

Abstract

Disasters and emergencies have been increasing all over the world. The importance of the technical and scientific communities in providing general people with proper information against the consequences of natural disasters has come under more attention in recent years. Thanks to technology innovation, tools like Geographic information systems (GIS) can assist us in reducing impacts and identifying high-risk locations. The goal of this study was to use a GIS-based methodology to identify high risk locations for flooding and landslides in Puerto Rico and, with the Normalized Difference Vegetation Index (NDVI), evaluate the impact before and after a hurricane.

Introduction

Determining and defining the community's demographics is essential for disaster mitigation, planning, and successful response. Natural catastrophes like hurricanes and earthquakes can result in property destruction, a drain on financial resources, as well as personal harm or death. Puerto Rico is one of the countries at high risk for hurricanes, which can be among the most devastating natural disasters. Every tropical cyclone has the potential to produce widespread heavy rains that result in significant floods, as well as landslides and debris flows. In certain places in Puerto Rico, during Hurricane Maria, flood waters reached a depth of 15 feet. Additionally, more than 40,000 landslides were triggered throughout the territory. Infrastructure and property were devastated. With a GIS based analysis, we identified the high risk locations for surge floods and landslides in Puerto Rico and we used the NDVI to determine Hurricane Maria's effects on the vegetation before and after.



Fig 1. Hurricanes like Maria are one of the direct cause of flooding and landslide in the island.

GIS Mapping Materials

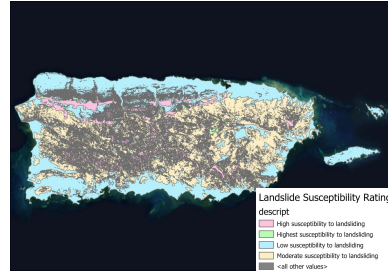


Fig 2. Landslide Risk Susceptibility for Puerto Rico.



Fig 4. NDVI Before Hurricane Maria (9/17/2017)

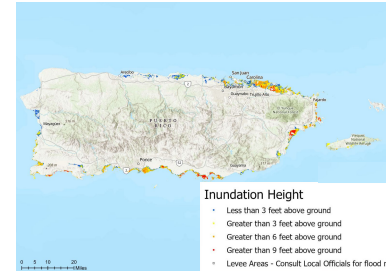


Fig 3. Category 5 Hurricane Flood Surge Risk in Puerto Rico

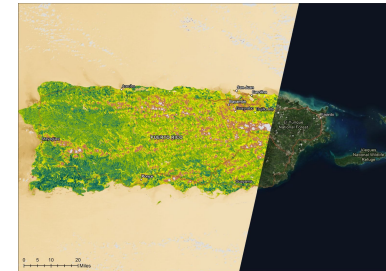


Fig 5. NDVI After Hurricane Maria (10/3/2017)

Conclusion

The highest susceptibility to landslides trends toward central parts of Puerto Rico, which is less densely populated compared to the coast, but still is a major concern for the interior residents. There is a major concern for areas around San Juan regarding flood surges during, and after, a hurricane event. The loss of vibrancy in the green hue as seen in the NDVI comparison is a result of the catastrophic effects to vegetation post a category 5 Hurricane capable of uprooting natural flora and agricultural plots alike. Puerto Rico's planning board places the cost of Maria's damage to \$43 billion. However, the governor asked for aid worth \$94.4 billion, an amount that may additionally account for the lost livelihoods of those immediately impacted by the hurricane as well as the ruined tourism economy that the island would face.

Methodology

The first phase of this study was to choose the risk criteria that would be employed on the GIS modeler and turn each piece of data into a scale of suitability, denoting the lowest risk and denoting the highest risk. The second phase was to analyze the impact on areas with the greatest risk. The third phase was to visualize the impact of vegetation before and after a hurricane with NDVI. Each risk criteria applied in this investigation is listed below:

Demography and Flood Risk: An elevation analysis of Puerto Rico was analyzed to determine which locations are more likely to flood after a category 5 storm. Analyzing inundation heights from less than 3 feet above ground to greater than 9 feet above ground.

Landslide: Analysis of landslide susceptibility for Puerto Rico, determining which areas are at high risk. We used 5 categories to describe the risk for susceptibility to land sliding: highest, high, moderate, low, and all other values.

Vegetation: Landsat satellite images were used to evaluate the impact on vegetation, using the Normalized Difference Vegetation Index (NDVI), before and after Hurricane Maria in Puerto Rico.

References

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NWS, NCEP, NHC, SSU, NOAA. *Category 5 Hurricane Storm Surge Risk Maps*. June 2022.
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Acknowledgement

A special thanks to Dr. Derin Ural and Mr. Abraham Parrish for delivering an educational overview on the risk mitigation strategy for hazards as well as technology applications using GIS mapping for suitability models in risk factors that are community-specific risk factors.