Efficiency Vs. resilience trade off in transportation in the USVI

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In September 2017, Category-5 Hurricanes Irma and Maria struck the U.S. Virgin Islands (USVI) within a two-week period and collectively devastated homes, businesses, and infrastructure throughout the Territory. The local transportation was significantly damaged, roads were blocked, car accident rate increased seven times, and the local population had to live under a curfew to keep roads clear. The possibility of the next storm is not a matter of if, it is a matter of when, so it is important to make the transportation system as resilient as possible to withstand future disasters. USVI received nearly $700 M from FEMA in order to re-establish itself.

However, the tradeoffs between resilience and efficiency for transportation infrastructure upgrades and mitigation activities are yet not fully known. Therefore, there is a risk of not taking full advantage of the given funds, or worse current changes will leave transportation infrastructure vulnerable to the next storm. The goal of this research is to determine which mitigation actions can be taken to minimize the negative impact of future disasters on the USVI transportation system while supporting efficient day-to-day operation.

The research defines an efficiency-resilience space to determine tradeoffs between various transportation system designs, such as intersections coordinating system (traffic light / 4-stop-sign / roundabout / other variations), road network structures (wide road, additional parallel roads), and population routing or timing. This research model is based on operator model which will demonstrate the dynamics of the USVI roads. The model will get as input data corresponding to the USVI characteristic, and as an output, the model returns the system dynamics and behavior with each of the examined transportation systems. The efficiency will be measured according to a bright day assessment while resilience will be defined as the efficiency decrease in a black-day scenario comparing to blue day.

This thesis will use this tradeoff space to quantify tradeoffs and provide recommendations for transportation hazard mitigation for the next storm in terms of various aspects of roadway. This work is in support of Federal Emergency Management Agency (FEMA) response and recovery activities and part of a broader FEMA-funded effort by the Naval Postgraduate School (NPS). This thesis additionally supports several other complementary efforts with the University of the Virgin Islands (UVI) to develop a next-generation Hazard Mitigation and Resilience Plan for the Territory.

The following is a proposed timeline of events to support this project:

- April 2020 - Site visit to USVI with presentation of notional infrastructure model
- July 2020 - Complete infrastructure model and results;
- August 2020 - Final visit to USVI to present findings and recommendations
- September 2020 – Graduation

References:

1. Good (2019) An operational model of the critical supply chain for the USVI islands, NPS.
2. Ganin et al. (2017) Resilience and efficiency in transportation networks, science advances.
3. Alderson at el. (2018) interdependent infrastructure resilience in the USVI islands: preliminary assessment, NPS.