INTEGRATING PREDICTION MODELING AND URBAN ANALYTICS INTO SCENARIO-BASED RESILIENT DESIGN

Professional Final Project
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Committee Members: Dr. Chang-Shan Huang | Dr. Michael O'Brien

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Tampa, Florida is ranked in the top five in the most vulnerable U.S. cities to flooding due to hurricanes. This research uses the LTM to predict potential future urban growth according to three different scenarios: 1) business as usual – predicted urban growth based on current growth patterns; 2) planned growth – predicted urban growth based on the current land use plan; and 3) resilient growth – predicted urban growth based on all future development occurring outside of the 100 year flood plain.
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Land Transformation Model – Process Diagram

Analysis Framework

SCENARIO MAKING
-- 3 Urban Growth Scenarios

SCENARIO 1: Business as Usual
Exclude existing urban, river & sensitive zones

SCENARIO 2: Growth as Plan
Exclude S1 and environmental sensitive zones

SCENARIO 3: Resilient Growth
Exclude S2 and 2040 sea level rise high & floodplain

Floodplain Prediction

8.40% BUILDING IN CURRENT FLOODPLAIN
ABOUT 1025323 SQ.FT
2,291 (9.02%) PEOPLE AT RISK
$144.94 MILLION FLOOD RISK (EXTENDED)

10.65% BUILDING IN HIGH FLOODPLAIN
ABOUT 1300086 SQ.FT
2,660 (9.31%) PEOPLE AT RISK
$175.93 MILLION FLOOD RISK (EXTENDED)

32.14% BUILDING IN EXTREME FLOODPLAIN
ABOUT 3922410 SQ.FT
6,114 (21.41%) PEOPLE AT RISK
$476.38 MILLION FLOOD RISK (EXTENDED)

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Early Adapter Non Adapter Late Adapter

Single Family (46\%) Multi-Family (4.8\%) Commercial (12\%) Mixed Use (9.8\%) Public Facilities

Multi-Family (4.8\%) Commercial (5.56\%) Mixed Use (13.52\%) Public Facilities (1.07\%)

Commercial (12\%) Mixed Use (9.8\%) Public Facilities

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L-THIA Model Outputs

**RUNOFF RESULTS**

<table>
<thead>
<tr>
<th></th>
<th>Current</th>
<th>S1</th>
<th>S2</th>
<th>S3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avg. Annual Runoff Volume (acre-ft)</td>
<td>292.51</td>
<td>354.99</td>
<td>293.94</td>
<td>214.83</td>
</tr>
<tr>
<td>Avg. Annual Runoff Depth (in)</td>
<td>5.21</td>
<td>6.32</td>
<td>5.24</td>
<td>3.82</td>
</tr>
</tbody>
</table>

**NONPOINT SOURCE POLLUTANT RESULTS**

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Current</th>
<th>S1</th>
<th>S2</th>
<th>S3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen (lbs)</td>
<td>1218</td>
<td>1466</td>
<td>1222</td>
<td>886</td>
</tr>
<tr>
<td>Phosphorous (lbs)</td>
<td>334</td>
<td>398</td>
<td>334</td>
<td>240</td>
</tr>
<tr>
<td>Suspended Solids (lbs)</td>
<td>39296</td>
<td>48185</td>
<td>39053</td>
<td>26463</td>
</tr>
<tr>
<td>Lead (lbs)</td>
<td>8.58</td>
<td>9.02</td>
<td>7.057</td>
<td>5.17</td>
</tr>
<tr>
<td>Copper (lbs)</td>
<td>8.613</td>
<td>10.045</td>
<td>8.115</td>
<td>6.367</td>
</tr>
<tr>
<td>Zinc (lbs)</td>
<td>109.032</td>
<td>136.027</td>
<td>107.069</td>
<td>70.235</td>
</tr>
<tr>
<td>Cadmium (lbs)</td>
<td>0.739</td>
<td>0.85</td>
<td>0.698</td>
<td>0.506</td>
</tr>
<tr>
<td>Chromium (lbs)</td>
<td>5.059</td>
<td>6.793</td>
<td>4.775</td>
<td>2.855</td>
</tr>
<tr>
<td>Nickel (lbs)</td>
<td>7.356</td>
<td>10</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>BOD (lbs)</td>
<td>18640</td>
<td>23046</td>
<td>19890</td>
<td>13245</td>
</tr>
<tr>
<td>COD (lbs)</td>
<td>66336</td>
<td>87606</td>
<td>69713</td>
<td>45547</td>
</tr>
<tr>
<td>Oil &amp; Grease (lbs)</td>
<td>4404</td>
<td>6021</td>
<td>4704</td>
<td>2960</td>
</tr>
<tr>
<td>Fecal Coliform</td>
<td>45378</td>
<td>51739</td>
<td>41328</td>
<td>33099</td>
</tr>
<tr>
<td>Fecal Strep</td>
<td>120272</td>
<td>141257</td>
<td>121329</td>
<td>90813</td>
</tr>
<tr>
<td>Total Pollutant</td>
<td>296017.39</td>
<td>359890.74</td>
<td>299798.71</td>
<td>213408.13</td>
</tr>
</tbody>
</table>

*L-THIA estimates changes in recharge, runoff, and nonpoint source pollution resulting from past or proposed development. In this basic model of L-THIA, users only need to input: their location (state and county); the type of soil in the area; and the type and size of land use change that will occur.*

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Design Strategies

**Ecological Landscape**
Clean the air while reducing the urban heat island effect, benefit for community’s recovery.
- Urban forest
- Urban tree canopy
- Environmental corridors
- Green belts
- Conservancy park
- Natural park
- Wetland
- Natural forest along the river
- Waterfront recreation
- Riverside jogging trail
- Habitat conservation
- Entrance biodiversity

**Community Redevelopment**
Redevelop communities, to reduce risk, improve ecological and human health.
- Neighborhood playground
- Neighborhood park
- Community park/Community garden
- Minparks
- Pool park
- Linear Park / Linkages
- Sports fields
- Dog park
- Amphitheater
- Community facilities
- Plaza and gathering space
- Shared courtyard

**Green Infrastructure**
Control flooding, provide needed community eco spaces.
- Green roof
- Rain garden
- Bioswale
- Green parking
- Carbon forest
- Permeable pavement
- Rainwater harvesting
- Small retention pond
- Sustainable urban drainage
- Low impact development

**Sustainable Transportation**
Use energy sparing by offering walkable, transit-oriented options for all supplemented by electric vehicles.
- Rapid transit buses
- Bike sharing scheme
- Green cycle lanes
- Good street connectivity
- Well-maintained footpaths
- Pedestrian crossings
- Charging facilities for an electric or hybrid vehicle
- Pedestrian-oriented signage
- Bus stop with shade
- Water transportation (pier)

**Local Economy Development**
Create functions for currently unused properties
- Fishing docks or piers
- Campgrounds
- Community-supported agriculture
- Small business incubators
- Lots + retail
- Public art focal point
- Affordable house
- Shared courtyard
- Neighborhood-serving retail space
- Cultural event/festival
- Diverse household types

**Adaptive Architecture**
Design and construct (or renovate) buildings to handle severe storms and flooding.
- Move or build house on higher ground
- Elevate above flood areas
- Build earthen barriers and levees around structures
- Flood proof
- Dry proofing and resistance
- Wet proofing and resilience
- Flood damage-resistant materials
- Roof root connection
- Roof extended into interior zone and building face
- Diverse household types

Data Source Website
7. https://tidesandcurrents.noaa.gov/sltrends/

Team Credits
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