

Hurricane Effect on Disease Transfer

New Mexico

Supercomputing Challenge

Final Report

April 4, 2018

SSMA48

Saturday Science and Math Academy

Team Members:

Naomi Rankin

Matuke Fomukong

EXECUTIVE SUMMARY

The recent hurricanes of Texas, Florida and our projects focus of Puerto Rico have left thousands of citizens without their everyday necessities. Above all of the loss it has left thousands without hope. The recent outbreaks of waterborne diseases (E Coli in Texas, Crypto in Puerto Rico) as a result of the catastrophic flooding have been due to the exhaustion of the wastewater systems. The hurricanes were not accurately predicted ahead of time, so there was not a way to determine its respective route and the treatment plants of target as a result. This project focuses on a better means of predicting where hurricanes will strike, and the proper preparations needed (moving citizens to safe houses, improving current wastewater treatment plants etc.) to return to normalcy after the aftermath of the storm.

DESCRIPTION OF PROBLEM

Hurricane Maria was the strongest storm to make landfall in Puerto Rico in 85 years, and it has left thousands in need of water supplies, sanitation, food supply, electricity, transportation, shelter, communications, security, medical care, and mosquito control. The health of many Puerto Ricans have been put in jeopardy due to the catastrophic flooding. The flooding has led to an increase in flood water related illnesses. In spite of the recent outbreaks officials say running water has been restored to 72 percent of the island's people. Internal and external contact with floodwaters can lead to cases of cryptosporidiosis (parasite), E. coli (bacteria) or giardiasis (parasite), which result in diarrhea, gas, nausea, and vomiting.

During times of trauma, it is easy to miss all the services that need to be repaired. When people are searching for food, clean water, and shelter, sewage is not the most important aspect

to repair after a disaster. Our project was developed to show exactly how easy it is for bacteria to spread when sewage systems are not operating during a hurricane.

METHOD

Our original plan was to have the hurricane pick up the bacteria as it traveled, but further research showed that the hurricane does not carry disease, but instead simply shuts down sewage treatment plants. The shutdown plants then release any untreated water into nearby waterways, and this contaminated water floods the streets and infects humans that interact with it. We modified our project to better reflect the circumstances surrounding bacterial outbreaks.

We took a map of Puerto Rico including the major rivers and added points to indicate the major sewage treatment plants. We then imported the map into netlogo and created turtles representing hurricanes and diseases within sewage treatment plants. The hurricane spawned in the Atlantic Ocean and appeared in the right hand corner of the map. The hurricane then followed a random path to the northwest, following the natural path of all hurricanes. Whenever the hurricane hit a sewage treatment plant, the hypothetical bacteria, be it leptospirosis or e. Coli, traveled down any nearby waterways and contaminated the ground nearby.

Our original plan was to have the hurricane pick up the bacteria as it traveled, but further research showed that the hurricane does not carry disease, but instead simply shuts down sewage treatment plants. The shutdown plants then release any untreated water into nearby waterways, and this contaminated water floods the streets and infects humans that interact with it.

RESULTS AND CONCLUSIONS

The simulation accurately portrayed the randomness of where hurricanes originate (along the West African Coast). The simulation shows the potential route of the hurricane and the wastewater treatments that will be affected as a result. The success of the simulation means that the the aftermath of these devastating storms will be greatly reduced. With a stored database of this model it can serve as a future reference predicting other natural disasters (tornadoes, Tsunami etc.). These records will help organization like the Environmental Protection Agency assess the water quality and reevaluate the strength of these systems so if this model fails, we will still be prepared.

As with all utilities, it is vital to return sewage treatment plants to full power as soon as possible after natural disasters, or else communities will be forced pay for the damage ten times over with future disease control.

SIGNIFICANT ACHIEVEMENT

Finishing the challenge was a bit of a struggle this past year. The many distractions of senior year for both of us made it hard to find time to come together and dedicate a reasonable amount of time toward our project. Thus, making it to the finish line and submitting a project is our biggest accomplishment for this years challenge.

ACKNOWLEDGEMENTS

Thank you to our parents, to everyone in admissions at Howard University and the UNM BA/MD Program for accepting us into the collegiate programs we wanted to be a part of. Thank you to the judges of the Supercomputing Challenge for remaining interested in our projects for

the past four years, and the most important thank you goes to Ms. Debra Johns for loving us through our antics and pushing us to succeed!

REFERENCES

"Huracán IRMA - Teléfonos De EMERGENCIA." *Acueductospr*, Government of Puerto Rico, www.acueductospr.com/SERVICIOS/telefonosemergencia.html

Silva, Daniella. "Puerto Ricans at Risk of Waterborne Disease Outbreaks in Wake of Hurricane Maria." *NBC News*. NBC, 26 Oct 2017.

Stallings, Kirsten. "Hurricane Simulation Phase 1." NetLogo Commons, 2015.

"In Pictures: Hurricane Maria Pummels Puerto Rico." *CNN*, Cable News Network, Sept. 2017, www.cnn.com/interactive/2017/09/world/hurricane-maria-puerto-rico-cnnphotos/.

"Raw sewage contaminating water in Puerto Rico after Maria." *CBSNews*. 17 October 2017, Web. 10 December 2017. <https://www.cbsnews.com/news/raw-sewage-contaminating-water-puerto-rico-hurricane-maria/>