Tufts UNIVERSITY

The Forgotten Isles

A Risk Assessment of the United States' Island Territories, 2008-2020

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Class: DHP-P207-01 GIS for Int'l Applications

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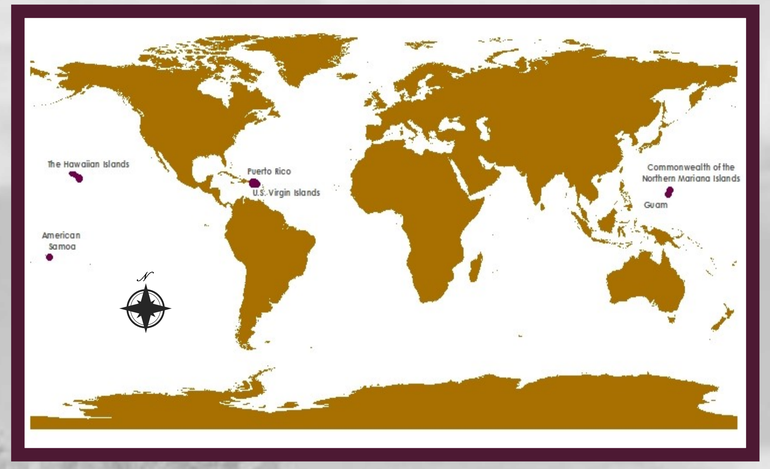
Projections: American Samoa 1962 StatePlane Amer. Samoa FIPS 5300 (US Feet); Guam 1963 Yap Islands; Old Hawaiian UTM Zone 4N; Puerto Rico StatePlane Puerto Rico FIPS 5201 (US Feet)

BACKGROUND

There are five populated island territories within the domain of the United States' political borders; American Samoa, the Commonwealth of the Northern Mariana Islands, Guam, Puerto Rico, and the U.S. Virgin Islands. While maintaining the status of citizenship (other than American Samoans who are considered "United States Nationals"), these territories receive considerably less attention than those in statehood. In 2017, Hurricane Maria devastated Puerto Rico and highlighted the logistical and bureaucratic challenges territories face in navigating their special status in times of crisis, specifically tropical cyclones, which are the most likely natural disasters to hit these regions. This research sought to conduct an initial assessment on the vulnerability of these territories in comparison to the United States' single island state, Hawaii.

According to the 2017 UN Human Development Index (HDI), Hawaii ranked highest of the six in 10th with 0.940, Guam 42nd with 0.901, the U.S. Virgin Islands 45th with 0.894, the Northern Mariana Islands 52nd with 0.875, Puerto Rico 55th, the 2nd lowest with 0.845, and American Samoa 56th, the lowest HDI score for the country with 0.827. While these remain high in relation to the global average of 0.728, all five territories fall below the U.S. average of 0.920.[1] These figures show significant disparity between the states that have been incorporated compared to the territories that do not maintain equal access and privileges, including the lack of voting rights in federal elections and limited political representation.



METHODOLOGY

There is a diverse spectrum of indicators in which vulnerability can be calculated, from environmental factors to economic and political trends. Considering the limited availability and scope of territorial data, this research focused on three broad categories of vulnerability; (1) food security, (2) infrastructure access, and (3) natural disaster risk. Individually, these are large in scope and can be studied through a variety of risk indices. For this overview project, only a handful of indices were selected so as to begin what should later be a much more in depth analysis. All calculations and projections were done on a county level by territory using a 1-5 ranking system, 1 representing lowest and 5 representing highest risk relative to that territory.

Food Security – For food security, three risk indices were chosen; population density measured in people per square kilometer, per capita income in dollars, and sales from all agricultural products in dollars. Significantly dense populations can pose a serious risk of straining resource and services access when a crisis occurs while per capita income can help better understand the level of poverty and purchasing power of the local population. Sales from the agriculture sector was added to represent the cultivation capabilities of an island territory. In the circumstance of a crisis such as a tropical cyclone, islands experience heightened vulnerability through their natural isolation and must therefore have some capacity for self-sustenance until supplies can be received. High population density, low per capita income, and low agricultural sales were all considered high risk for this calculation.

Infrastructure – For infrastructure, two risk indices were chosen; distance to the nearest hospital and distance to the U.S. mainland, both measured in kilometers. In a crisis, access to healthcare is critical and further distances to travel over potentially obstructed terrain will largely increase vulnerability. The second index was deemed relevant due to a lesser known law that came to light during Hurricane Maria, the Merchant Marine Act of 1920, also known as "the Jones Act." The law was established to protect the American shipping industry during World War I and requires goods being transported between U.S. ports to be on American ships. Therefore, further distances to hospitals and to the U.S. mainland were both considered high risk for this calculation.

Natural Disasters – For natural disasters, tropical cyclone prevalence was the only vulnerability index selected. Using data from the National Oceanic and Atmospheric Administration, tropical cyclone tracks (based on the Saffir-Simpson scale of Categories 1-5) since 1980 were overlaid onto the six island areas. Buffer zones were then created at 0, 100, and 500-km distances from county borders to calculate cyclone occurrence within a hazardous proximity (hurricane size averages roughly 300 miles/482 km). The recorded tracks were then weighted for their potential destruction capability, 0-km passes multiplied by 0.5, 100 -km passes by 0.3, and 500-km passes by 0.2. More contact with tropical cyclones was considered high risk for this calculation.

Finally, each territory received six scores from 1-5 for all aforementioned indices, for a total possible of 30. Cross-county averages were then calculated and then compared to identify which indices represented the highest and lowest risk within that territory.

TABLE 1: County Average Vulnerability Index Figures Per American Island Territory

Average by Index	*Population Density (2010)*	*Agricultural Sales (2008)*	*Per Capita Income (2010)*	*Distance to Hospital (2019)*	*Cyclones within 500 km Radius (1980—2020)*	*Distance to U.S. Mainland (2020)*
(Units)	*People/sq. km*	*$*	*$*	*km*	*#*	*km*
AMERICAN SAMOA	159.82	$2,762,538.60	$5,529.40	331.13	2.7	7,631.38
NORTHERN MARIANA ISLANDS	115.13	$602,378.25	$7,509.75	116.09	4.3	8,658.74
GUAM	466.01	$215,085.79	$17,770.21	9.03	13.5	8,935.7
HAWAII	46.96	$7,620,600.00	$58,683.00	154.47	3.9	3,877.54
PUERTO RICO	461.82	$6,593,386.13	$10,244.83	28.89	49.45	1,660.75
U.S. VIRGIN ISLANDS	306.38	$690,340.67	$22,690.33	34.72	2.67	1,786.45

RESULTS

The main findings of this research can be found in Figure 1 and Figure 2, which represent the cross-county index average figures and ranks respectively by each of the six island regions. In the top right corner of the projections below, we can see the cumulative average rank sum, with 6 being the least vulnerable and 30 being the most vulnerable. While observing the territories together might help provide a base reference point, we should be careful about reading into the cross-territory comparison, as there are a significant number of extenuating circumstances that might alter the reality of these regions' true vulnerability in a crisis.

Based solely off of HDI figures, it would be expected that territories such as American Samoa and the Northern Mariana Islands would have particularly high vulnerability scores. One explanation for their lower figures may come from the use of low population density as low risk, which can have a limit when that population drops below a threshold suitable to higher productivity and development. On the other hand, with its large population, relatively low per capita income, and especially high susceptibility to tropical cyclones, Puerto Rico met its HDI-based expectations with the highest vulnerability score in the set. As the second furthest territory in the set, Guam also received a relatively high score, with greater risk of cyclones, low sales from agricultural goods, and the largest population density; although it should be noted that Guam was the only island region studied that contained all counties within a single land mass. With the lowest population density, the largest agricultural sales, and highest per capita income in the set, Hawaii's expansive island network appears to be the main reason it did not receive an even lower score.

LIMITATIONS

Calculating vulnerability is a highly complicated and extensive process when done correctly. In attempting to do so, there are a large number of limitations to the conducted research that should be addressed. The following briefly highlight a few key limitations of this particular study. The first, as briefly mentioned, regards the classification of population density. While this study chose to view greater density as of higher risk, the case can equally be made that below a certain point, a low population density can also signify less development and access to commodities and services that might be vital in a crisis. Second, agricultural productivity is a complex network of production, transport, infrastructure, environmental, economic, social, and political factors that cannot be fully encompassed by the sales index used in this study. Third, a majority of the island regions studied contain fewer than ten counties, allotting greater weight to each county that can alter the accuracy of the data. Fourth and most importantly, more specific and lower administrative level data remains rare, incomplete, and out of date. While the upcoming 2020 census is expected to help fill in some gaps, much greater research and analysis efforts need to be conducted to establish more solid statistical foundation for data-based programming and response.

TABLE 2: County Average Vulnerability Rank Per American Island Territory

Average by Rank	*Population Density*	*Agricultural Sales*	*Per Capita Income*	*Distance to Hospital*	*Cyclones within 500 km Radius*	*Distance to U.S Mainland*	*Sum Rank*
American Samoa	2.4	3.2	3	1.8	3.2	2.6	16.2
CNMI	1.75	1.5	2.25	1.75	2.25	2	11.5
Guam	3.05	4.16	3.42	2.58	2.37	3.1	18.6
Hawaii	1.8	2.6	2.6	1.8	2.8	2.4	14.0
Puerto Rico	2.24	3.97	3.6	2.4	3.82	3.24	19.28
USVI	2.67	3.33	3	2.33	2.33	3	16.67

CONCLUSIONS

As mentioned, this analysis only broaches the surface of a much-needed deeper dive into the vulnerability of the United States' territories. Greater efforts, by academics and practitioners alike, need to be made to incorporate the five territories in policy and implementation strategies. This begins with greater attention towards data collection on the local level to better equip the greater public and policymakers who may in turn help strengthen the resilience of these communities in times of crisis.

CITATIONS

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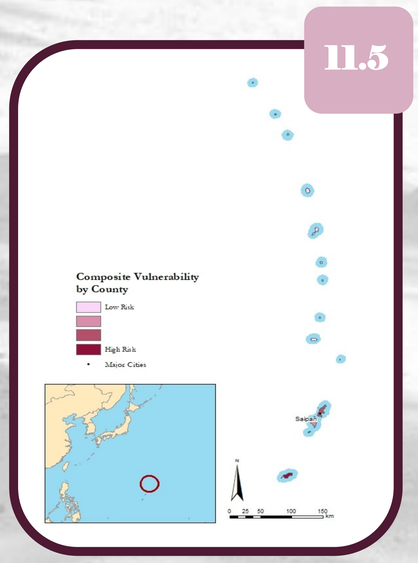
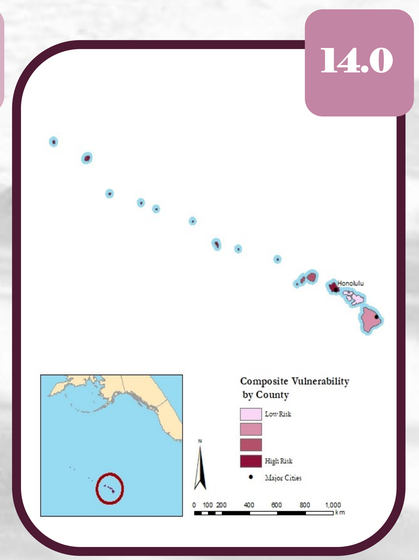
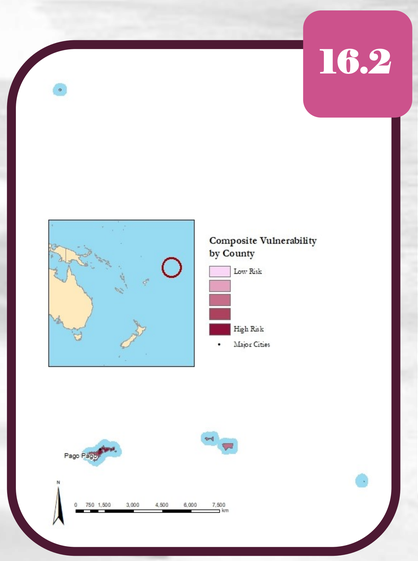


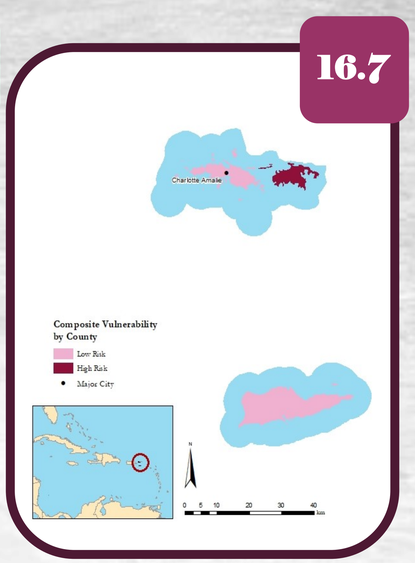
COMMONWEALTH OF THE NORTHERN MARIANA ISLANDS



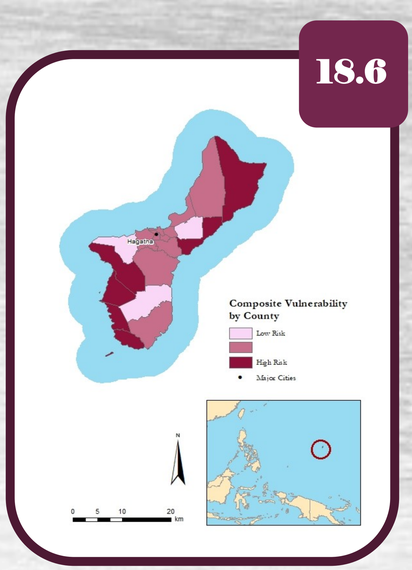
THE HAWAIIAN ISLANDS



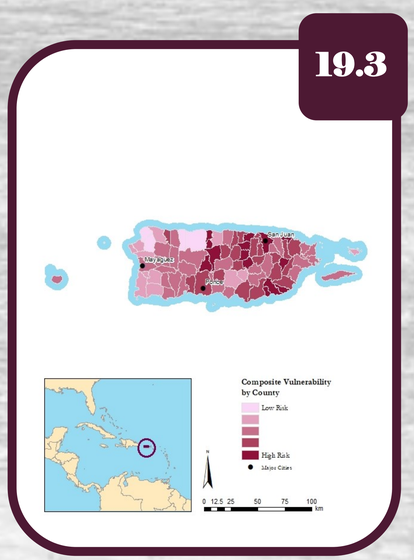
AMERICAN SAMOA



U.S. VIRGIN ISLANDS



GUAM



PUERTTO RICO