Risk-Based Transportation Planning for Uncertainty

A Partnership between the Florida Department of Transportation and Three Florida Universities – Florida State University, University of Florida, and University of South Florida

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Assessment of Planning Risks and Alternative Futures for the Florida Transportation Plan (FTP) Update

How should Florida’s transportation system evolve to support mobility in the future?

How might the FTP goal areas and visions of alternate futures change in response to changes in risk and uncertainty?

How will the enhanced understanding of risk be incorporated into FDOT’s business, from preliminary planning and design through project implementation?

How might the planning, policy setting process and implementation of the FTP change to accommodate risk and uncertainty?
Participants and Tasks

- Three Universities
  - University of South Florida, Florida State University, & University of Florida
  - Involvement of students
- A common scope and set of tasks
- Non-collaboration during the research phase was a requirement
Five Areas of Inquiry

Population
Florida’s population will continue to grow
Florida will continue to have an aging population

Economics
Other sources for transportation funding will need to be explored
Public Private Partnerships

Environment
Climate change risks in Florida include sea level rise, extreme temperatures, and storm surge
Florida’s population will become more sprawled

Technology
Autonomous vehicles will impact the built environment and how people travel
Cyber security and user privacy will need to be considered when implementing new technologies

Global Issues
Threats of terrorism and global conflict are possible factors that can impact the transportation network
Florida should plan for an increase in volume for global trade routes
What are the greatest hazards that the transportation system in your community will face over the next 25 years?
Literature Review

**Population**
- Rapid Population Growth
- Congestion from Suburbanization
- Population Decline
- Immigration
- Political Polarization
- Aging Population

**Economic**
- Another Recession
- Increasing Fuel Costs
- Growing Household Income Inequality
- Financing New Infrastructure
- Worsening Traffic Congestion
- Decreasing Transportation Funding

**Environment**
- Storm Surge
- Sea Level Rise
- Extreme Weather
- Inland Flooding
- Open Space Reductions
- Extreme Temperatures
- Declining Water Quality
- Fire Hazards
- Water Scarcity

**Technology**
- Cyber Security
- Outdated Government Regulations
- User Privacy
- Lack of Funding for Smart Infrastructure
- Slow Adoption of New Technology

**Global Issues**
- Rising Energy Prices
- Global Recession
- Terrorism
- Climate Refugees
- Global Epidemics
- Global Conflict
- Food Crises
Plan Review

Reviewed State DOT’s Long-Range Transportation Plans

Identified best practices in risk assessment:

- What risks are addressed?
- How are they being addressed?
- Where in the planning process?
- How is risk assessment integrated into the planning process?

<table>
<thead>
<tr>
<th>State</th>
<th>Plan Type</th>
<th>Modes Addressed</th>
<th>Investment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Corridor-based</td>
<td>Financially-realistic</td>
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<td>Need-based</td>
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<td>Performance-based</td>
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<td>Project-based</td>
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<td>Vision-based</td>
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<td></td>
<td></td>
<td>All Roads</td>
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<td></td>
<td></td>
<td>Aviation</td>
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<td>Bicycle</td>
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<td>Connected/Autonomous Vehicles</td>
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<td>Freight Modes</td>
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<td>Highways</td>
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<td></td>
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<td>Intercity Passengerways</td>
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<td>Pedestrian</td>
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<td>Pipelines</td>
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<td></td>
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<td>Ports</td>
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<td></td>
<td></td>
<td>Transit</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Funding Strategies</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Needs Revenue Estimates</td>
<td></td>
</tr>
</tbody>
</table>

- Florida
- California
- Georgia
- Illinois
- Michigan
- Minnesota
- Missouri
- New Mexico
- New York
- North Carolina
- Ohio
- Texas
- Utah
Risk to Assets

Promote an agile, resilient, and quality infrastructure (FDOT, 2015 FTP Policy Element),

Steps:

• Established a preliminary list of assets (2015 Florida Transportation Asset Management Plan)
• Reviewed assets included in various state LRTPs to expand categories (CA, GA, MN, MI, NY, UT)
• Accessed extensive asset databases maintained by state agencies (FDOT, DEP)
• Grouped asset vulnerability by type; transportation, environmental, economic
• Assigned of risk levels based on expert polling, validated by in-class review, and confirmed by final expert review.

<table>
<thead>
<tr>
<th>Category</th>
<th>Cumulative Risk to Assets</th>
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<tbody>
<tr>
<td>Assets</td>
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<tr>
<td>Transit</td>
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<td>Airports</td>
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<td>Seaports</td>
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<td>Rail</td>
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<td>US Highways</td>
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<td>Interstates</td>
<td>42</td>
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<td>Toll Roads</td>
<td>42</td>
</tr>
<tr>
<td>Bridges</td>
<td>41</td>
</tr>
<tr>
<td>State Roads</td>
<td>38</td>
</tr>
<tr>
<td>County Roads</td>
<td>36</td>
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<td>Scenic Highways</td>
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<tr>
<td>Amtrak</td>
<td>37</td>
</tr>
<tr>
<td>Facilities</td>
<td>36</td>
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<tr>
<td>Trails</td>
<td>34</td>
</tr>
<tr>
<td>Bike Lanes</td>
<td>32</td>
</tr>
<tr>
<td>Spaceports</td>
<td>30</td>
</tr>
<tr>
<td>Traffic signals</td>
<td>24</td>
</tr>
<tr>
<td>State Parks</td>
<td>43</td>
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<td>National Parks</td>
<td>41</td>
</tr>
<tr>
<td>Canals</td>
<td>30</td>
</tr>
<tr>
<td>Wetlands</td>
<td>29</td>
</tr>
<tr>
<td>Springs</td>
<td>27</td>
</tr>
<tr>
<td>Lakes</td>
<td>26</td>
</tr>
<tr>
<td>Rivers/streams</td>
<td>26</td>
</tr>
<tr>
<td>Protected Lands</td>
<td>26</td>
</tr>
<tr>
<td>Oil and gas wells</td>
<td>31</td>
</tr>
<tr>
<td>Mines</td>
<td>30</td>
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</tbody>
</table>
Tools to Evaluate Risk and Uncertainty
## Risk Register

**Flexible and customizable**

**Comprehensive tool**

**Useful at different stages of planning process**

- Project evaluation
- Stakeholder engagement

### Risk Event

<table>
<thead>
<tr>
<th>Risk Event</th>
<th>Likelihood</th>
<th>Consequence</th>
<th>Vulnerability</th>
<th>Overall Risk</th>
<th>Timeframe</th>
<th>Risk Level</th>
<th>Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of public acceptance of proposed projects</td>
<td>5</td>
<td>5</td>
<td>4</td>
<td>100</td>
<td>C</td>
<td>Critical</td>
<td>Mitigate</td>
</tr>
<tr>
<td>Inadequate funding and economic downturns restrict ability to expand travel options</td>
<td>5</td>
<td>4</td>
<td>4</td>
<td>80</td>
<td>E</td>
<td>Extreme Risk</td>
<td>Mitigate &amp; Coordinate</td>
</tr>
<tr>
<td>Increased urban sprawl and auto-dependent development</td>
<td>5</td>
<td>5</td>
<td>3</td>
<td>75</td>
<td>C</td>
<td>Extreme Risk</td>
<td>Coordinate &amp; Transfer</td>
</tr>
<tr>
<td>Limited system connectivity due to poorly coordinated agency deployment</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>64</td>
<td>N</td>
<td>High Risk</td>
<td>Coordinate</td>
</tr>
<tr>
<td>Increased travel demand due to population growth</td>
<td>5</td>
<td>3</td>
<td>3</td>
<td>45</td>
<td>C</td>
<td>Moderate Risk</td>
<td>Mitigate &amp; Coordinate</td>
</tr>
<tr>
<td>Transit investment fails to increase or attract sufficient ridership</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>36</td>
<td>C</td>
<td>Moderate Risk</td>
<td>Mitigate</td>
</tr>
<tr>
<td>Inequity of AV applications for growing disadvantaged population</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>27</td>
<td>N</td>
<td>Moderate Risk</td>
<td>Coordinate &amp; Transfer</td>
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<tr>
<td>Societal shifts in transportation preferences and needs in light of changing technology</td>
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<td>2</td>
<td>3</td>
<td>24</td>
<td>E</td>
<td>Low Risk</td>
<td>Mitigate</td>
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<tr>
<td>Inadequate EV charging infrastructure</td>
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<td>2</td>
<td>2</td>
<td>16</td>
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<td>Low Risk</td>
<td>Coordinate &amp; Transfer</td>
</tr>
</tbody>
</table>

### Opportunities

- Improved first and last mile connectivity by ridesourcing and ridesharing
- Ease of integrated corridor management (ICM) and multimodal integration
- More mobility options for aging population, teenagers, and users with limited mobility
- Improved public information (or public awareness) across different modes of transportation
- Ability to accommodate increase density and mix of uses
- Improved public transportation services in rural areas and between rural and urban areas
- Expanded interregional travel options for residents, visitors, and freight
- Reduced travel demand due to e-commerce, telecommunications and telecommuting
- UAVs reduce freight costs through the use of last-mile delivery services

### Goals

**Goal 4: More transportation choices for people and freight**

- More mobility options for aging population, teenagers, and users with limited mobility
- Improved public information (or public awareness) across different modes of transportation
- Ability to accommodate increase density and mix of uses
- Improved public transportation services in rural areas and between rural and urban areas
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**Potential threat or opportunity for each agency goal**
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<td>4</td>
<td>64</td>
<td>N</td>
<td>High Risk</td>
<td>Coordinate</td>
</tr>
</tbody>
</table>

1 – 24 Low Risk
25 – 49 Moderate Risk
50 – 74 High Risk
75 – 99 Extreme Risk
100 – 125 Critical Risk
## Consequence Management

<table>
<thead>
<tr>
<th>Risk Event</th>
<th>Likelihood</th>
<th>Consequence</th>
<th>Vulnerability</th>
<th>Overall Risk</th>
<th>Timeframe</th>
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<th>Risk Level Management</th>
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</tr>
</tbody>
</table>

**Threats**
- Avoid
- Mitigate
- Transfer
- Coordinate

**Opportunities**
- Exploit
- Share
- Enhance
Select the most disruptive or extreme event that may affect the future of transportation in your state

- Population/demographic trends
- Economic shifts
- Environmental impacts/natural hazards
- Advancements in technology
- Global issues
Case Study: Sea Level Rise In Florida
Sea Level Rise Scenarios

Sea Level Rise @ 2080
Curve 1 = USACE and NOAA Low
Curve 3 = NOAA Intermediate
Curve 5 = NOAA High
Fall 2018 Student Studio Work

1. Impacts on Vulnerable Populations
   Vulnerable populations are a main area of concern. These risks are in the short term for FDOT when planning for mobility and evacuation.

2. Future Populations
   Florida’s population trends present long-term risks on physical infrastructure and FDOTs.

3. Roads & Property
   Sea level rise (SLR) poses very high long-term threats to property, residents, and foundation of roads.

4. Florida’s Critical Infrastructure
   SLR will impact critical facilities in the form of ports, airports, and first responder facilities and schools.

5. Intermodal Rail Service
   SLR impacts on intermodal freight systems and connectivity throughout the state.
Future Populations

Impacted Residents in 2070 from Projection at NOAA High Scenario

Legend
- Orange: NR NOAA High Scenario
- Blue: Impacted Population
  - 34 - 2,151
  - 2,152 - 3,162
  - 3,163 - 5,279
  - 5,280 - 9,715
  - 9,716 - 19,008
  - 19,009 - 38,476
  - 38,477 - 79,262
  - 79,263 - 164,707
  - 164,708 - 343,714
  - 343,715 - 718,730

Total Number of Residents from Projection Impacted by Sea Level Rise in 2070

Why Focus on Future Populations?
- People moving inland
  - Increased inland road capacity
  - Physical deterioration of existing roads
  - Changes in land use and new roads
- Loss of future taxable land
- Changing travel patterns

Sources: Enviros, Garbird, USGS, WRI, NOAA, NRCC, EIA, Japan, NPT, EAF China, Hong Kong, EPI, Thailand, NOCC. © ORNL/USGS/Florida EPI, NOAA, ESRI

Florida 2070
Vulnerable Populations

Why Focus on Vulnerable Populations?
• Shift in travel patterns and mobility
• Barriers to certain forms of travel
• Vulnerable when thinking of extreme cases like evacuation routes

Statewide Impacts of High Risk Scenario (CS) on Population 30 - 39

- < 161: 5,314 - 7,646
- 162 - 481: 7,647 - 12,597
- 482 - 1,024: 12,598 - 17,593
- 1,025 - 1,963: 17,594 - 46,056

Statewide Impacts of High Risk Scenario (CS) on Population 65 and Up

- < 161: 3,804 - 5,313
- 162 - 481: 5,314 - 7,646
- 482 - 1,024: 7,647 - 12,597
- 1,025 - 1,963: 12,598 - 17,593
- 1,964 - 3,803: 17,594 - 46,056

Highest Concentrations of 65 Up impacted by permanent flooding

<table>
<thead>
<tr>
<th>County</th>
<th>Population</th>
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</thead>
<tbody>
<tr>
<td>Miami-Dade</td>
<td>37,974</td>
</tr>
<tr>
<td>Broward</td>
<td>28,557</td>
</tr>
<tr>
<td>Lee</td>
<td>21,273</td>
</tr>
</tbody>
</table>

This highlights where characteristics of current populations are
### Summary of Road Inventory and Parcels

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Length of Road Inventory Affected</th>
<th>Length of On-System FDOT Road Network Affected</th>
<th>Length of Designated Evacuation Routes Affected</th>
<th>Count of Property Parcels Affected</th>
<th>Area of Property Parcels Affected (Acres)</th>
<th>Sum of Taxable Property Value Affected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Risk Scenario (SLR C1)</td>
<td>4.5 miles</td>
<td>3 miles</td>
<td>3.5 miles</td>
<td>17,853</td>
<td>720,589</td>
<td>$2,840,396,372</td>
</tr>
<tr>
<td>Moderate Risk Scenario (SLR C3)</td>
<td>274 miles</td>
<td>53 miles</td>
<td>87 miles</td>
<td>149,125</td>
<td>1,786,740</td>
<td>$51,386,624,960</td>
</tr>
<tr>
<td>High Risk Scenario (SLR C5)</td>
<td>1,102 miles</td>
<td>260 miles</td>
<td>431 miles</td>
<td>493,486</td>
<td>2,878,609</td>
<td>$194,933,075,402</td>
</tr>
</tbody>
</table>

*NEARLY $200 BILLION IN TAXABLE PROPERTY IS IMPACTED IN THE CURVE 5 SCENARIO*

*NEARLY 40% OF ROAD LENGTH AFFECTED IN CURVE 5 ARE DESIGNATED EVACUATION ROUTES*
Critical Infrastructure

Damage to critical infrastructure at a regional level would have overall significant consequences on Florida’s Economy.

**Why Focus on Vulnerable Critical Infrastructure?**

<table>
<thead>
<tr>
<th>Facilities/Infrastructure</th>
<th>Total (Statewide)</th>
<th>2080 LOW</th>
<th>2080 MODERATE</th>
<th>2080 HIGH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transportation Infrastructure/facilities</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seaports</td>
<td>15 4 (26.66%)</td>
<td>9 (60%)</td>
<td>12 (80%)</td>
<td></td>
</tr>
<tr>
<td>Airports</td>
<td>18 1 (5.5%)</td>
<td>2 (11%)</td>
<td>6 (33%)</td>
<td></td>
</tr>
<tr>
<td>Emergency Response facilities</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fire Stations</td>
<td>2125 0</td>
<td>13 (0.6%)</td>
<td>56 (2.6%)</td>
<td></td>
</tr>
<tr>
<td>Police Stations/Law enforcement</td>
<td>994 0</td>
<td>5 (0.5%)</td>
<td>35 (3.5%)</td>
<td></td>
</tr>
<tr>
<td>Hospitals</td>
<td>349 1 (0.28%)</td>
<td>2 (0.57%)</td>
<td>2 (0.57%)</td>
<td></td>
</tr>
<tr>
<td>Schools</td>
<td>8552 0</td>
<td>14 (0.16%)</td>
<td>127 (1.48%)</td>
<td></td>
</tr>
</tbody>
</table>

Everglades Port

Miami Port
## Intermodal Rail Service

### Table 13
**Sea Level Rise Table FDOT District 5**

<table>
<thead>
<tr>
<th>Railroad</th>
<th>Name of Corridor</th>
<th>County Impacted</th>
<th>Miles of Track Impacted</th>
<th>Impacted by SLR C1</th>
<th>Impacted by SLR C3</th>
<th>Impacted by SLR C5</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSX</td>
<td>A-Line</td>
<td>Volusia</td>
<td>40 Miles</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Florida East Coast</td>
<td>FEC Mainline</td>
<td>Brevard</td>
<td>70 Miles</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Volusia</td>
<td>44 Miles</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Post Study and Collaboration

- Florida Transportation Plan Long Range Visioning
- Community of practice
- **Support** to Florida Transportation Plan subcommittees (Technology & Resilience)
- Framework for incorporating resilience into FDOT’s work:
  - Identifying future research needs
  - Providing tools and resources
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