



U.S. Department
of Transportation
**Federal Highway
Administration**

FHWA Climate Resilience Pilot Program:

Hillsborough County Metropolitan Planning Organization

The Federal Highway Administration's (FHWA)'s Climate Resilience Pilot Program seeks to assist state Departments of Transportation (DOTs), Metropolitan Planning Organizations (MPOs), and Federal Land Management Agencies (FLMAs) in enhancing resilience of transportation systems to extreme weather events and climate change. In 2013-2015, nineteen pilot teams from across the country partnered with FHWA to assess transportation vulnerability to extreme weather events and climate change and evaluate options for improving resilience. For more information about the pilot programs, visit: http://www.fhwa.dot.gov/environment/climate_change/adaptation/.

Transportation infrastructure and operations in Florida's Hillsborough County have been severely impacted by extreme weather events in recent years. These impacts have resulted in damage to and deterioration of transportation infrastructure, cutting off access to critical facilities and creating significant disruptions to the movement of people and goods and ultimately the local economy. The project team therefore assessed its surface transportation vulnerabilities to sea level rise, storm surge, and flooding. This evaluation helped the team understand these risk factors and consider mitigation measures as a part of the regular road repair and replacement cycle in order to use limited resources more efficiently.



Scope

The assessment evaluated and identified the economic impact of sea level rise, storm surge, and flooding to the surface transportation system in Hillsborough County. The assessment included multimodal transportation assets countywide, with more focused analysis on critical assets (including segments of several major highways, expressways, and streets) along the coast. The Hillsborough MPO and City/County Planning Commission partnered with the Florida DOT, the County Public Works Department, the University of Florida, the University of South Florida, and the Tampa Bay Regional Planning Council (TBRPC). The project leveraged insights and expertise from these partners, as well as the Hillsborough County Local Mitigation Strategy Working Group (LMS_WG), which served in an advisory role throughout the project.

Objectives

Identify cost-effective strategies to mitigate and manage the risks of coastal and inland inundation for incorporation into:

- The Hillsborough County MPO's 2040 Long Range Transportation Plan (LRTP),
- The County's Post Disaster Redevelopment Plan (PDRP), and
- Other transportation planning and decision-making processes.



Inundated Street in Hillsborough County.
Photo credit: Hillsborough County MPO, 2014



Downtown Tampa.
Photo credit: Jacobs Engineering, 2014



Wave Attenuating Devices.
Photo credit: Scott L. Douglass, University of South Alabama (credited to Lamb, 2006)

Approach

Phase 1: Assemble data and identify assets for further study

Collect information on transportation facilities and destinations. With support from State, regional, and local project stakeholders, the project team assembled and organized a transportation asset geodatabase containing spatial data on transportation, climate, topography, and base layers on assets of regional importance (e.g., hospitals). In addition to selecting activity centers (destinations), the team used Tampa Bay Regional Planning Model (TBRPM) roadway network data for the roadway layer, and the associated Traffic Analysis Zones for socioeconomic data.

Screen assets for criticality. In order to focus analytical resources, the analysis identified critical areas and destinations as well as the transportation networks that support them. The team screened the regional roadway network using TBRPM's travel demand model, which identified three tiers of criticality.

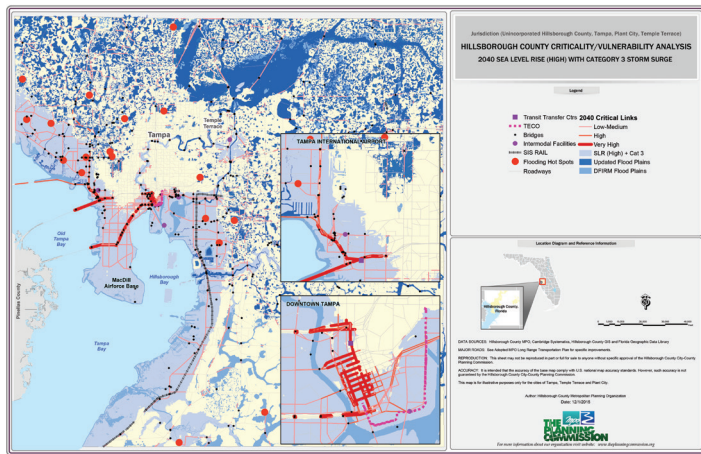


Figure 1. 2040 Sea Level Rise (High Scenario) with Category 3 Storm Surge in Combination with Floodplains.

Obtain topographical data. The project team used the Florida Digital Elevation Model (DEM) from the University of Florida GeoPlan Center's Sea Level Scenario Sketch Planning Tool to obtain topographical terrain data used to help identify areas at risk of inundation. The dataset was a composite DEM from four regional DEMs that was clipped to be specific to Hillsborough County. Elevation data was used to calculate water depths above land elevations associated with each sea level rise and storm surge scenario. To identify areas of potential inland flooding, the project team then used Federal Emergency Management Agency's (FEMA) 100-year floodplains and inland flooding "hotspots" provided by Hillsborough County.

Obtain climate data. Using geographic information system (GIS) data and in consultation with TBRPC and Hillsborough County, the project team selected sea level rise scenarios for 2040 (see Figure 1) and 2060, with high and low observed projections selected for each year. The team used National Oceanic and Atmospheric Administration's Sea, Lakes, and Overland Surges from Hurricanes model to estimate the greatest depth and extent of coastal flooding associated with Category 1 and 3 hurricanes at specific locations. Using the outputs, the team modeled the potential increase in storm surge depths under different sea level rise scenarios. Finally, the team used FEMA's Digital Flood Insurance Rate Map and County resources to obtain information on inland flood hazard areas and flooding hotspots.

Phase 2: Assess vulnerability of critical assets

Select transportation assets to assess. Potential exposure of transportation assets to the climate stressors was determined by overlaying asset data with extents of inundation in a GIS platform. The team held a workshop with the LMS_WG to identify transportation assets for closer assessment and adaptation analysis and then pared this short list of assets down through a third tier selection process (see Figure 2) to obtain a more manageable selection. Through consideration of factors such as average annual daily traffic and network redundancy, the team identified six transportation facilities (including highways, boulevards, and bridges) to assess further.

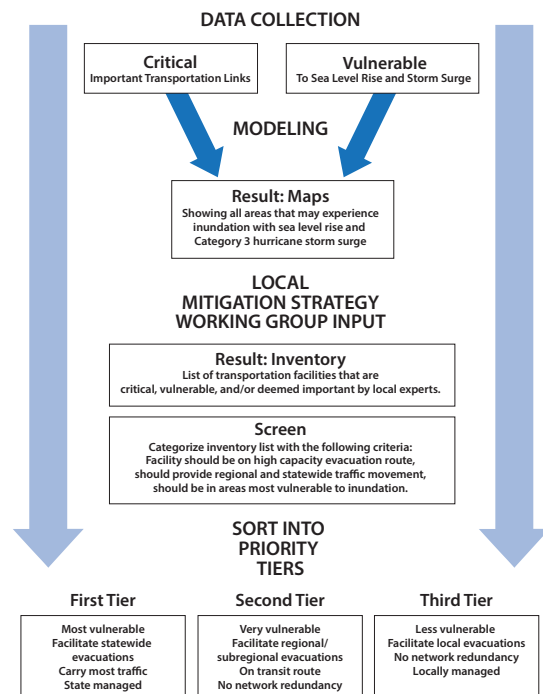


Figure 2. Assets Screening Process.

Screen for vulnerability. The vulnerability screening of the six identified assets considered the following:

- **Exposure.** Using GIS and the climate, topographical, and transportation datasets assembled in the data collection phase, the project team evaluated each facility’s potential exposure to inundation from sea level rise, sea level rise plus storm surge, and a 100-year (1% chance) flood event.
- **Sensitivity.** The project team screened the sensitivity of each asset to storm surge and flooding exposure. The analysis was qualitative in nature, applying engineering expertise and local knowledge to develop a “Baseline Impact Narrative,” which was translated into an associated travel disruption time.
- **Adaptive capacity.** The project team used the TBRPM travel demand model to show how regional mobility metrics (change in vehicle miles traveled, delay, and lost trips) would be affected. A “typical” travel day was used in each model run, and outputs were the modeled change in the regional mobility metrics. Greater percentage increases in VMT, delay, and lost trips potentially indicated relatively less functional redundancy, and therefore less adaptive capacity.

Phase 3: Estimate general economic losses

Assess impacts to regional mobility and regional economy. As discussed, the team utilized the TBRPM travel demand model to estimate the losses in regional mobility associated with disruption of the selected transportation facilities. The project team also estimated general economic losses associated with the disruption of selected critical links, using the Regional & Economic Models, Inc. tool to translate VMT and vehicle hours of delay model outputs into associated changes in operating costs, work hours, income, and gross regional product.

Analyze adaptation options. The project team developed a package of adaptation strategies to manage the projected set of inundation risks faced by each asset. The project team estimated the marginal costs of each strategy package, assuming adaptation strategies were implemented during regular rehabilitation, reconstruction, and replacement activities. The team also developed an adaptation impact narrative to illustrate the potential range of reductions in disruption.

Key Results & Findings

The impact assessments produced two summary variables that describe the relative cost-effectiveness of the illustrative adaptation strategy package proposed for each asset: estimated net benefits/avoided losses resulting from reductions in the duration of disruption; and the “tipping point” (the number of days of avoided disruption required for the strategy package to achieve cost neutrality). The metrics are summarized in Figure 3.

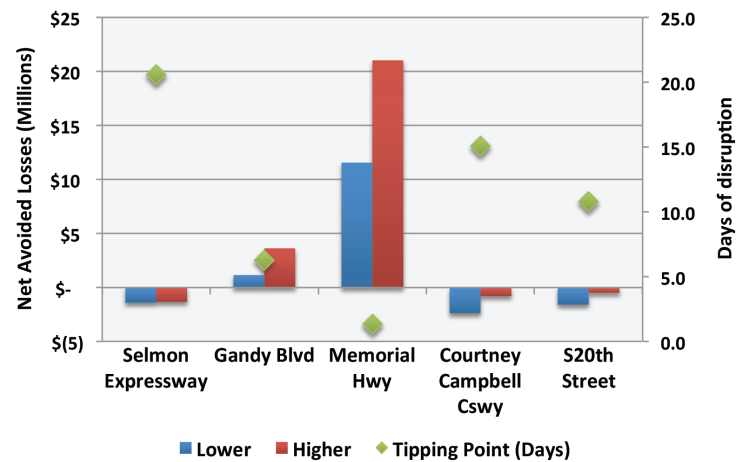


Figure 3. Estimated Net Benefits (Avoided Losses) to a Category 3 Hurricane Storm Surge Scenario

Two of the assessments reported a positive return on investment. The Memorial Highway assessment found that a reduction of 1.3 days or more of disruption would justify the \$4.2 million marginal cost of the investment and the Gandy Boulevard assessment reported a tipping point of 6.3 days for a \$1.9 million marginal cost of investment. However, three of the assessments reported a negative return on investment, with corresponding tipping points of 11 to nearly 21 days. These results are partially due to the conservative approach in modeling regional mobility losses, in which only the facility in question is removed from the travel demand model, leaving adjacent and connecting links unaffected. Because the estimated mobility losses informed the econometric model, associated economic losses are generally low.

Lessons Learned

Take a regional approach to consider the potential losses associated with significant inundation.

The project team's storm surge models overestimated the extent of potential inundation from a single event. In response, the team removed transportation links associated with the assessed facilities to reduce the potential exaggeration of impacts. This, in turn, caused potentially significant under-representations of regional mobility impacts. For assessments that focus on a very high value asset or area, using a more advanced and resource-intensive modeling platform should be considered to measure potential impacts more accurately.

Establish a small, dedicated technical advisory group. While the LMS_WG was a valuable resource for the project, the composition of attendees varied significantly across project meetings, making continuity a challenge. A smaller, dedicated technical advisory group could meet more frequently and provide consistent feedback.

Focus on mastering one model before using many. The study depended on several models, and each had a learning curve associated with understanding its functions and results. The project team found that agencies conducting first phase assessments should focus on mastering one or two models to ensure that results are in line with expectations before adding complexity in additional assessments.

Consider overlaps in flood zones. Because all of the FEMA 100-year flood zones in the region were along the coast, it was challenging to distinguish between the potential effects of coastal and inland flooding. Future studies that focus on the effects of precipitation-induced flooding may consider incorporating hydrological analysis.

"This study, along with regional and state efforts, constitutes an initial step toward an ongoing process of managing extreme weather and climate change risks in Hillsborough County and beyond."

– Hillsborough Pilot Team

Next Steps

Disseminate findings regionally. The project findings have been incorporated into the MPO's 2040 LRTP update public outreach effort, and findings have been presented to the Planning Commission Board and the Hillsborough MPO Board and Sub-Committees. The study's companion technical memorandum, 2040 Long Range Transportation Plan – Needs Assessment: Vulnerability Reduction Cost and Benefits, was adopted as a part of the 2040 LRTP. In coordination with the TBRPC, the project team continues to share project information at presentations, conferences, and publications as the opportunities arise locally, regionally, and nationally.

For More Information

Final report available at:
www.fhwa.dot.gov/environment/climate/adaptation/2015pilots/

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