.1% - 40%) | Medium (40.1% - 60%) | Medium High (60.1% - 80%) | High (80.1% - 100%) |
| Adjuntas | 67.10 | | | | | |
| Aguada | 23.15 | 2.45 | 1.48 | 2.91 | | 0.92 |
| Aguadilla | 30.62 | 2.97 | 1.14 | 1.07 | 0.33 | 0.47 |
| Aguas Buenas | 30.10 | | | | | |
| Aibonito | 31.34 | | | | | |
| Anasco | 31.25 | 2.36 | 1.03 | 1.30 | 0.50 | 3.12 |
| Arecibo | 103.56 | 4.16 | 3.62 | 4.73 | 2.56 | 8.34 |
| Arroyo | 11.53 | 0.50 | 1.36 | | 0.54 | 1.11 |
| Barceloneta | 9.43 | 1.97 | 1.01 | 1.33 | 1.90 | 3.12 |
| Barranquitas | 34.28 | | | | | |
| Bayamon | 40.47 | 3.18 | 0.68 | | 0.17 | 0.01 |

| | | | | | | |
|-------------|-------|------|------|------|------|-------|
| Cabo Rojo | 45.40 | 9.01 | 3.46 | 4.26 | 3.06 | 7.93 |
| Caguas | 59.07 | | | | | |
| Camuy | 43.99 | 0.60 | 0.85 | 0.33 | 0.51 | 0.08 |
| Canovanas | 26.91 | 3.66 | 0.50 | 0.39 | 0.90 | 0.64 |
| Cantano | 27.00 | 7.87 | 0.50 | 1.71 | 1.34 | 8.89 |
| Carolina | | 0.31 | 1.09 | | 0.61 | 3.08 |
| Cayey | 51.96 | | | | | |
| Ceiba | 17.78 | 1.69 | 1.98 | 2.07 | 2.69 | 4.16 |
| Ciales | 66.71 | | | | | |
| Cidra | 36.46 | | | | | |
| Coamo | 78.03 | | | | | |
| Comerio | 28.52 | | | | | |
| Corozal | 42.58 | | | | | |
| Culebra | 2.00 | 1.98 | 1.29 | 3.39 | 3.28 | 1.37 |
| Dorado | 13.22 | 4.25 | 1.66 | 0.39 | 0.79 | 3.11 |
| Fajardo | 21.46 | 2.45 | 1.48 | 2.34 | 1.38 | 1.40 |
| Florida | 15.22 | | | | | |
| Guanica | 22.63 | 4.72 | 3.51 | 4.20 | 2.52 | 1.42 |
| Guayama | 56.50 | 2.94 | 1.00 | 0.77 | 1.01 | 3.65 |
| Guayanilla | 34.25 | 1.77 | 0.86 | 1.60 | 1.54 | 2.97 |
| Guaynabo | 25.17 | 0.82 | 0.53 | | 0.50 | 0.74 |
| Gurabo | 28.31 | | | | | |
| Hatillo | 38.85 | 1.67 | | 0.56 | 0.60 | 0.16 |
| Hormigueros | 10.88 | 0.46 | | | | |
| Humacao | 31.20 | 4.38 | 1.17 | 1.37 | 1.98 | 5.01 |
| Isabela | 49.31 | 2.25 | 2.21 | 0.57 | 0.70 | 0.37 |
| Jayuya | 44.53 | | | | | |
| Juana Diaz | 53.38 | 2.07 | 1.53 | 0.98 | 0.00 | 2.77 |
| Juncos | 26.62 | | | | | |
| Lajas | 46.25 | 5.62 | 2.92 | 1.26 | 2.31 | 3.00 |
| Lares | 61.64 | | | | | |
| Las Marias | 46.51 | | | | | |
| Las Piedras | 33.89 | | | | | |
| Loiza | 0.35 | 0.35 | | 1.60 | 0.89 | 17.34 |
| Luquillo | 19.60 | 2.00 | 2.39 | | 0.51 | 1.37 |
| Manati | 34.48 | 3.97 | 2.84 | 1.11 | 1.28 | 3.14 |
| Maricao | 36.63 | | | | | |
| Maunabo | 17.64 | 1.98 | 0.33 | 0.64 | 0.11 | 0.38 |
| Mayaguez | 56.70 | 9.40 | 1.94 | 1.16 | 1.45 | 7.32 |
| Moca | 50.37 | | | | | |
| Morovis | 38.93 | | | | | |
| Naguabo | 41.45 | 3.43 | 0.41 | 0.99 | 2.63 | 2.96 |

| | | | | | | |
|--------------------|----------------|---------------|--------------|--------------|--------------|---------------|
| Naranjito | 27.75 | | | | | |
| Orocovis | 63.78 | | | | | |
| Patillas | 43.52 | 0.51 | 1.39 | | 1.21 | 0.58 |
| Penuelas | 40.47 | 0.50 | 1.74 | 0.47 | 0.51 | 1.07 |
| Ponce | 100.50 | 2.93 | 1.54 | 2.82 | 1.41 | 7.78 |
| Quebradillas | 20.17 | 2.19 | 0.25 | | 0.53 | 0.00 |
| Rio Grande | 9.48 | 1.47 | 1.86 | 0.65 | 0.51 | 0.42 |
| Rincon | 45.91 | 2.32 | 1.06 | 1.50 | 1.50 | 8.52 |
| Sabana Grande | 35.84 | | | | | |
| Salinas | 58.14 | 2.96 | | 2.14 | 1.16 | 5.65 |
| San German | 54.51 | | | | | |
| San Juan | 33.51 | 3.15 | 2.02 | 2.49 | 4.60 | 3.76 |
| San Lorenzo | 53.21 | | | | | |
| San Sebastian | 71.22 | | | | | |
| Santa Isabel | 26.36 | 1.00 | 2.36 | 1.20 | 0.99 | 2.67 |
| Toa Alta | 27.56 | | | | | |
| Toa Baja | 7.66 | 2.73 | 2.02 | 1.00 | 2.19 | 8.21 |
| Trujillo Alto | 20.09 | 1.29 | | | | |
| Utua | 115.07 | | | | | |
| Vega Alta | 26.22 | 0.07 | 0.50 | 0.49 | 0.36 | 0.09 |
| Vega Baja | 31.04 | 4.01 | 0.90 | 2.66 | 3.11 | 4.91 |
| Vieques | 24.00 | 11.76 | 3.65 | 4.26 | 6.24 | 3.27 |
| Villalba | 37.04 | | | | | |
| Yabucoa | 48.14 | 2.49 | 1.47 | 0.70 | 1.50 | 1.11 |
| Yauco | 68.14 | 0.23 | 0.43 | | | 0.02 |
| Grand Total | 2984.50 | 136.88 | 65.95 | 63.43 | 64.44 | 148.43 |

Table 97: Percent of (Municipio) Hexagonal Area by Sea Level Rise (10 feet) per Municipio

| Municipio | Sea Level Rise (10 Feet) Percent Area by Total (Municipio) Land Area | | | | | |
|--------------|--|-------------|--------------------------|----------------------|---------------------------|---------------------|
| | No SLR/No Data | Low (< 20%) | Medium Low (20.1% - 40%) | Medium (40.1% - 60%) | Medium High (60.1% - 80%) | High (80.1% - 100%) |
| Adjuntas | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Aguada | 74.86% | 7.93% | 4.80% | 9.42% | 0.00% | 2.98% |
| Aguadilla | 83.65% | 8.12% | 3.12% | 2.92% | 0.90% | 1.29% |
| Agua Buenas | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Aibonito | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Anasco | 78.99% | 5.96% | 2.61% | 3.28% | 1.26% | 7.89% |
| Arecibo | 81.56% | 3.27% | 2.85% | 3.73% | 2.02% | 6.57% |
| Arroyo | 76.64% | 3.32% | 9.02% | 0.00% | 3.62% | 7.40% |
| Barceloneta | 50.27% | 10.49% | 5.38% | 7.10% | 10.13% | 16.63% |
| Barranquitas | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |

| | | | | | | |
|--------------------|---------|--------|--------|--------|--------|--------|
| Bayamon | 90.92% | 7.14% | 1.54% | 0.00% | 0.38% | 0.03% |
| Cabo Rojo | 62.09% | 12.32% | 4.74% | 5.83% | 4.19% | 10.84% |
| Caguas | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Camuy | 94.87% | 1.30% | 1.84% | 0.71% | 1.11% | 0.17% |
| Canovanas | 81.53% | 11.10% | 1.51% | 1.17% | 2.74% | 1.95% |
| Cantano | 57.07% | 16.65% | 1.05% | 3.61% | 2.83% | 18.79% |
| Carolina | 0.00% | 6.05% | 21.51% | 0.00% | 11.94% | 60.50% |
| Cayey | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Ceiba | 58.55% | 5.56% | 6.53% | 6.81% | 8.85% | 13.70% |
| Ciales | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Cidra | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Coamo | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Comerio | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Corozal | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Culebra | 15.03% | 14.88% | 9.66% | 25.51% | 24.65% | 10.28% |
| Dorado | 56.45% | 18.16% | 7.08% | 1.66% | 3.35% | 13.30% |
| Fajardo | 70.33% | 8.04% | 4.86% | 7.67% | 4.51% | 4.59% |
| Florida | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Guanica | 58.01% | 12.10% | 8.99% | 10.78% | 6.47% | 3.65% |
| Guayama | 85.78% | 4.46% | 1.51% | 1.17% | 1.54% | 5.54% |
| Guayanilla | 79.67% | 4.12% | 2.01% | 3.72% | 3.58% | 6.91% |
| Guaynabo | 90.67% | 2.94% | 1.91% | 0.00% | 1.80% | 2.68% |
| Gurabo | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Hatillo | 92.85% | 3.99% | 0.00% | 1.34% | 1.43% | 0.39% |
| Hormigueros | 95.94% | 4.06% | 0.00% | 0.00% | 0.00% | 0.00% |
| Humacao | 69.17% | 9.72% | 2.59% | 3.04% | 4.38% | 11.10% |
| Isabela | 89.00% | 4.06% | 3.98% | 1.03% | 1.26% | 0.67% |
| Jayuya | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Juana Diaz | 87.89% | 3.40% | 2.53% | 1.61% | 0.00% | 4.56% |
| Juncos | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Lajas | 75.36% | 9.17% | 4.75% | 2.05% | 3.77% | 4.90% |
| Lares | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Las Marias | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Las Piedras | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Loiza | 1.70% | 1.71% | 0.00% | 7.77% | 4.36% | 84.46% |
| Luquillo | 75.78% | 7.73% | 9.22% | 0.00% | 1.98% | 5.28% |
| Manati | 73.63% | 8.48% | 6.07% | 2.38% | 2.73% | 6.71% |
| Maricao | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Maunabo | 83.66% | 9.41% | 1.56% | 3.04% | 0.51% | 1.81% |
| Mayaguez | 72.72% | 12.05% | 2.49% | 1.49% | 1.86% | 9.39% |
| Moca | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Morovis | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |

| | | | | | | |
|----------------------|---------|--------|--------|-------|--------|--------|
| Naguabo | 79.90% | 6.61% | 0.79% | 1.92% | 5.08% | 5.70% |
| Naranjito | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Orocovis | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Patillas | 92.17% | 1.09% | 2.94% | 0.00% | 2.57% | 1.22% |
| Penuelas | 90.43% | 1.12% | 3.88% | 1.04% | 1.14% | 2.39% |
| Ponce | 85.91% | 2.51% | 1.32% | 2.41% | 1.21% | 6.65% |
| Quebradillas | 87.17% | 9.46% | 1.08% | 0.00% | 2.28% | 0.01% |
| Rio Grande | 65.86% | 10.24% | 12.89% | 4.54% | 3.58% | 2.90% |
| Rincon | 75.50% | 3.82% | 1.74% | 2.47% | 2.47% | 14.00% |
| Sabana Grande | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Salinas | 82.99% | 4.23% | 0.00% | 3.06% | 1.66% | 8.07% |
| San German | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| San Juan | 67.66% | 6.35% | 4.08% | 5.03% | 9.29% | 7.58% |
| San Lorenzo | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| San Sebastian | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Santa Isabel | 76.24% | 2.89% | 6.82% | 3.46% | 2.88% | 7.71% |
| Toa Alta | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Toa Baja | 32.17% | 11.46% | 8.47% | 4.20% | 9.22% | 34.48% |
| Trujillo Alto | 93.98% | 6.02% | 0.00% | 0.00% | 0.00% | 0.00% |
| Utua | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Vega Alta | 94.51% | 0.26% | 1.80% | 1.78% | 1.31% | 0.34% |
| Vega Baja | 66.55% | 8.61% | 1.93% | 5.71% | 6.68% | 10.52% |
| Vieques | 45.13% | 22.12% | 6.87% | 8.01% | 11.73% | 6.15% |
| Villalba | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Yabucoa | 86.88% | 4.49% | 2.65% | 1.27% | 2.70% | 2.01% |
| Yauco | 99.01% | 0.33% | 0.63% | 0.00% | 0.00% | 0.02% |

Table 98: Percent of (Island) Hexagonal Area by Sea Level Rise (10 feet) per Municipio

| Municipio | Sea Level Rise (10 Feet) Percent Area by Total (Island) Land Area | | | | | |
|---------------------|---|-------------|--------------------------|----------------------|---------------------------|---------------------|
| | No SLR/No Data | Low (< 20%) | Medium Low (20.1% - 40%) | Medium (40.1% - 60%) | Medium High (60.1% - 80%) | High (80.1% - 100%) |
| Adjuntas | 2.25% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Aguada | 0.78% | 1.79% | 2.25% | 4.59% | 0.00% | 0.62% |
| Aguadilla | 1.03% | 2.17% | 1.73% | 1.69% | 0.51% | 0.32% |
| Aguas Buenas | 1.01% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Aibonito | 1.05% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Anasco | 1.05% | 1.72% | 1.57% | 2.04% | 0.78% | 2.10% |
| Arecibo | 3.47% | 3.04% | 5.50% | 7.46% | 3.98% | 5.62% |
| Arroyo | 0.39% | 0.37% | 2.06% | 0.00% | 0.84% | 0.75% |
| Barceloneta | 0.32% | 1.44% | 1.53% | 2.10% | 2.95% | 2.10% |
| Barranquitas | 1.15% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |

| | | | | | | |
|--------------------|-------|-------|-------|-------|-------|--------|
| Bayamon | 1.36% | 2.32% | 1.04% | 0.00% | 0.26% | 0.01% |
| Cabo Rojo | 1.52% | 6.58% | 5.25% | 6.72% | 4.75% | 5.34% |
| Caguas | 1.98% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Camuy | 1.47% | 0.44% | 1.29% | 0.52% | 0.80% | 0.05% |
| Canovanas | 0.90% | 2.68% | 0.76% | 0.61% | 1.40% | 0.43% |
| Cantano | 0.90% | 5.75% | 0.75% | 2.69% | 2.08% | 5.99% |
| Carolina | 0.00% | 0.22% | 1.66% | 0.00% | 0.94% | 2.07% |
| Cayey | 1.74% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Ceiba | 0.60% | 1.23% | 3.01% | 3.26% | 4.17% | 2.80% |
| Ciales | 2.24% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Cidra | 1.22% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Coamo | 2.61% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Comerio | 0.96% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Corozal | 1.43% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Culebra | 0.07% | 1.45% | 1.95% | 5.35% | 5.09% | 0.92% |
| Dorado | 0.44% | 3.11% | 2.51% | 0.61% | 1.22% | 2.10% |
| Fajardo | 0.72% | 1.79% | 2.25% | 3.69% | 2.14% | 0.94% |
| Florida | 0.51% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Guanica | 0.76% | 3.45% | 5.32% | 6.63% | 3.92% | 0.96% |
| Guayama | 1.89% | 2.15% | 1.51% | 1.21% | 1.57% | 2.46% |
| Guayanilla | 1.15% | 1.29% | 1.31% | 2.52% | 2.39% | 2.00% |
| Guaynabo | 0.84% | 0.60% | 0.80% | 0.00% | 0.78% | 0.50% |
| Gurabo | 0.95% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Hatillo | 1.30% | 1.22% | 0.00% | 0.89% | 0.93% | 0.11% |
| Hormigueros | 0.36% | 0.34% | 0.00% | 0.00% | 0.00% | 0.00% |
| Humacao | 1.05% | 3.20% | 1.77% | 2.16% | 3.07% | 3.37% |
| Isabela | 1.65% | 1.64% | 3.34% | 0.90% | 1.08% | 0.25% |
| Jayuya | 1.49% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Juana Diaz | 1.79% | 1.51% | 2.33% | 1.54% | 0.00% | 1.87% |
| Juncos | 0.89% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Lajas | 1.55% | 4.11% | 4.42% | 1.99% | 3.59% | 2.02% |
| Lares | 2.07% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Las Marias | 1.56% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Las Piedras | 1.14% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Loiza | 0.01% | 0.26% | 0.00% | 2.52% | 1.39% | 11.68% |
| Luquillo | 0.66% | 1.46% | 3.62% | 0.00% | 0.79% | 0.92% |
| Manati | 1.16% | 2.90% | 4.31% | 1.75% | 1.98% | 2.12% |
| Maricao | 1.23% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Maunabo | 0.59% | 1.45% | 0.50% | 1.01% | 0.17% | 0.26% |
| Mayaguez | 1.90% | 6.87% | 2.94% | 1.83% | 2.25% | 4.93% |
| Moca | 1.69% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Morovis | 1.30% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |

| | | | | | | |
|----------------------|-------|-------|-------|-------|-------|-------|
| Naguabo | 1.39% | 2.51% | 0.62% | 1.57% | 4.09% | 1.99% |
| Naranjito | 0.93% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Orocovis | 2.14% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Patillas | 1.46% | 0.38% | 2.10% | 0.00% | 1.88% | 0.39% |
| Penuelas | 1.36% | 0.37% | 2.63% | 0.74% | 0.79% | 0.72% |
| Ponce | 3.37% | 2.14% | 2.33% | 4.45% | 2.19% | 5.24% |
| Quebradillas | 0.68% | 1.60% | 0.38% | 0.00% | 0.82% | 0.00% |
| Rio Grande | 0.32% | 1.08% | 2.81% | 1.03% | 0.80% | 0.28% |
| Rincon | 1.54% | 1.70% | 1.60% | 2.36% | 2.33% | 5.74% |
| Sabana Grande | 1.20% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Salinas | 1.95% | 2.16% | 0.00% | 3.38% | 1.80% | 3.81% |
| San German | 1.83% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| San Juan | 1.12% | 2.30% | 3.06% | 3.93% | 7.14% | 2.53% |
| San Lorenzo | 1.78% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| San Sebastian | 2.39% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Santa Isabel | 0.88% | 0.73% | 3.57% | 1.89% | 1.54% | 1.80% |
| Toa Alta | 0.92% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Toa Baja | 0.26% | 1.99% | 3.06% | 1.58% | 3.40% | 5.53% |
| Trujillo Alto | 0.67% | 0.94% | 0.00% | 0.00% | 0.00% | 0.00% |
| Utua | 3.86% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Vega Alta | 0.88% | 0.05% | 0.76% | 0.78% | 0.56% | 0.06% |
| Vega Baja | 1.04% | 2.93% | 1.37% | 4.20% | 4.83% | 3.31% |
| Vieques | 0.80% | 8.59% | 5.54% | 6.71% | 9.68% | 2.20% |
| Villalba | 1.24% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Yabucoa | 1.61% | 1.82% | 2.23% | 1.11% | 2.32% | 0.75% |
| Yauco | 2.28% | 0.17% | 0.66% | 0.00% | 0.00% | 0.01% |

Table 99: Sea Level Rise (10 feet) Hazard Scores and Ranks by Municipio

| Municipio | Sea Level Rise (10 Feet) Hazard Score (Log Multiplied) | | |
|------------|--|--------------------------|------------------------|
| | Total Score | Standardized Score (0-1) | Rank of Score (1 – 78) |
| Loiza | 10177.1975 | 1.0000 | 1 |
| Carolina | 5379.1416 | 0.5285 | 2 |
| Arecibo | 5332.6982 | 0.5240 | 3 |
| Rio Grande | 5185.6525 | 0.5095 | 4 |
| Cabo Rojo | 5161.2298 | 0.5071 | 5 |
| Toa Baja | 5111.4621 | 0.5022 | 6 |
| Ponce | 4775.2550 | 0.4692 | 7 |
| Mayaguez | 4484.8948 | 0.4407 | 8 |
| Salinas | 3489.7799 | 0.3429 | 9 |
| Vega Baja | 3388.8586 | 0.3330 | 10 |
| Humacao | 3236.0426 | 0.3180 | 11 |
| Vieques | 2987.0529 | 0.2935 | 12 |

| | | | |
|--------------|-----------|--------|----|
| San Juan | 2961.7929 | 0.2910 | 13 |
| Ceiba | 2878.8438 | 0.2829 | 14 |
| Guayama | 2286.9289 | 0.2247 | 15 |
| Naguabo | 2151.2555 | 0.2114 | 16 |
| Lajas | 2138.2723 | 0.2101 | 17 |
| Barceloneta | 2135.0209 | 0.2098 | 18 |
| Manati | 2049.3914 | 0.2014 | 19 |
| Guayanilla | 1996.6959 | 0.1962 | 20 |
| Dorado | 1934.7518 | 0.1901 | 21 |
| Anasco | 1910.8489 | 0.1878 | 22 |
| Catano | 1873.8014 | 0.1841 | 23 |
| Santa Isabel | 1728.1665 | 0.1698 | 24 |
| Juana Diaz | 1622.0071 | 0.1594 | 25 |
| Culebra | 1390.2438 | 0.1366 | 26 |
| Guanica | 1323.9798 | 0.1301 | 27 |
| Fajardo | 1082.0722 | 0.1063 | 28 |
| Yabucoa | 901.1467 | 0.0885 | 29 |
| Luquillo | 876.4141 | 0.0861 | 30 |
| Arroyo | 733.0881 | 0.0720 | 31 |
| Penuelas | 713.3990 | 0.0701 | 32 |
| Aguada | 597.7969 | 0.0587 | 33 |
| Patillas | 532.0206 | 0.0523 | 34 |
| Canovanas | 526.2047 | 0.0517 | 35 |
| Guaynabo | 510.7560 | 0.0502 | 36 |
| Aguadilla | 350.7395 | 0.0345 | 37 |
| Isabela | 344.4149 | 0.0338 | 38 |
| Rincon | 341.7857 | 0.0336 | 39 |
| Maunabo | 252.3595 | 0.0248 | 40 |
| Hatillo | 201.3805 | 0.0198 | 41 |
| Camuy | 138.1980 | 0.0136 | 42 |
| Vega Alta | 124.0816 | 0.0122 | 43 |
| Quebradillas | 87.1037 | 0.0086 | 44 |
| Bayamon | 35.7280 | 0.0035 | 45 |
| Yauco | 10.4031 | 0.0010 | 46 |
| Adjuntas | 0.0000 | 0.0000 | 47 |
| Aguas Buenas | 0.0000 | 0.0000 | 47 |
| Aibonito | 0.0000 | 0.0000 | 47 |
| Barranquitas | 0.0000 | 0.0000 | 47 |
| Caguas | 0.0000 | 0.0000 | 47 |
| Cayey | 0.0000 | 0.0000 | 47 |
| Ciales | 0.0000 | 0.0000 | 47 |
| Cidra | 0.0000 | 0.0000 | 47 |

| | | | |
|---------------|--------|--------|----|
| Coamo | 0.0000 | 0.0000 | 47 |
| Comerio | 0.0000 | 0.0000 | 47 |
| Corozal | 0.0000 | 0.0000 | 47 |
| Florida | 0.0000 | 0.0000 | 47 |
| Gurabo | 0.0000 | 0.0000 | 47 |
| Hormigueros | 0.0391 | 0.0000 | 47 |
| Jayuya | 0.0000 | 0.0000 | 47 |
| Juncos | 0.0000 | 0.0000 | 47 |
| Lares | 0.0000 | 0.0000 | 47 |
| Las Marias | 0.0000 | 0.0000 | 47 |
| Las Piedras | 0.0000 | 0.0000 | 47 |
| Maricao | 0.0000 | 0.0000 | 47 |
| Moca | 0.0000 | 0.0000 | 47 |
| Morovis | 0.0000 | 0.0000 | 47 |
| Naranjito | 0.0000 | 0.0000 | 47 |
| Orocovis | 0.0000 | 0.0000 | 47 |
| Sabana Grande | 0.0000 | 0.0000 | 47 |
| San German | 0.0000 | 0.0000 | 47 |
| San Lorenzo | 0.0000 | 0.0000 | 47 |
| San Sebastian | 0.0000 | 0.0000 | 47 |
| Toa Alta | 0.0000 | 0.0000 | 47 |
| Trujillo Alto | 0.1095 | 0.0000 | 47 |
| Utua | 0.0000 | 0.0000 | 47 |
| Villalba | 0.0000 | 0.0000 | 47 |

Vulnerability

Understanding which populations and what assets are likely to be impacted by hazard events is critical for developing sound mitigation planning activities and projects. Here, vulnerability is defined by combining three different indicators: critical infrastructure assets provide a representation of what is at risk; socially vulnerable areas provide an idea of who has a lower capacity to absorb shocks and stresses, and total population supports a utilitarian approach to serving the greatest number of peoples. Combining these three vulnerability indicators into a single measure enables an accounting of all three characteristics in an empirical way. Vulnerability was determined by developing a GIS inventory of critical infrastructure assets⁴⁵, population of people, and population of socially vulnerable populations. Critical infrastructure assets are transportation facilities, communication facilities, water and wastewater facilities, and power facilities. These facilities are those that all other infrastructure lifelines are dependent on. Social vulnerable populations were derived from the Social Vulnerability Index first developed by Cutter (2003)⁴⁶ and later refined by scholars at the University of Central Florida⁴⁷. Understanding where populations reside who have a lower ability to prepare for, respond to, and recover from disaster events can help decision makers distribute scarce resources before, during, or after disasters. Population density was derived from the HUD LMISD at the block group level. Each of the three components of vulnerability used here are summarized below.

Critical Infrastructure

Critical infrastructure assets (Table 100) across Puerto Rico were assessed using FEMA's Lifeline⁴⁸ with the understanding that

- Lifelines enable the continuous operation of critical government and business functions and is essential to human health and safety or economic security.
- Lifelines are the most fundamental services in the community that, when stabilized, enable all other aspects of society to function.
- FEMA has developed a construct for objectives-based response that prioritizes the rapid stabilization of Community Lifelines after a disaster.
- The integrated network of assets, services, and capabilities that provide lifeline services are used day-to-day to support the recurring needs of the community and enable all other aspects of society to function.

⁴⁵ <https://www.fema.gov/lifelines>

⁴⁶ <https://onlinelibrary.wiley.com/doi/abs/10.1111/1540-6237.8402002>

⁴⁷ www.vulnerabilitymap.org

⁴⁸ <https://www.fema.gov/lifelines>

- When disrupted, decisive intervention (e.g., rapid re-establishment or employment of contingency response solutions) is required to stabilize the incident.

Table 100: Critical Infrastructure Included in Puerto Rico’s Hazard Risk Assessment

| Critical Infrastructure Asset | Data Source | URL | Date Accessed |
|---|---|---|---------------|
| Water/Wastewater Lines | PRASA | | 2/25/2020 |
| Water/Wastewater Facilities | PRASA | | 2/25/2020 |
| Power Plants | Homeland Infrastructure Foundation-Level Data (HIFLD) | https://hifld-geoplatform.opendata.arcgis.com/ | 4/16/2020 |
| Electric Power Transmission Lines | Homeland Infrastructure Foundation-Level Data (HIFLD) | https://hifld-geoplatform.opendata.arcgis.com/ | 4/16/2020 |
| PR Roads | United State Census Bureau | https://www.census.gov/cgi-bin/geo/shapefiles/index.php | 4/16/2020 |
| Major Ports | Homeland Infrastructure Foundation-Level Data (HIFLD) | https://hifld-geoplatform.opendata.arcgis.com/ | 4/19/2020 |
| Ports | Homeland Infrastructure Foundation-Level Data (HIFLD) | https://hifld-geoplatform.opendata.arcgis.com/ | 4/19/2020 |
| Airports | Homeland Infrastructure Foundation-Level Data (HIFLD) | https://hifld-geoplatform.opendata.arcgis.com/ | 4/19/2020 |
| Broadband Radio and Educational Broadband Radio | Homeland Infrastructure Foundation-Level Data (HIFLD) | https://hifld-geoplatform.opendata.arcgis.com/ | 4/22/2020 |
| FM Radio Towers | Homeland Infrastructure Foundation-Level Data (HIFLD) | https://hifld-geoplatform.opendata.arcgis.com/ | 4/22/2020 |
| Land Mobile Radio Stations | Homeland Infrastructure Foundation-Level Data (HIFLD) | https://hifld-geoplatform.opendata.arcgis.com/ | 4/22/2020 |
| AM Radio Transmitters | Homeland Infrastructure Foundation-Level Data (HIFLD) | https://hifld-geoplatform.opendata.arcgis.com/ | 4/22/2020 |
| Cellular Radio Towers | Homeland Infrastructure Foundation-Level Data (HIFLD) | https://hifld-geoplatform.opendata.arcgis.com/ | 4/22/2020 |
| Microwave Radio Transmitters | Homeland Infrastructure Foundation-Level Data (HIFLD) | https://hifld-geoplatform.opendata.arcgis.com/ | 4/22/2020 |

Critical Infrastructure Density

Critical infrastructure locations are captured and mapped using either point features (individual locations) or line features (sets of point features) depending on the infrastructure asset. For example, electric generation facilities would be represented by a point while electrical transmission lines would be represented as line features inside a GIS system. For this assessment, line feature classes representing critical infrastructure were converted to point feature classes using the ESRI ArcGIS Pro Generate Points Along Lines tool generating a point at each end point and every 200 meters along the line feature. Critical infrastructure point data and point data generated from the line features was then merged to create one complete point feature representation of critical infrastructure. This point data was then geoprocessed with the ESRI ArcGIS Pro Summarize Within tool to generate a count of points within each .5-mile hex grid. Critical infrastructure counts were then classified using an equal interval classifications scheme and mapped using the same output hex grid as the hazard threat maps (Figure 32).

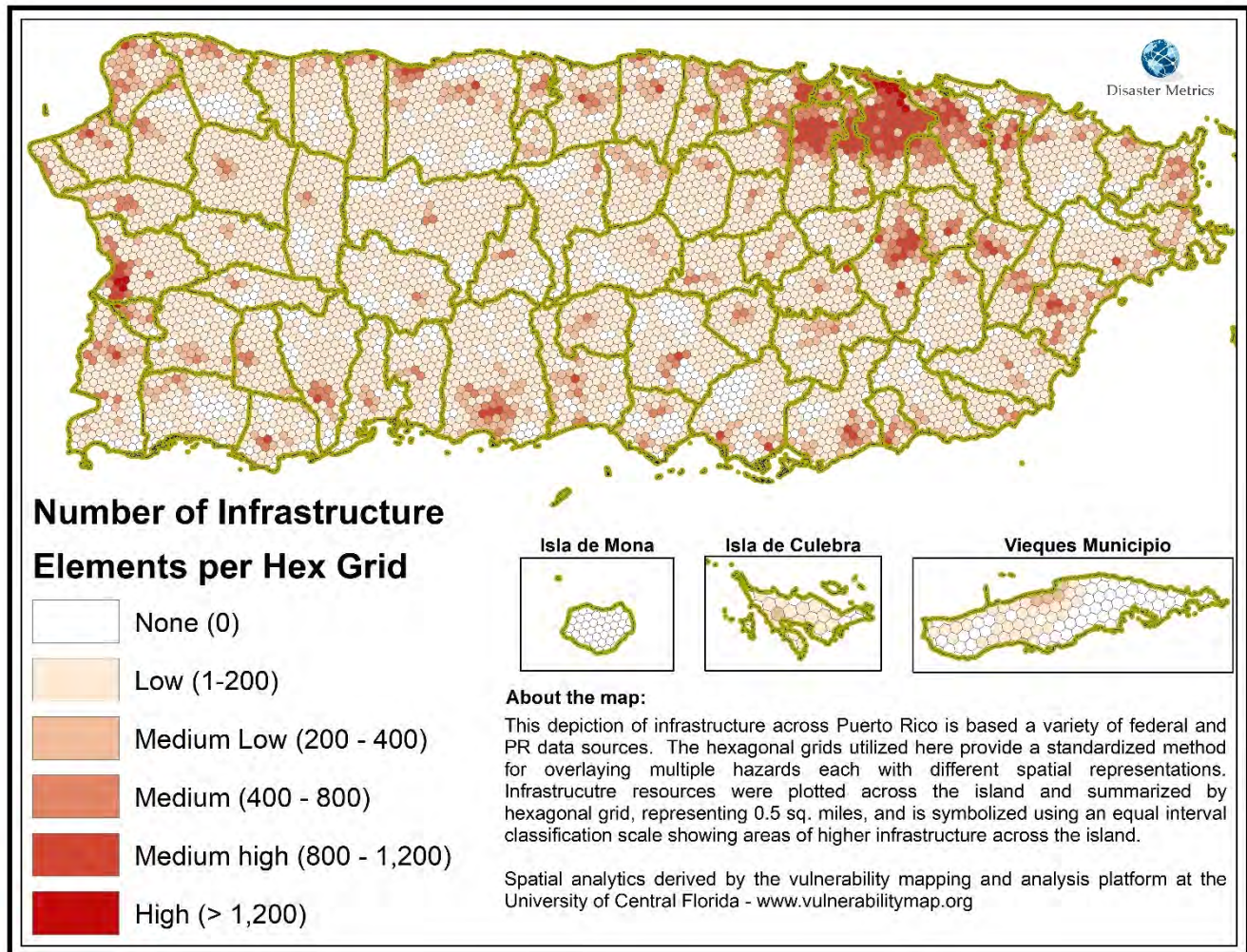


Figure 32: Puerto Rico's Critical Infrastructure Elements gathered using FEMA's lifeline guidance.

Social Vulnerability

Social vulnerability, a concept focused on understanding an area's capacity to prepare for, respond to, and rebound from disaster events⁴⁹, has a long conceptual and theoretical history in social and disaster science fields.⁵⁰ Socially vulnerable populations have fewer resources to aid in preparation for disasters, often bear the brunt of disaster impacts, and take longer to bounce back from disaster events. Empirical measures of social vulnerability enable decision makers and emergency managers to understand where vulnerable populations reside and how that vulnerability is manifest across a landscape. Here, 29 indicators of social vulnerability, collected from www.vulnerabilitymap.org, were used to create a SoVI for Puerto Rico. SoVI scores were categorized from (0 – no data to 5 – high social vulnerability) using a standard deviation classification scheme (Figure 33).

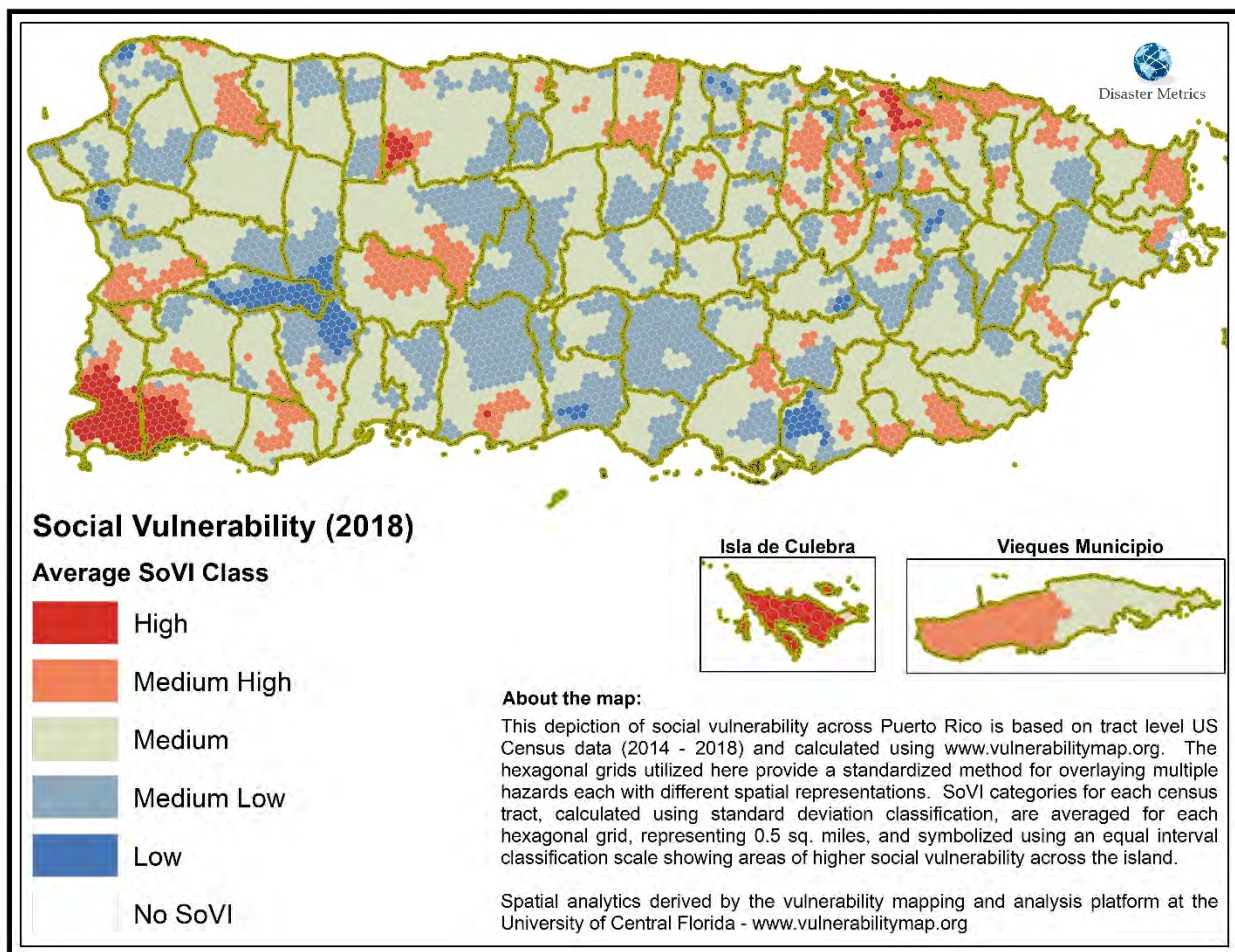


Figure 33: Puerto Rico's Social Vulnerability Index⁵¹

⁴⁹ <https://doi.org/10.1177/0002716205285515>

⁵⁰ <https://unu.edu/publications/books/measuring-vulnerability-to-natural-hazards-towards-disaster-resilient-societies-second-edition.html#overview>

⁵¹ Created from www.vulnerabilitymap.org

Population Density

Population data collected from the American Community Survey products developed for HUD's LMI block group dataset the block group level.⁵² This population data was geo-processed with the ESRI ArcGIS Pro Create Random Points tool to randomly distribute population (Low- Moderate Universe). Like critical infrastructure, this population data was geo-processed with the ESRI ArcGIS Pro Summarize Within tool to generate a count of points within each .5-mile hex grid. Population per hex grid was classified on a quasi-exponential classification scale showing areas with higher populations across Puerto Rico (Figure 34).

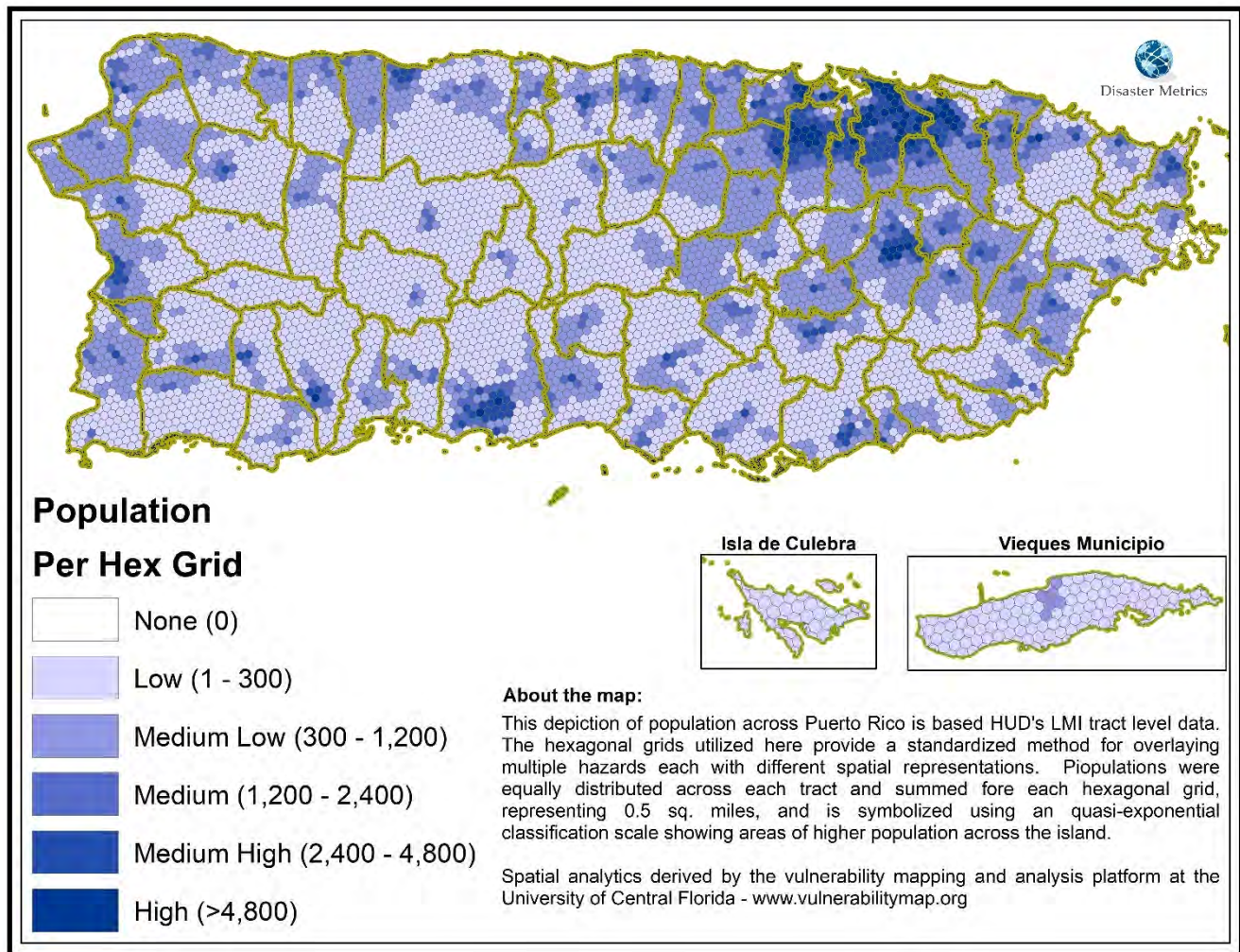


Figure 34: Puerto Rico's Population Distribution

⁵² <https://www.hudexchange.info/programs/acs-low-mod-summary-data/acs-low-mod-summary-data-block-groups-places/>

Each vulnerability variable (Critical Infrastructure Density, Social Vulnerability, and Population Density) was classified from zero (0) to five (5). The variables were then summed and divided by three (3) to develop a composite vulnerability score from zero (0) to five (5) (Equation 1 and Figure 35).

Equation 1: Vulnerability Calculation

$$VUL = \frac{(SoVI) + (INF) + (POP)}{3}$$

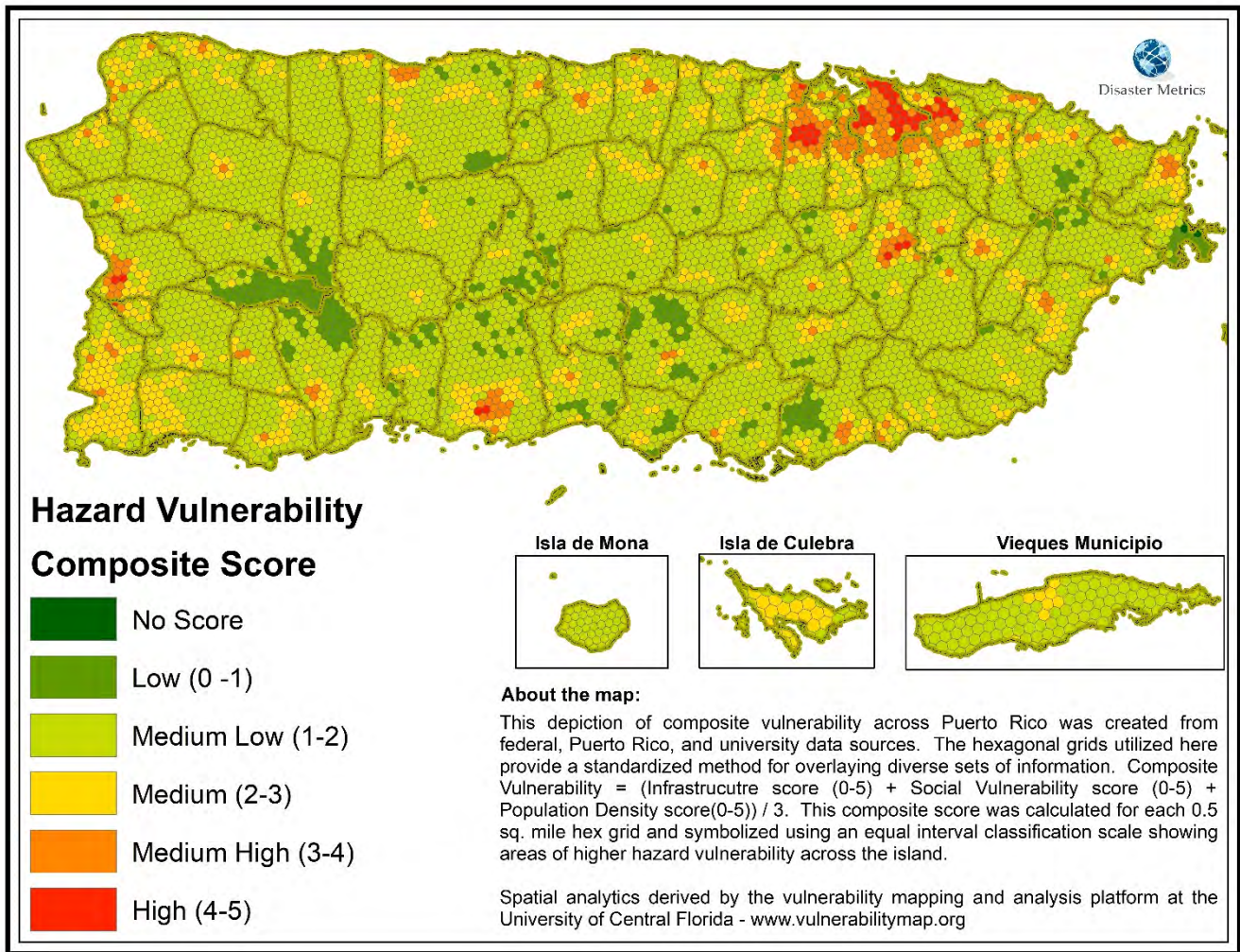


Figure 35: Puerto Rico's Composite Hazard Vulnerability

Severity of Consequences

Each single hazard event and event type (flooding, hurricane, etc.) has a different severity of consequence. Creating a universal understanding of hazard risk for Puerto Rico required creation of a robust accounting of consequences accounting for historical losses and also forward looking and able to reflect possible climate sensitivities, current high priority hazards, and those likely to cause continued losses if not mitigated. For this assessment, Severity of Consequences is calculated (Equation 2) using equal parts Historical Consequence, Climate Sensitivity, a measure of probability vs consequence, and a measure of future impacts (or high priority hazards for Puerto Rico) derived from Puerto Rico’s current Hazard Mitigation Plan.⁵³

Equation 2: Severity of Consequences Calculation

$$\begin{aligned} CON_{HAZ_n} = & (HISTORIC\ CONSEQUENCE) \\ & + (CLIMATE\ SENSITIVE) \\ & + (PROBABILITY\ CONSEQUENCE) \\ & + (FUTURE\ CONSEQUENCE) \end{aligned}$$

HAZ= Flood, Earthquake, Landslide, Category-1 Storm Surge, Category-2 Storm Surge, Category-3 Storm Surge, Category-4 Storm Surge, Category-5 Storm Surge, Severe Storm, Tsunami, Drought, Wind, Fog, Hail, High Temperature, Lightning, Tornado, Wildfire, Sea Level Rise 1-foot, Sea Level Rise 4-foot, Sea Level Rise 10-foot, Liquefaction, Human Hazard, Hurricane Force Wind;

Historic Consequence

Hazard consequence is the sum of historical frequency, economic impacts, fatalities, and injuries from past disaster events.

Equation 3: Historical Consequence Calculation

$$\begin{aligned} HAZCON_{HAZ_n} = & \textit{Historical Frequency Score} \\ & + \textit{Historical Economic Impacts Score} \\ & + \textit{Historical Fatality Score} \\ & + \textit{Historical Injury Score} \end{aligned}$$

Where:

⁵³ Puerto Rico Hazard Mitigation Plan - <https://recovery.pr/en/document-library>

Historical Frequency Score - a Min/Max standardized (0-1) indicator of recorded⁵⁴ frequency of occurrence for past loss causing Hazard (*HAZ*) events.

Historical Economic Impacts Score - a Min/Max standardized (0-1) indicator of recorded damages from past loss causing Hazard (*HAZ*) events.

Historical Fatality Score - a Min/Max standardized (0-1) indicator of recorded fatalities from past loss causing Hazard (*HAZ*) events.

Historical Injury Score (Table 101) - a Min/Max standardized (0-1) indicator of recorded injuries from past loss causing Hazard (*HAZ*) events.

Table 101: Historical Consequence Scores by Hazard

| Hazard | Historical Frequency Score (0-1) | Historical Consequence Score (0-1) | Historical Fatality Score (0-1) | Historical Injury Score (0-1) | Sum of Historical Scores (0-4) |
|-----------------------------|----------------------------------|------------------------------------|---------------------------------|-------------------------------|--------------------------------|
| Flood | 0.502331 | 1 | 1 | 0.093023 | 2.297677 |
| Coastal Flood and SLR | 0.023103 | 0.000276 | 0.314286 | 0.395349 | 0.523787 |
| Hurricane (Surge and wind) | 0.02925 | 0.174968 | 0.057143 | 0.023256 | 0.258363 |
| Earthquake and Liquefaction | 0.002755 | 0.149326 | 0 | 0 | 0.150704 |
| Landslide | 0.072064 | 0.000311 | 0.042857 | 0.093023 | 0.125712 |
| Drought | 0.004875 | 0.000326 | 0 | 0 | 0.002764 |
| Tsunami | 0 | 0 | 0 | 0 | 0 |
| Human Hazards | 0.091988 | 0.00298 | 0.314286 | 1 | 0.86326 |
| Wildfire | 0.009326 | 0.000547 | 0 | 0 | 0.00521 |
| Severe Storm | 0.204324 | 0.001342 | 0.185714 | 0.511628 | 0.545032 |
| Fog | 1 | 0 | 0.028571 | 0 | 0.528571 |
| Lightning | 0.005935 | 2.66E-05 | 0.085714 | 0.139535 | 0.158476 |
| Tornado | 0.028826 | 8.72E-05 | 0 | 0 | 0.0145 |
| Wind | 0.008266 | 2.26E-05 | 0 | 0.046512 | 0.027412 |
| Hail | 0.013141 | 2.71E-05 | 0 | 0.023256 | 0.018226 |
| Heat | 0.017804 | 0 | 0 | 0 | 0.008902 |

⁵⁴ <https://www.ncdc.noaa.gov/stormevents/>

Climate Sensitivity

Each hazard was classified (0 or 1) on its climate sensitivity, or its connection to current and future weather. If a hazard’s root cause is meteorological (floods, hurricanes, heat, hail, etc.) it is climate sensitive and scored with a one (1). If a hazard is geophysical (earthquake, tsunami, etc.) is not climate sensitive and is scored with a zero (0).

Probability/Consequence

Generally, hazards fall into two specific types in terms of probability and consequence. Low probability/high consequence disasters (Earthquake, tsunami) have a generally low frequency of occurrence with a much higher consequence when they do occur. Conversely, high probability/low consequence events occur more frequently but cause less damage and impact on society when they do. Each hazard event type was appraised on its probability/consequence and scored between (Low - .05 and High – 1).

Future Consequence

Each hazard included in the assessment has either impacted Puerto Rico in the past or has the potential to cause future impacts. Future consequence scores each hazard on its potential to be an impactful hazard in the future. Future consequence scores range from (Low - .05 and High – 1) and are derived from review of Puerto Rico’s Hazard Mitigation Plan⁵⁵. Hazards identified as “high priority” in the plan were scored high future consequence and hazards not in the plan (heat, tornado, severe storm, etc.) were scored lower on future consequence (.05 or .1).

Resulting Severity of Consequences (SOC) score

Applying (Equation 2) to historical consequences, climate sensitivity, probability/consequence, and future consequences results in a standardized value for severity of consequences (SOC) for each hazard analyzed in this assessment. In this case, flooding hazard poses the highest risk and heat hazard poses the lowest risk across Puerto Rico (Table 102).

Table 102: Severity of Consequence Scores by Hazard

| Hazard | Sum of Historical Scores (0-4) | Climate Sensitive (0-1) | Probability / Consequence (0-1) | Future Consequence (0-1) | Composite SOC Score (0-7) | Standardized SOC Score (0-1) | Rank | Severity of Consequences Score (0 – 5) |
|-----------------------|--------------------------------|-------------------------|---------------------------------|--------------------------|---------------------------|------------------------------|------|--|
| Flood | 2.298 | 1.000 | 0.500 | 1.000 | 4.798 | 1.000 | 1 | 5.000 |
| Coastal Flood and SLR | 0.524 | 1.000 | 0.500 | 1.000 | 3.024 | 0.506 | 2 | 2.529 |

⁵⁵ Puerto Rico Hazard Mitigation Plan - <https://recovery.pr/en/document-library>

| | | | | | | | | |
|--------------------------------|-------|-------|-------|-------|-------|-------|----|-------|
| Hurricane Storm Surge and Wind | 0.258 | 1.000 | 0.750 | 1.000 | 3.008 | 0.501 | 3 | 2.507 |
| Earthquake and Liquefaction | 0.151 | 0.000 | 1.000 | 1.000 | 2.151 | 0.262 | 4 | 1.312 |
| Landslide | 0.126 | 1.000 | 0.500 | 0.500 | 2.126 | 0.255 | 5 | 1.277 |
| Drought | 0.003 | 1.000 | 0.500 | 0.500 | 2.003 | 0.221 | 6 | 1.106 |
| Tsunami | 0.000 | 0.000 | 1.000 | 1.000 | 2.000 | 0.220 | 7 | 1.102 |
| Human Hazards | 0.863 | 0.000 | 0.500 | 0.500 | 1.863 | 0.182 | 8 | 0.912 |
| Wildfire | 0.005 | 1.000 | 0.250 | 0.500 | 1.755 | 0.152 | 9 | 0.761 |
| Severe Storm | 0.545 | 1.000 | 0.100 | 0.100 | 1.745 | 0.149 | 10 | 0.747 |
| Fog | 0.529 | 1.000 | 0.100 | 0.100 | 1.729 | 0.145 | 11 | 0.724 |
| Lightning | 0.158 | 1.000 | 0.250 | 0.100 | 1.508 | 0.083 | 12 | 0.417 |
| Tornado | 0.015 | 1.000 | 0.250 | 0.100 | 1.365 | 0.043 | 13 | 0.217 |
| Wind | 0.027 | 1.000 | 0.100 | 0.100 | 1.227 | 0.005 | 14 | 0.026 |
| Hail | 0.018 | 1.000 | 0.100 | 0.100 | 1.218 | 0.003 | 15 | 0.013 |
| Heat | 0.009 | 1.000 | 0.100 | 0.100 | 1.209 | 0.000 | 16 | 0.001 |

Risk

The risk from hazard for each ½ mile hex grid was derived from the product of Vulnerability, Hazard, and Severity of Consequence (Equation 4).

Equation 4: Hazard Risk Calculation

$$RISK_{HAZ_n} = (VUL)(HAZ_n)(CON_{HAZ_n})$$

Risk scores for each hazard were created using this method and the most risky hazards (by hex grid) were mapped to identify trends in risk across Puerto Rico (Figure 36).

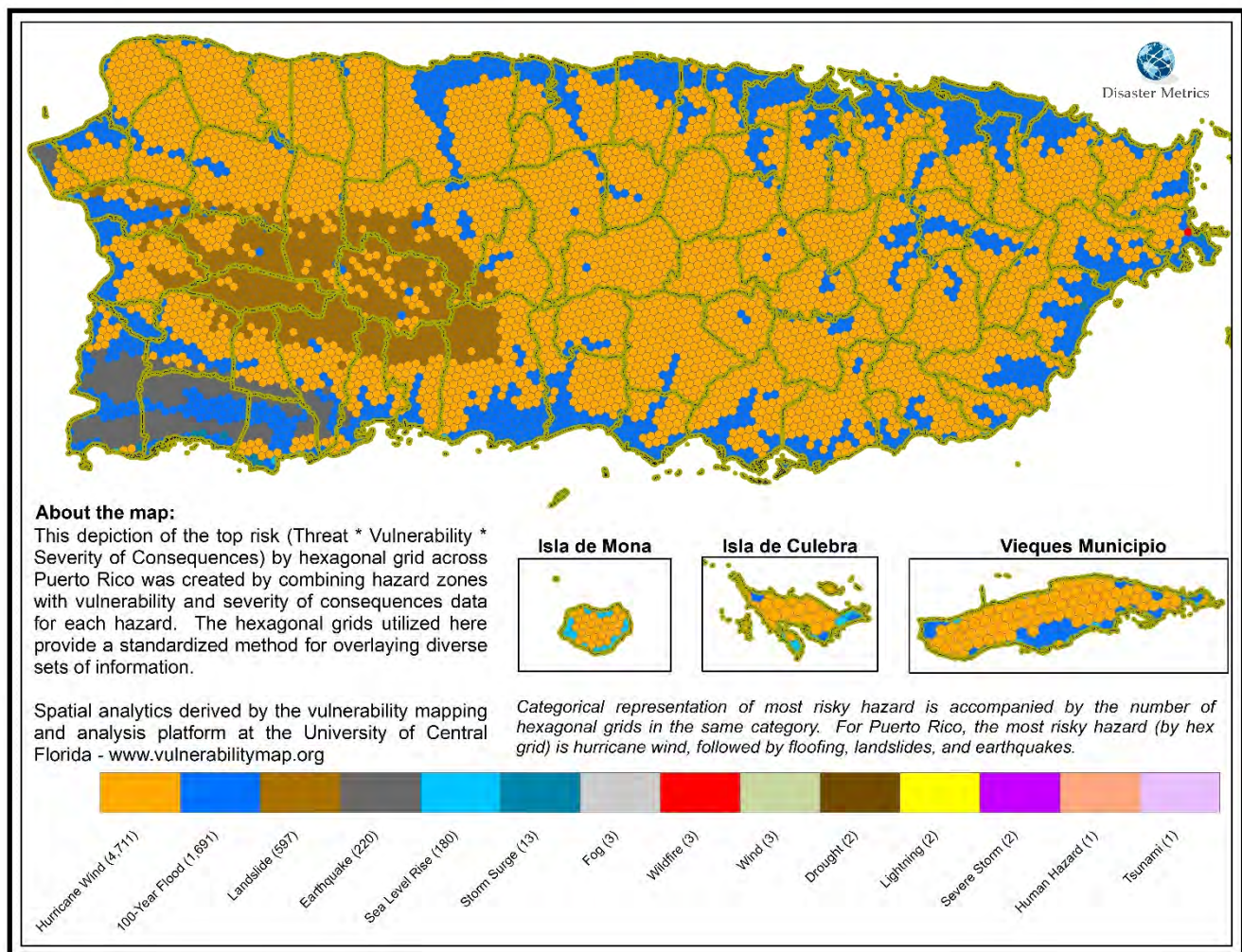


Figure 36: Puerto Rico's Highest Risk Hazards by Hexagonal Grid

Aggregate risk was determined by the sum of risk for each hazard per ½ mile hex grid (Equation 5). Figure 37 shows the aggregate risk in Puerto Rico at the hex grid level.

Equation 5: Total Risk Calculation

$$SUM\ RISK = \sum_{n=1}^{24} RISK_{HAZ_n}$$

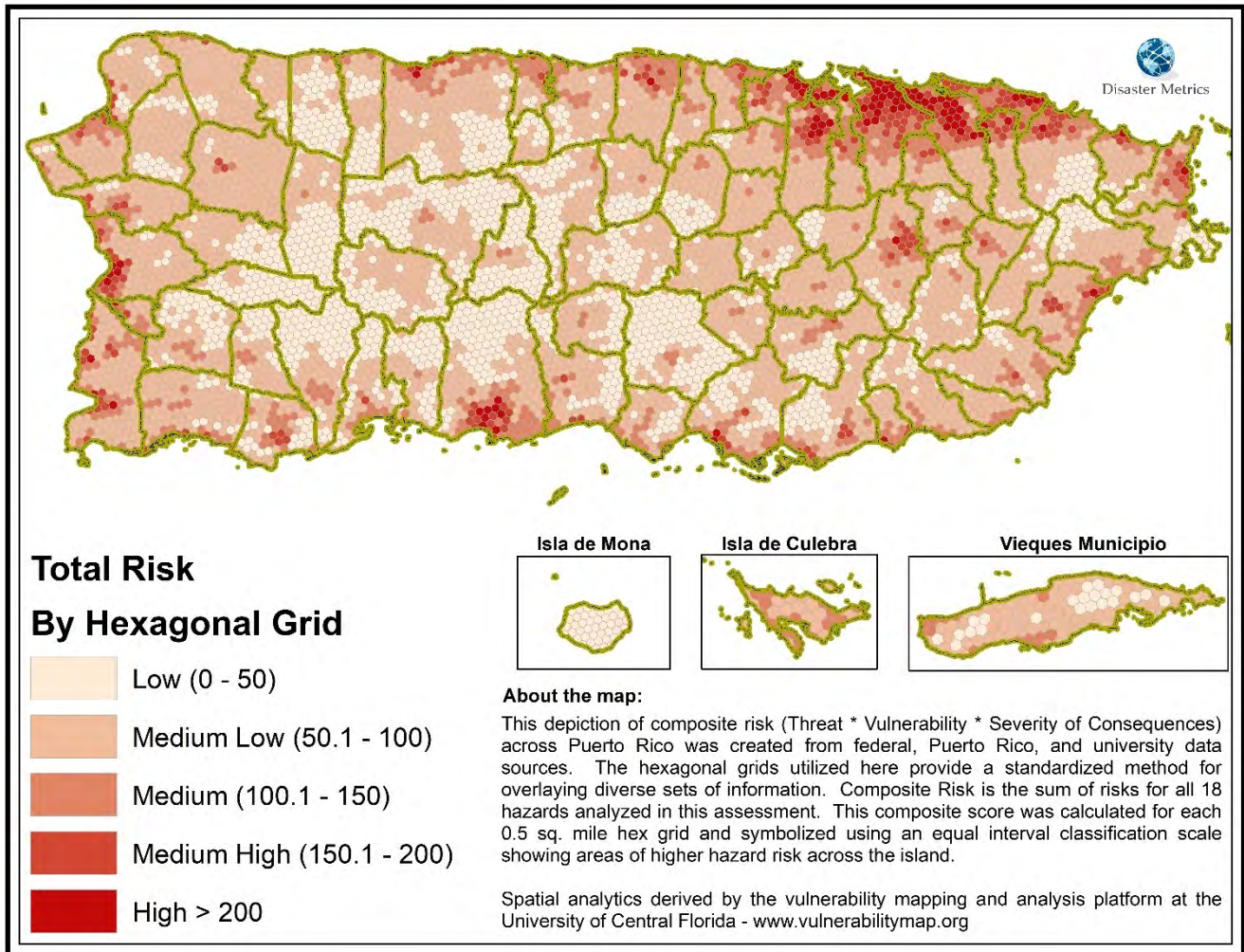


Figure 37: Puerto Rico's Aggregate Risk

Hazards were ranked based on risk at the hex grid level and also at the municipio level. To rank hazards based on risk at the Municipio level, ESRI ArcGIS Pro was used to perform a union between GIS layers of Puerto Rico Municipios and a hex grid with the calculated risk described above and noted in Equation 6. The sum of total risk per hazard per municipio (Figure 38).

Equation 6: Aggregate Hazard Risk Per Municipio Calculation

$$AGGREGATE\ RISK\ PER\ MUNICIPIO = SUM\ RISK$$

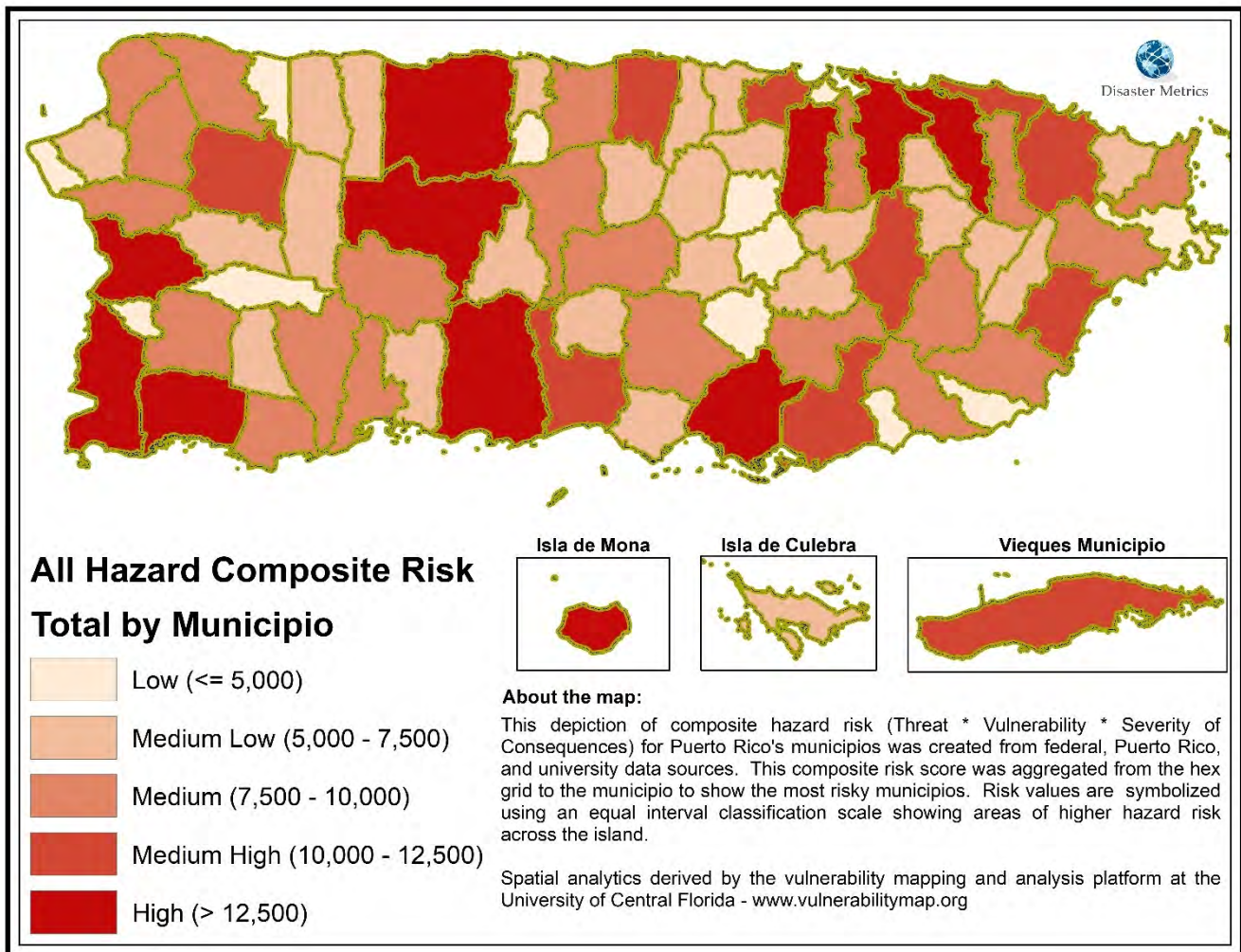


Figure 38: Puerto Rico's Total Risk by Municipio

Total risk was then normalized based on total area of each municipio to provide an area weighted perspective of risks using Equation 7. Figure 39 displays the area weighted risks for each municipio across Puerto Rico.

Equation 7: Hazard Risk Per Municipio Calculation

$$RISK\ PER\ MUNICIPIO = \frac{SUM\ RISK}{AREA\ OF\ MUNICIPIO}$$

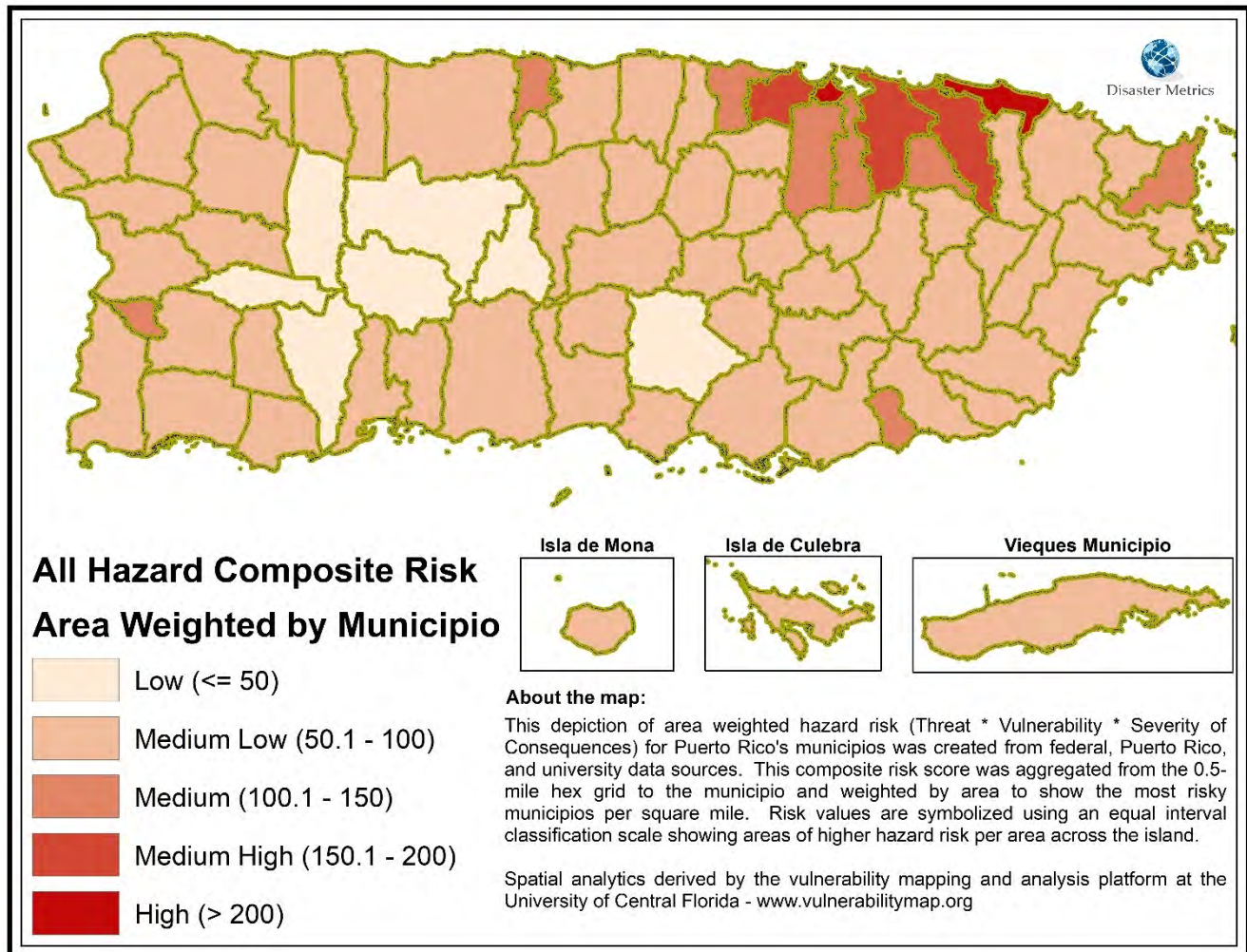


Figure 39: Puerto Rico's Area Weighted Risk by Municipio

Finally, top hazard risks per municipio were selected from the aggregated hazard risk data for each municipio. Mapping the top 2 hazard risks provides a unique perspective into the variety of hazards impacting Puerto Rico (Figure 40) and the more robust list of top 5 hazards per municipio identifies several priority hazards for Puerto Rico in terms of overall risks (Table 103).

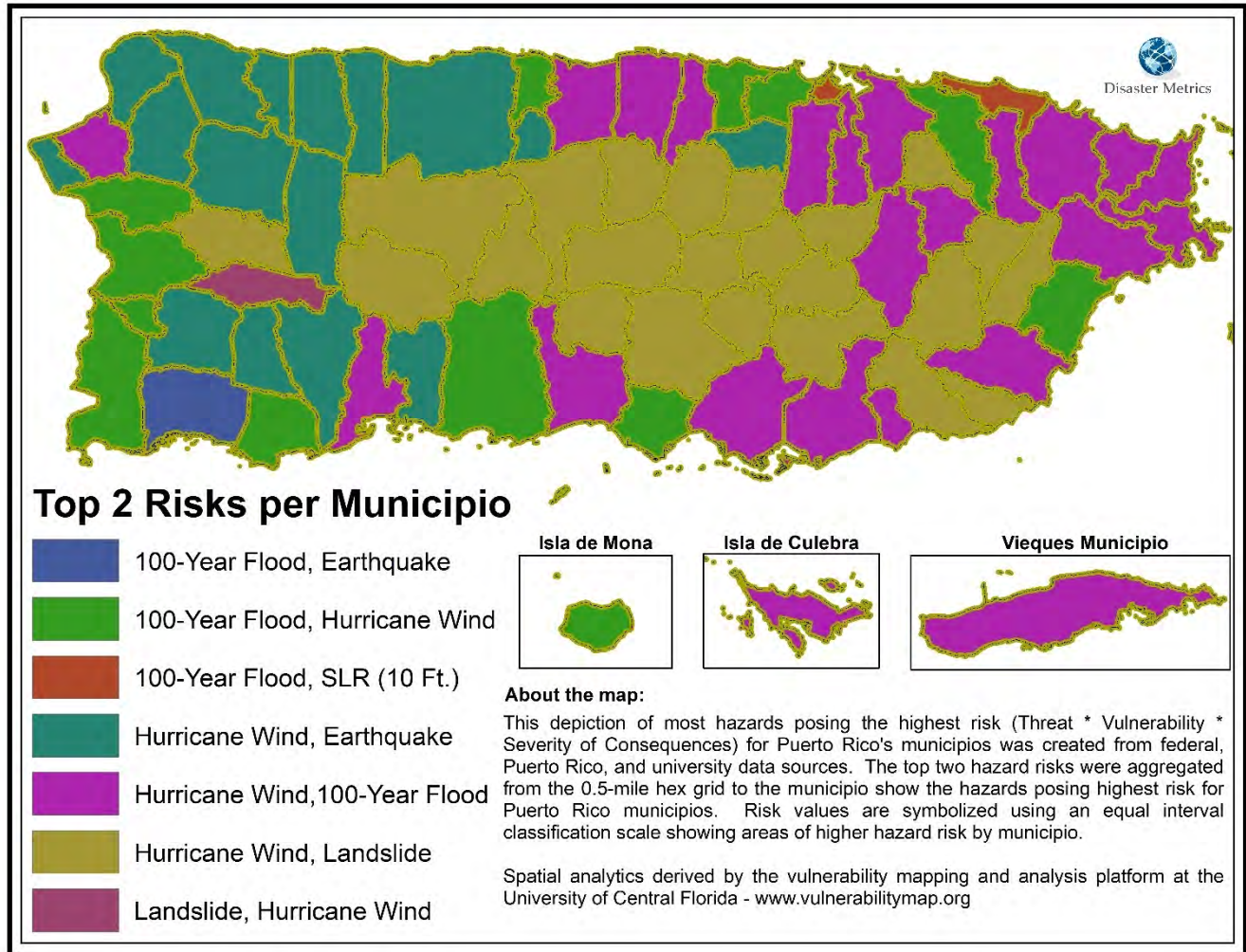


Figure 40: Puerto Rico's Top 2 Hazard Risks by Municipio

Table 103: Top 5 Hazard Risk by Municipio

| Municipio | Top Risk | 2nd Highest Risk | 3rd Highest Risk | 4th Highest Risk | 5th Highest Risk |
|--------------|-------------------|-------------------|-------------------|-------------------|-------------------|
| Adjuntas | Hurricane Wind | Landslide | Earthquake | 100-Year Flooding | Lightning |
| Aguada | Hurricane Wind | 100-Year Flooding | Earthquake | Landslide | Liquefaction |
| Aguadilla | Hurricane Wind | Earthquake | 100-Year Flooding | Landslide | Liquefaction |
| Aguas Buenas | Hurricane Wind | Landslide | Earthquake | Drought | Severe Storm |
| Aibonito | Hurricane Wind | Landslide | Drought | Earthquake | 100-Year Flooding |
| Anasco | 100-Year Flooding | Hurricane Wind | Earthquake | Landslide | Severe Storm |
| Arecibo | Hurricane Wind | Earthquake | 100-Year Flooding | Landslide | Liquefaction |

| Municipio | Top Risk | 2nd Highest Risk | 3rd Highest Risk | 4th Highest Risk | 5th Highest Risk |
|--------------|-------------------|-------------------|------------------|------------------|------------------------|
| Arroyo | Hurricane Wind | 100-Year Flooding | Landslide | Earthquake | Drought |
| Barceloneta | 100-Year Flooding | Hurricane Wind | Earthquake | SLR (10 Feet) | Liquefaction |
| Barranquitas | Hurricane Wind | Landslide | Earthquake | Drought | Wildfire |
| Bayamon | Hurricane Wind | 100-Year Flooding | Earthquake | Landslide | Liquefaction |
| Cabo Rojo | 100-Year Flooding | Hurricane Wind | Earthquake | Liquefaction | SLR (10 Feet) |
| Caguas | Hurricane Wind | 100-Year Flooding | Landslide | Earthquake | Drought |
| Camuy | Hurricane Wind | Earthquake | Landslide | Liquefaction | 100-Year Flooding |
| Canovanas | Hurricane Wind | 100-Year Flooding | Landslide | Earthquake | Severe Storm |
| Carolina | 100-Year Flooding | Hurricane Wind | Earthquake | Landslide | SLR (10 Feet) |
| Catano | 100-Year Flooding | SLR (10 Feet) | Hurricane Wind | Earthquake | Category 5 Storm Surge |
| Cayey | Hurricane Wind | Landslide | Drought | Earthquake | 100-Year Flooding |
| Ceiba | Hurricane Wind | 100-Year Flooding | Landslide | Earthquake | Fog |
| Ciales | Hurricane Wind | Landslide | Earthquake | Severe Storm | 100-Year Flooding |
| Cidra | Hurricane Wind | Landslide | Drought | Earthquake | 100-Year Flooding |
| Coamo | Hurricane Wind | Landslide | Earthquake | Drought | 100-Year Flooding |
| Comerio | Hurricane Wind | Landslide | Drought | Earthquake | Liquefaction |
| Corozal | Hurricane Wind | Landslide | Earthquake | Drought | Severe Storm |
| Culebra | Hurricane Wind | 100-Year Flooding | SLR (10 Feet) | Earthquake | Category 5 Storm Surge |
| Dorado | 100-Year Flooding | Hurricane Wind | Earthquake | Liquefaction | SLR (10 Feet) |
| Fajardo | Hurricane Wind | 100-Year Flooding | Earthquake | Landslide | SLR (10 Feet) |
| Florida | Hurricane Wind | Earthquake | Landslide | Liquefaction | Wildfire |
| Guanica | 100-Year Flooding | Hurricane Wind | Earthquake | SLR (10 Feet) | Landslide |
| Guayama | Hurricane Wind | 100-Year Flooding | Drought | Landslide | Earthquake |

| Municipio | Top Risk | 2nd Highest Risk | 3rd Highest Risk | 4th Highest Risk | 5th Highest Risk |
|-------------|-------------------|-------------------|-------------------|------------------------|-------------------|
| Guayanilla | Hurricane Wind | 100-Year Flooding | Earthquake | Landslide | Drought |
| Guaynabo | Hurricane Wind | 100-Year Flooding | Landslide | Earthquake | Human Hazard |
| Gurabo | Hurricane Wind | 100-Year Flooding | Landslide | Earthquake | Drought |
| Hatillo | Hurricane Wind | Earthquake | Landslide | Liquefaction | 100-Year Flooding |
| Hormigueros | 100-Year Flooding | Hurricane Wind | Earthquake | Liquefaction | Landslide |
| Humacao | 100-Year Flooding | Hurricane Wind | Landslide | Earthquake | Drought |
| Isabela | Hurricane Wind | Earthquake | Landslide | 100-Year Flooding | Liquefaction |
| Jayuya | Hurricane Wind | Landslide | Earthquake | Severe Storm | Liquefaction |
| Juana Diaz | Hurricane Wind | 100-Year Flooding | Earthquake | Landslide | Drought |
| Juncos | Hurricane Wind | Landslide | 100-Year Flooding | Earthquake | Drought |
| Lajas | 100-Year Flooding | Earthquake | Hurricane Wind | Landslide | Liquefaction |
| Lares | Hurricane Wind | Earthquake | Landslide | Lightning | Severe Storm |
| Las Marias | Hurricane Wind | Landslide | Earthquake | Severe Storm | Lightning |
| Las Piedras | Hurricane Wind | Landslide | Earthquake | Drought | Severe Storm |
| Loiza | 100-Year Flooding | SLR (10 Feet) | Hurricane Wind | Category 5 Storm Surge | Liquefaction |
| Luquillo | Hurricane Wind | 100-Year Flooding | Landslide | Earthquake | Liquefaction |
| Manati | Hurricane Wind | 100-Year Flooding | Earthquake | Landslide | Liquefaction |
| Maricao | Landslide | Hurricane Wind | Earthquake | Severe Storm | Lightning |
| Maunabo | Hurricane Wind | Landslide | 100-Year Flooding | Earthquake | Drought |
| Mayaguez | 100-Year Flooding | Hurricane Wind | Earthquake | Landslide | SLR (10 Feet) |
| Moca | Hurricane Wind | Earthquake | Landslide | Severe Storm | Liquefaction |
| Morovis | Hurricane Wind | Landslide | Earthquake | Severe Storm | Liquefaction |
| Naguabo | Hurricane Wind | 100-Year Flooding | Landslide | Earthquake | Liquefaction |

| Municipio | Top Risk | 2nd Highest Risk | 3rd Highest Risk | 4th Highest Risk | 5th Highest Risk |
|---------------|-------------------|-------------------|-------------------|-------------------|------------------------|
| Naranjito | Hurricane Wind | Landslide | Earthquake | Drought | 100-Year Flooding |
| Orocovis | Hurricane Wind | Landslide | Earthquake | Drought | Severe Storm |
| Patillas | Hurricane Wind | Landslide | 100-Year Flooding | Earthquake | Drought |
| Penuelas | Hurricane Wind | Earthquake | 100-Year Flooding | Landslide | Drought |
| Ponce | 100-Year Flooding | Hurricane Wind | Earthquake | Landslide | Drought |
| Quebradillas | Hurricane Wind | Earthquake | Landslide | 100-Year Flooding | Liquefaction |
| Rincon | Hurricane Wind | Earthquake | Landslide | 100-Year Flooding | SLR (10 Feet) |
| Rio Grande | Hurricane Wind | 100-Year Flooding | Landslide | Earthquake | SLR (10 Feet) |
| Sabana Grande | Hurricane Wind | Earthquake | Landslide | Wildfire | Liquefaction |
| Salinas | Hurricane Wind | 100-Year Flooding | Drought | Earthquake | Landslide |
| San German | Hurricane Wind | Earthquake | 100-Year Flooding | Landslide | Liquefaction |
| San Juan | Hurricane Wind | 100-Year Flooding | Human Hazard | Earthquake | Landslide |
| San Lorenzo | Hurricane Wind | Landslide | Earthquake | Drought | Severe Storm |
| San Sebastian | Hurricane Wind | Earthquake | Landslide | Severe Storm | 100-Year Flooding |
| Santa Isabel | 100-Year Flooding | Hurricane Wind | Earthquake | Drought | SLR (10 Feet) |
| Toa Alta | Hurricane Wind | Earthquake | Landslide | 100-Year Flooding | Liquefaction |
| Toa Baja | 100-Year Flooding | Hurricane Wind | SLR (10 Feet) | Earthquake | Liquefaction |
| Trujillo Alto | Hurricane Wind | Landslide | Earthquake | 100-Year Flooding | Drought |
| Utua | Hurricane Wind | Landslide | Earthquake | 100-Year Flooding | Lightning |
| Vega Alta | Hurricane Wind | 100-Year Flooding | Earthquake | Landslide | Liquefaction |
| Vega Baja | Hurricane Wind | 100-Year Flooding | Earthquake | Landslide | Liquefaction |
| Vieques | Hurricane Wind | 100-Year Flooding | SLR (10 Feet) | Earthquake | Category 5 Storm Surge |
| Villalba | Hurricane Wind | Landslide | Earthquake | 100-Year Flooding | Severe Storm |

| Municipio | Top Risk | 2nd Highest Risk | 3rd Highest Risk | 4th Highest Risk | 5th Highest Risk |
|------------------|-----------------|-------------------------|-------------------------|-------------------------|-------------------------|
| Yabucoa | Hurricane Wind | 100-Year Flooding | Landslide | Earthquake | Drought |
| Yauco | Hurricane Wind | Earthquake | Landslide | 100-Year Flooding | Drought |