Into the Woods: Measuring Storm Resiliency in Atlantic Canada

A Network Analysis of Forested Road Networks Measuring the Access of Rural Areas to Medical Aid in Hurricane Season.

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BACKGROUND

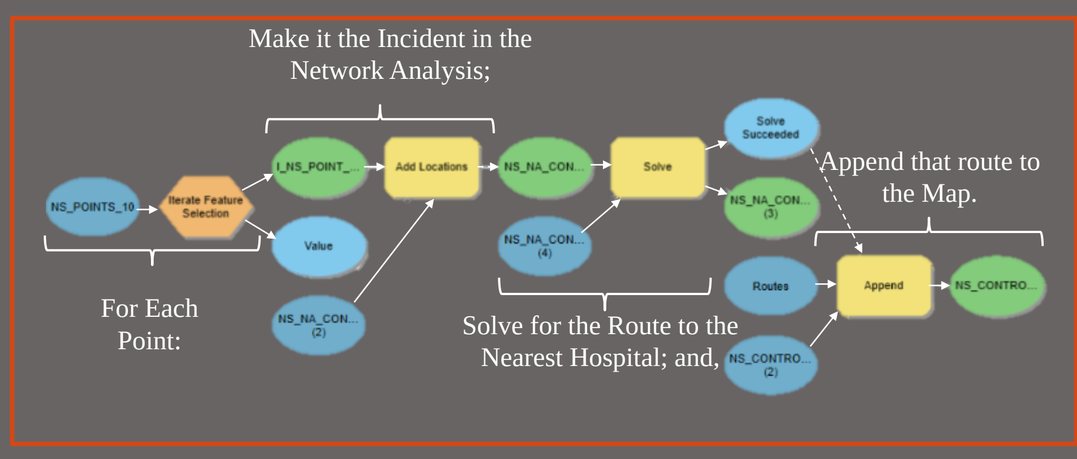
On the 24th of September, 2022, a category 4 hurricane ravaged the coast of Atlantic Canada. Thousands of people were left without power for days on end and transportation was brought to a virtual halt due to downed trees and powerlines blockading people in their homes. The damage was intense, with many people comparing it to 'White Juan', a tropical storm that had done similar amounts of damage to the area in 2003. These storms, however catastrophic, are well known to be a familiar annual occurrence for this region of Canada, with large amounts of the population jokingly referring to the season between August and October as 'Hurricane Season' as they tie down their Adirondack chairs and stock up on shingle tar and Covered Bridge brand Storm Chips. The unfortunate truth of the matter is that the Atlantic Provinces (New Brunswick, Nova Scotia, Prince Edward Island, and Newfoundland and Labrador) are equipped for these continuous bombardments with little more than the waning resilience of their residents (Henstra, 2012; Vasseur, Thornbush, & Plante, 2018), leaving coastlines, roadways, forests, and crumbling infrastructure to bear the brunt of heavy winds and rain year after year.

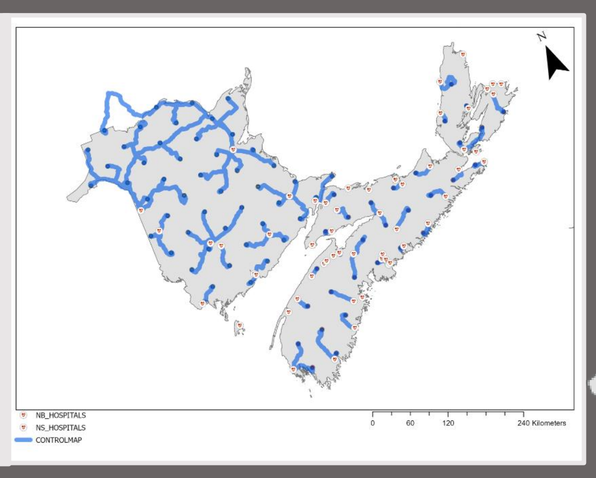
This particular research project was a group undertaking to understand the regional storm vulnerability of the Atlantic Provinces and included research into the forests, the coastlines, and road infrastructure. This branch of the project focuses on road infrastructure and was formed around the question: can the residents of the Atlantic Provinces access medical assistance in the event of a road blockage due to downed trees or powerlines in a storm? This research uses Esri's ArcGIS Closest Facility Network Analysis to explore the implications of blocked forested roads to provincial road networks in Nova Scotia and New Brunswick.

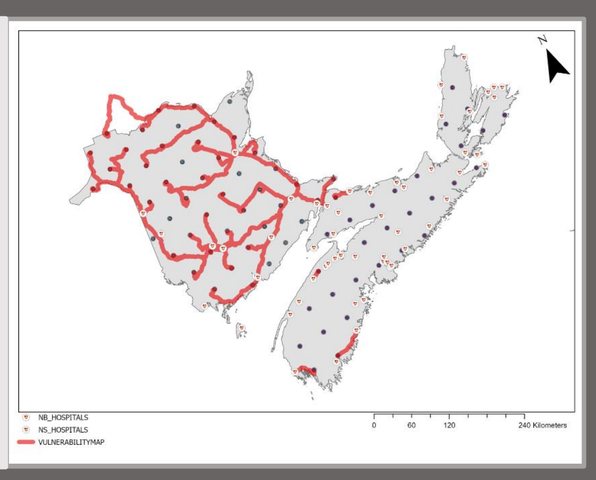
METHOD

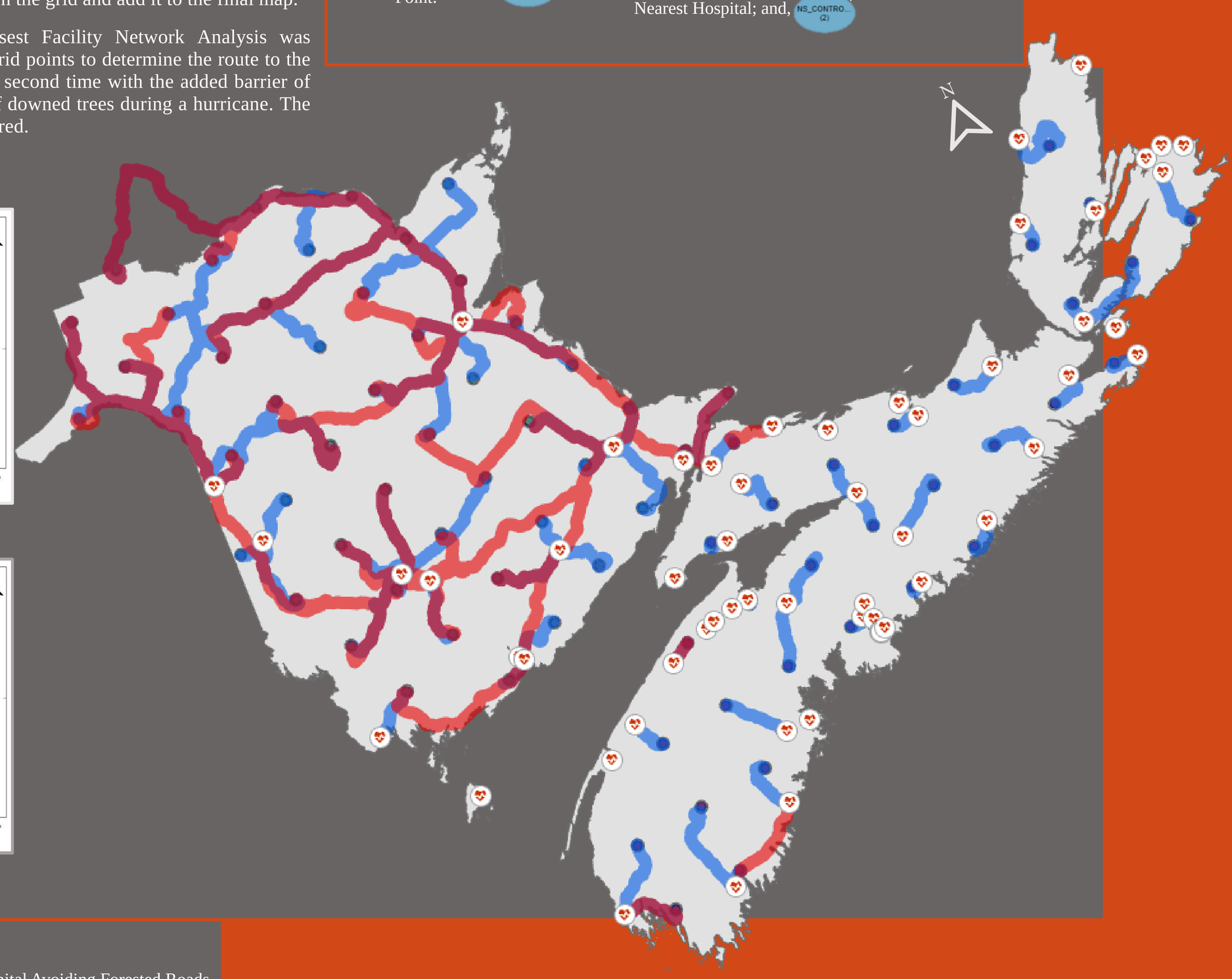
To create the barriers for the network analysis the forest polygons were pared down to only those that existed within 5 meters of a road. Study points were set to a 60-kilometer grid overlayed on the province to create a sample of provincial address points. These grid points were used as the incident markers in the network analysis, the point data for hospitals and medical centers were used as the facilities (or end points) for the study. With the map data prepared for analysis the last step of preparation was to create an iterative model to perform the Closest Facility Network Analysis on each of the incident (start) points on the grid and add it to the final map.

Using the ArcGIS Model Builder, the Closest Facility Network Analysis was performed iteratively on each of the incident grid points to determine the route to the nearest medical facility. This was performed a second time with the added barrier of avoiding forested roads to simulate the risks of downed trees during a hurricane. The resulting two maps were then able to be compared.









Hospital Locations
Route to Nearest Hospital Avoiding Forested Roads
Route to Nearest Hospital

LIMITATIONS

This project was majorly kept back from both the lack of available data as well as the quality of the data that was available. Due to the nature of this study area being largely rural, the scope and original intentions of this project had to be largely altered. The original study area had to be cut down from all Atlantic provinces to only Nova Scotia and New Brunswick since Prince Edward Island and Newfoundland and Labrador simply did not have the necessary data available for this study. Furthermore, it should be noted that the stark differences in results between Nova Scotia and New Brunswick could possibly be due to the quality of data for New Brunswick's forest polygons not being of the same level of quality as those of Nova Scotia, which may account for a different number of them being cut from the study and altering the results.

RESULTS

The results of the network analysis show a great amount of difference between normal conditions and storm conditions for drivers in these areas, with many being either completely cut off from medical care or having to find longer, different routes to receive it. Especially for the province of Nova Scotia, many of the points analyzed were completely cut off from receiving medical care due to the constraints and barriers posed by rural forested roads.

The need for further infrastructure investment becomes clear through the comparison of the two maps which show that the amount of the road network in these two provinces that is bordered closely by forest is enough to effectively cripple necessary transportation for households in the event of an emergency.

FURTHER RESEARCH

For this methodology to be more widely applicable to the Atlantic provincial context, it would be beneficial to focus on a smaller study area (for example, a single municipality), and utilize the local knowledge of community hubs and anecdotal knowledge of places where the power is least likely to go out as well as an archive of data to analyze the network connectivity and vulnerability to storms. Further data that could be applicable is historical rainfall and floodplain data, as well as wind data. A model could then be created showing historical storms and then calibrated to predict what an oncoming storm could do to the area. This model would be able to flag certain roads as vulnerable to flooding or to tree blockages and the municipality would be better equipped to issue warnings and supplies to these areas prior to a storm as well as determine the hierarchy for road clearance after a storm has hit. This type of usage of a GIS could massively improve the Atlantic province's response and preparedness for large storms, which are becoming more frequent and disastrous because of climate change.

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REFERENCES & ACKNOWLEDGEMENTS

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Government of Canada, Statistics Canada. (2015, November 23). *Statistics Canada: Canada's national statistical agency*. https://www.statcan.gc.ca/en/start

Henstra, D. (2012). Toward the Climate-Resilient City: Extreme Weather and Urban Climate Adaptation Policies in Two Canadian Provinces. *Journal of Comparative Policy Analysis: Research and Practice*, *14*(2), 175–194. https://doi.org/10.1080/13876988.2012.665215

Nova Scotia Government - Open Data Portal | Open Data | Nova Scotia. (n.d.). Tyler Data & Insights. https://data.novascotia.ca/

Open Data Portal | New Brunswick. (n.d.). Tyler Data & Insights. https://gnb.socrata.com/

Vasseur, L., Thornbush, M. J., & Plante, S. (2018). Adaptation to Coastal Storms in Atlantic Canada. In *Springer eBooks*. https://doi.org/10.1007/978-3-319-63492-0