Studies for Resilient Electric Power Infrastructure

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Introduction

- After Hurricane Maria, which occurred September 19-22, 2017, households went 84 days without power and 41 days without cellular service until August 2018, almost a year after the storm.
- 100% of the electricity on the island was not working, which left over three million residents in the dark.
- Puerto Rico is still recovering from the devastating impacts of Hurricane Maria such as dealing with day-long power outages from time to time.
- This is definitely a storm worth researching in all aspects to try and prevent any lasting, harmful impacts that hurricanes can have on its residents
- This study explored the overall intensity of Hurricane Maria by analyzing and comparing data from the National Weather Service (NWS) and Weather Research and Forecasting (WRF) and an Electric Power Structure was developed based on the wind speed.

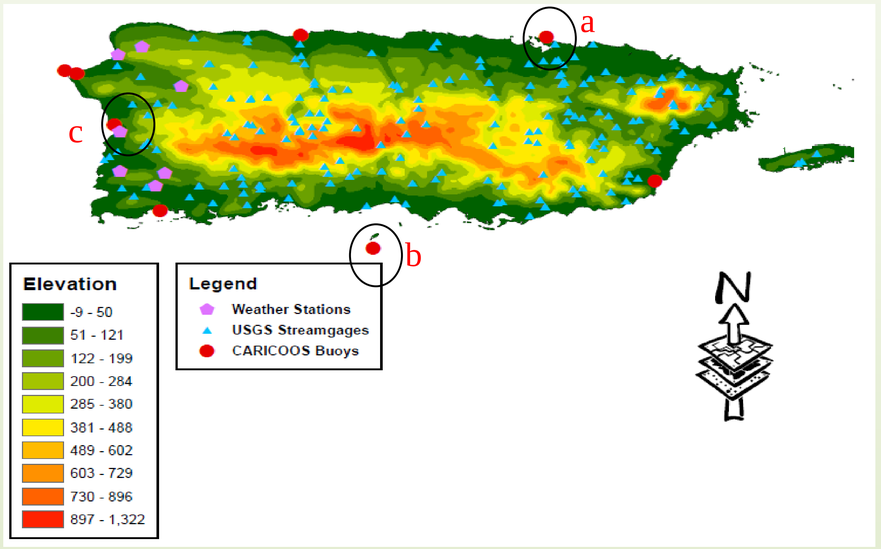
Research Question

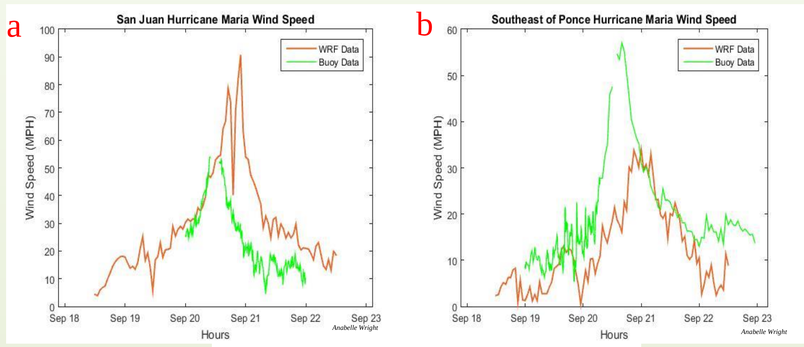
How can the negative impacts that Hurricane Maria had on the island of Puerto Rico act as a driving force to create infrastructure resilient to future weather events?

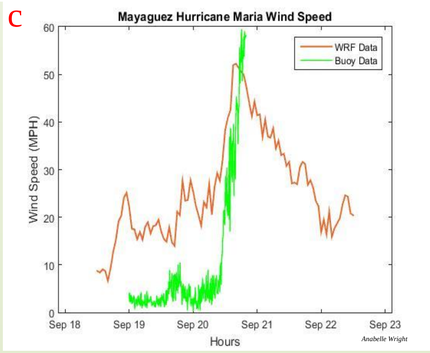
Methods

- ArcMap was used to visualize the precipitation data from WRF and NWS during Hurricane Maria along with elevation in Puerto Rico
- The programming tool was also utilized to create a map of the elevation of Puerto Rico with the location of the weather CARICOOS buoys.
- Inverse Distance Weighting (IDW) interpolation, located in the ArcToolbox in ArcMap, was used to display the rainfall in Puerto Rico.
- The graphical comparison between wind speed data from buoys and WRF was done by utilizing MATLAB.
- A code was written in MATLAB to obtain the equivalent grid points of the CARICOOS Buoys and simulated WRF data
- Another code was written to graph the wind speed of the CARICOOS buoys given its latitude and longitude points along with the WRF wind speed data.
- A 3D printed model of an electric power structure was developed to withstand the simulated wind speeds and precipitation during Hurricane Maria in a wind tunnel.

Results

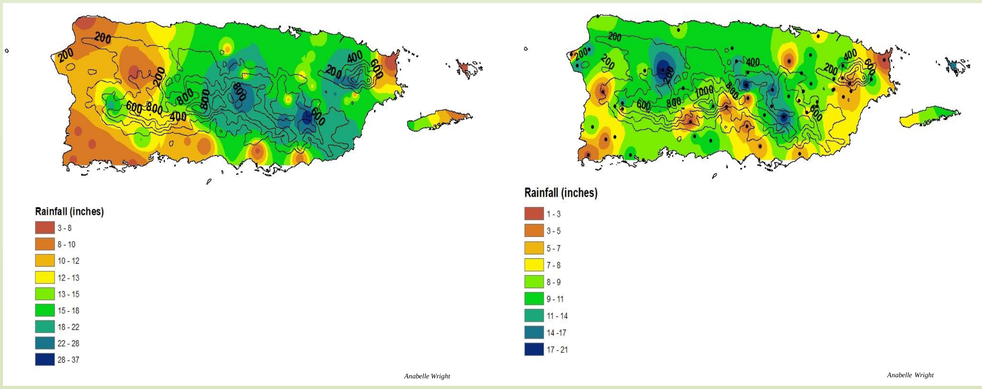






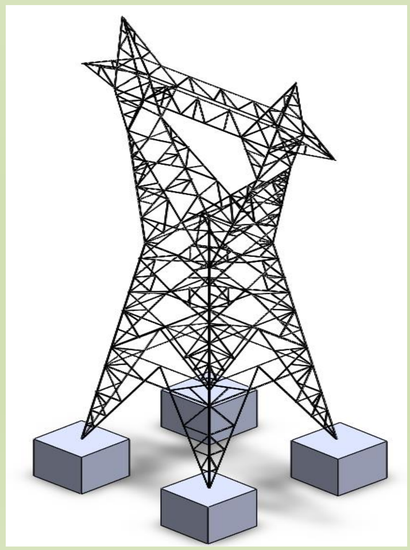
WRF Cumulative Rainfall

NWS Cumulative Rainfall



The Root Mean Square error (RMSE) is 7.19" and the normalized RMSE is 0.2 between the WRF and NWS data

Electric Power Tower Model



Discussion

- From observing our graphs of wind speed, the buoys and WRF stations were able to identify wind speeds over 90 MPH at one location, and around 30-50 MPH at the other two.
  - This data will be used to simulate wind speeds in a wind tunnel to test the electric power tower model's resiliency
- Our data shows that areas with high elevation experienced the most rainfall and the highest wind speeds
  - These areas will be targeted to develop more durable electric power structures
- By researching what type of material can withstand these conditions and how big the power tower needs to be to generate enough voltage to supply the area, the residents of Puerto Rico would soon be able to use electricity following a similar storm.

References

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