Climate Change Risks and Adaptation Strategies in Chatham County/Savannah

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MPC – Savannah, GA

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Overview

- Climate Models
- Climate Impacts Statewide
  - Temperature Projections
- Climate Impacts in Chatham County
  - Temperature and Precipitation Projections
  - Surge and Sea Level Rise
- Climate Risk Matrix
- Identification of Adaptation Strategies

Climate Models

- Global Atmosphere-Ocean General Circulation Models (AOGCMs) [1]
  - Based upon accepted physical principles
  - Provide credible estimates of future climate change
- Global resolution not actionable on regional and local scales
- Earth System Models of Intermediate Complexity (EMIC) often used with AOCGMs to assess uncertainties associated with climate model parameters [1]

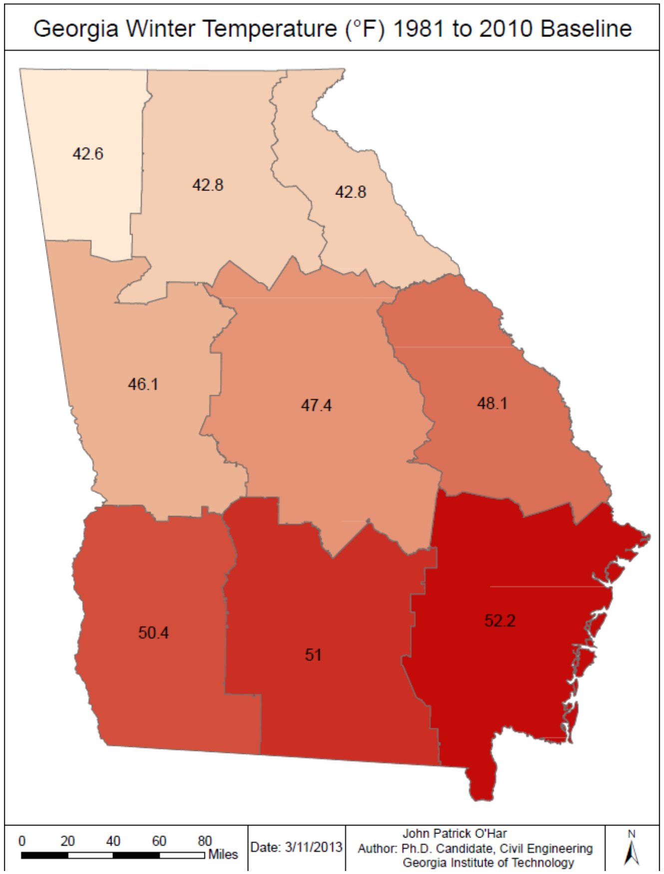
Emissions Scenarios

- IPCC Special Report on Emissions Scenarios (SRES) contains 6 scenario groups
  - Predict future GHG emissions based on demographic, social, economic, technological, and environmental developments [2]
- 3 used in this research
  - A1FI “Higher” emissions
  - A2 “Moderate” emissions
  - B1 “Low” emissions

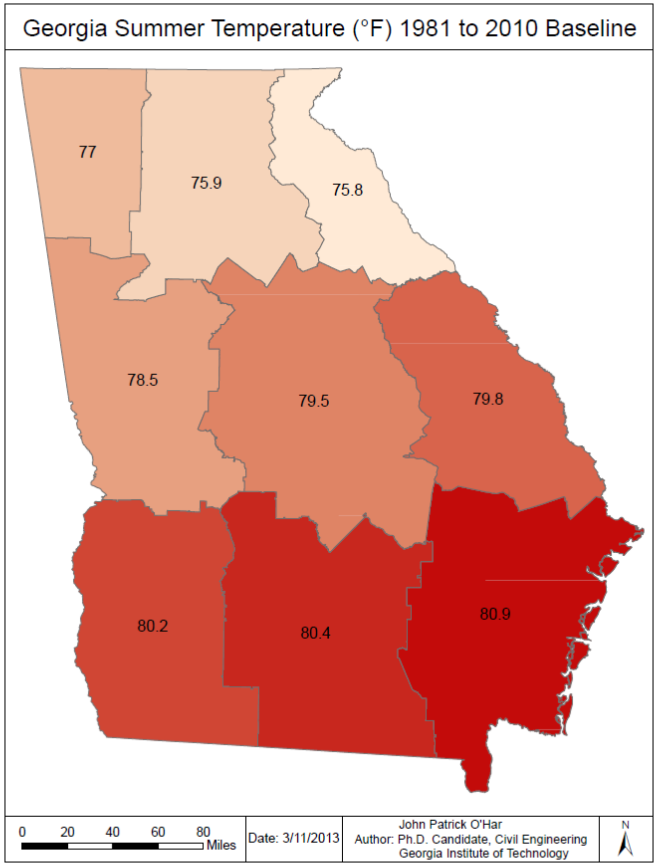
Downscaled Climate Projections

- USGS Southeast Regional Assessment Project (SERAP) best state-of-practice readily-available downscaled projections [3]
  - http://cida.usgs.gov/climate/gdp
- Statistical downscaling techniques produce model results at a higher spatial resolution
  - 1/8° or approximately 7.5 miles (12 km)
- Baseline data (1981 to 2010) from NOAA's National Climatic Data Center and records from the National Weather Service [4]

Georgia Statewide Baselines

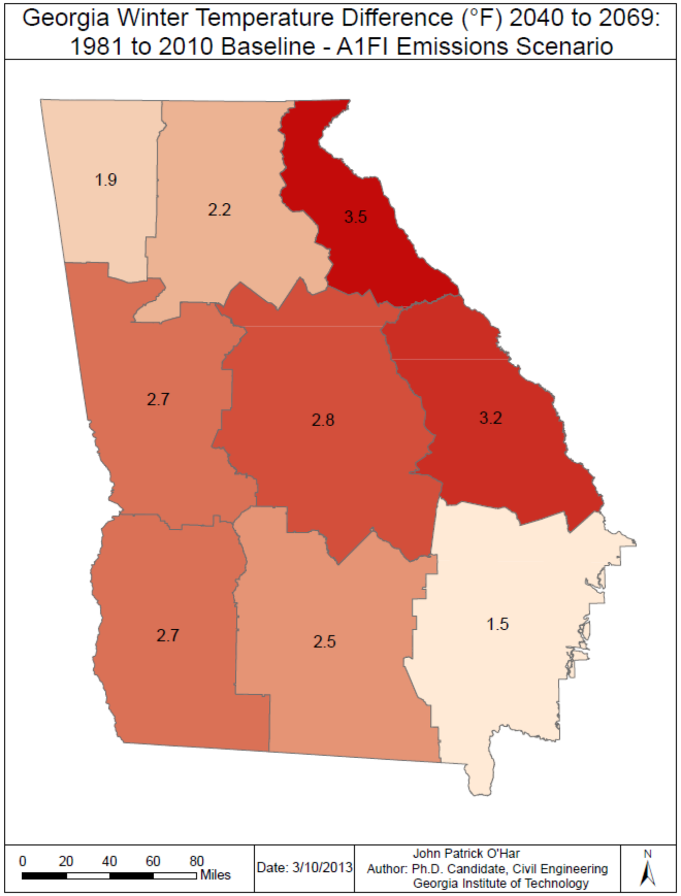


GA Winter 1981 to 2010 Mean Temp (°F) Baseline

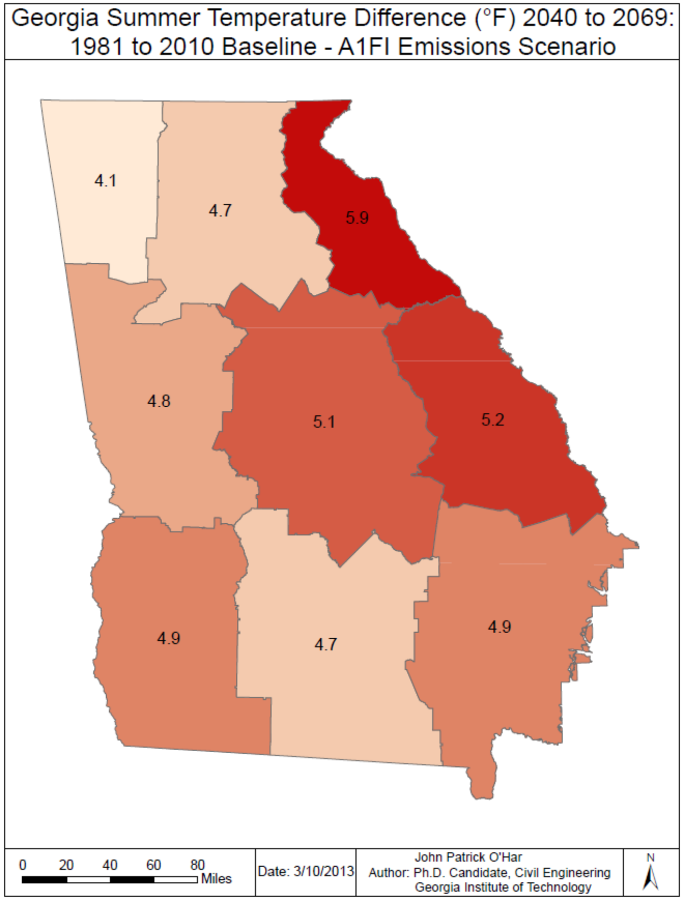


GA Summer 1981 to 2010 Mean Temp (°F) Baseline

2040 to 2069 GA Higher Emissions Projections

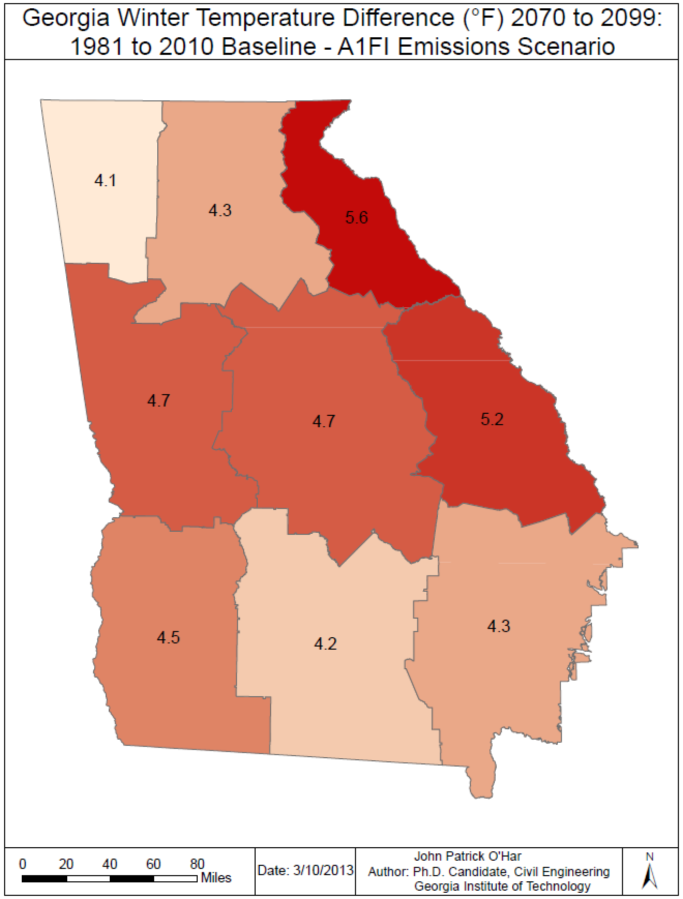


GA Winter 2040 to 2069 Temp (°F) Difference

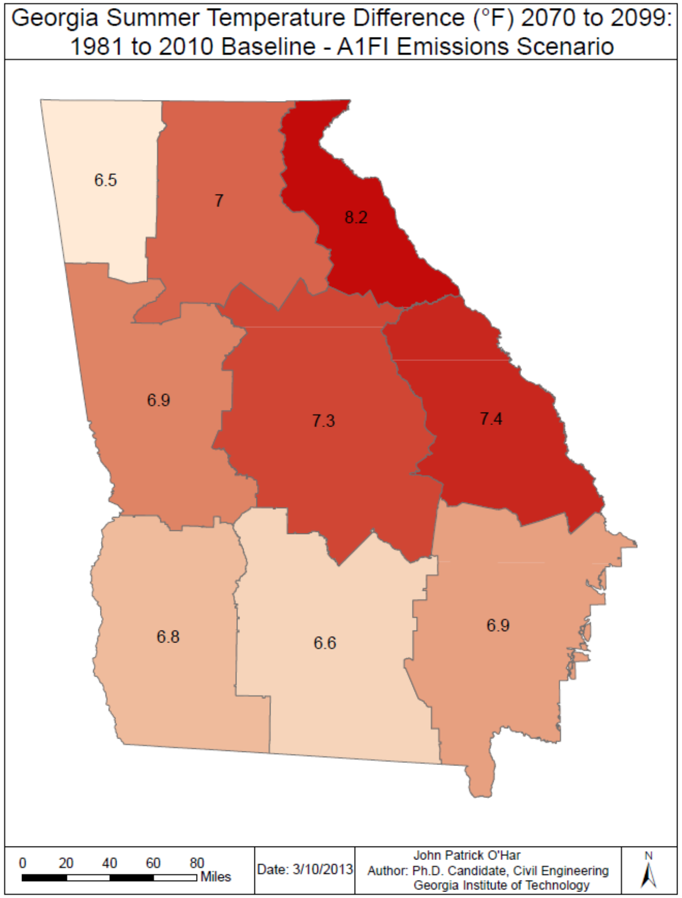


GA Summer 2040 to 2069 Temp (°F) Difference

2070 to 2099 GA Higher Emissions Projections



GA Winter 2070 to 2099 Temp (°F) Difference



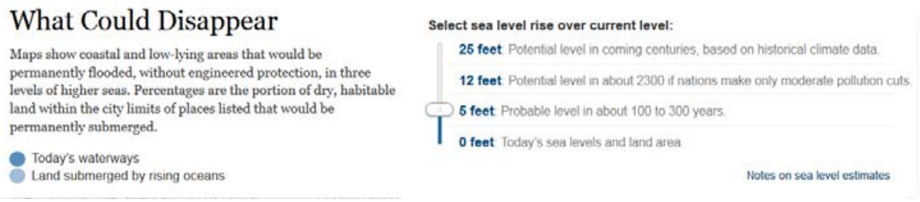
GA Summer 2070 to 2099 Temp (°F) Difference

Illustrative Impacts in Chatham County

- Sea Level Rise
- Coastal Storms and Surge
- Increased Wind Velocities
- Increased Temperatures
- Increased Frequency/Intensity of Precipitation
- Increased Extreme Temperatures
  - But Decreased Extreme Cold Over Time

Sea Level Rise

- Savannah featured in the press
  - New York Times [5]
  - NPR [6]
- Inundation due to tides already a concern



What Could Disappear

Maps show coastal and low-lying areas that would be permanently flooded, without engineered protection, in three levels of higher seas. Percentages are the portion of dry, habitable land within the city limits of places listed that would be permanently submerged.

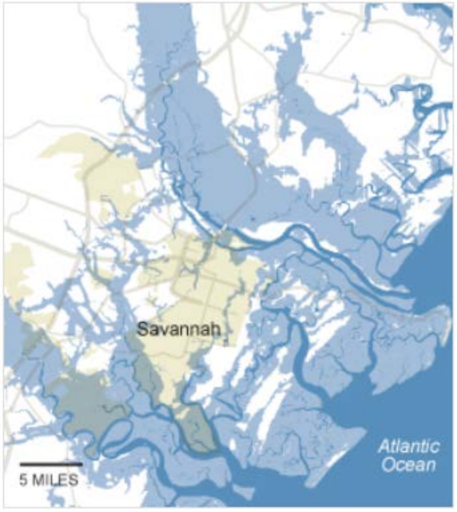
● Today's waterways
● Land submerged by rising oceans

Select sea level rise over current level:

25 feet Potential level in coming centuries, based on historical climate data.
12 feet Potential level in about 2300 if nations make only moderate pollution cuts.
5 feet Probable level in about 100 to 300 years.
0 feet Today's sea levels and land area

Notes on sea level estimates

Savannah, Ga. 8% flooded



Widespread flooding of estuaries along the Atlantic coast.

Source: NY Times

As seas rise, planning starts

Posted: November 9, 2009 - 4:15am | **Updated:** March 30, 2010 - 1

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By Mary La

Sea level ri
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This is what Burnside Island could look like with a 1 meter rise in sea level. (Image provided by Architecture 2030)

Source: savannahnow.com

Sea Level Rising Much Faster Than U.N. Projections

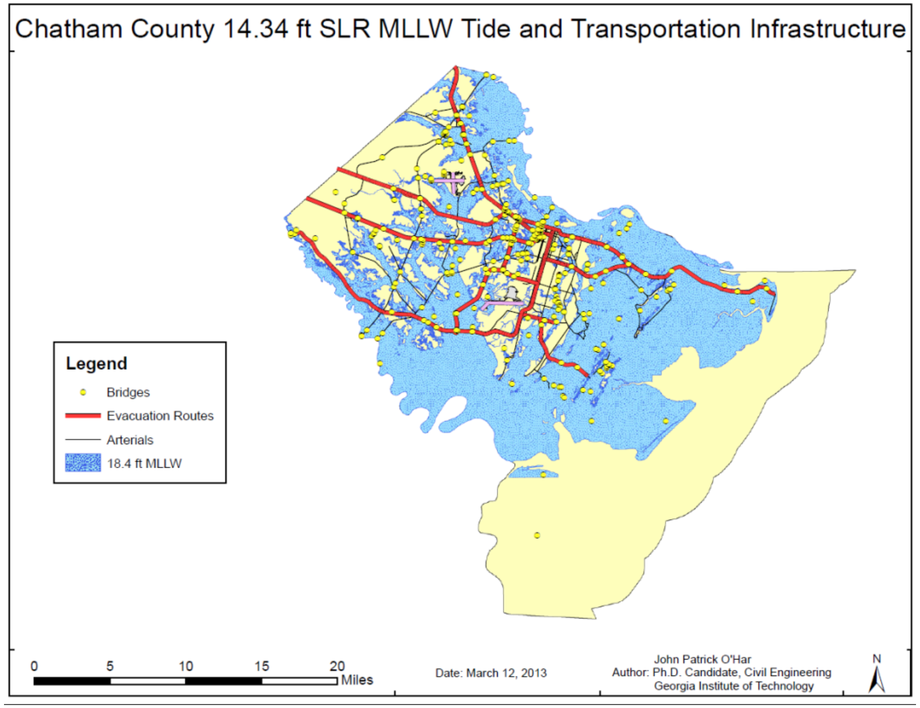
by EYDER PERALTA

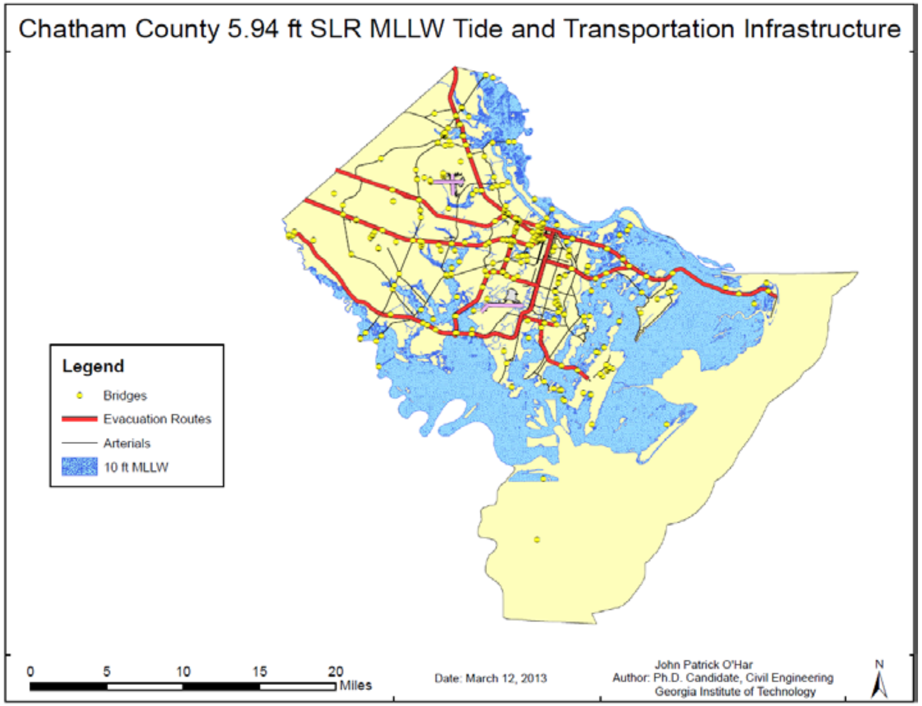
November 28, 2012 6:52 PM

"It singled out the California cities of Los Angeles and San Diego on the Pacific coast and Jacksonville, Florida, and Savannah, Georgia on the Atlantic, as the most vulnerable to historic flooding due to sea-level rise.

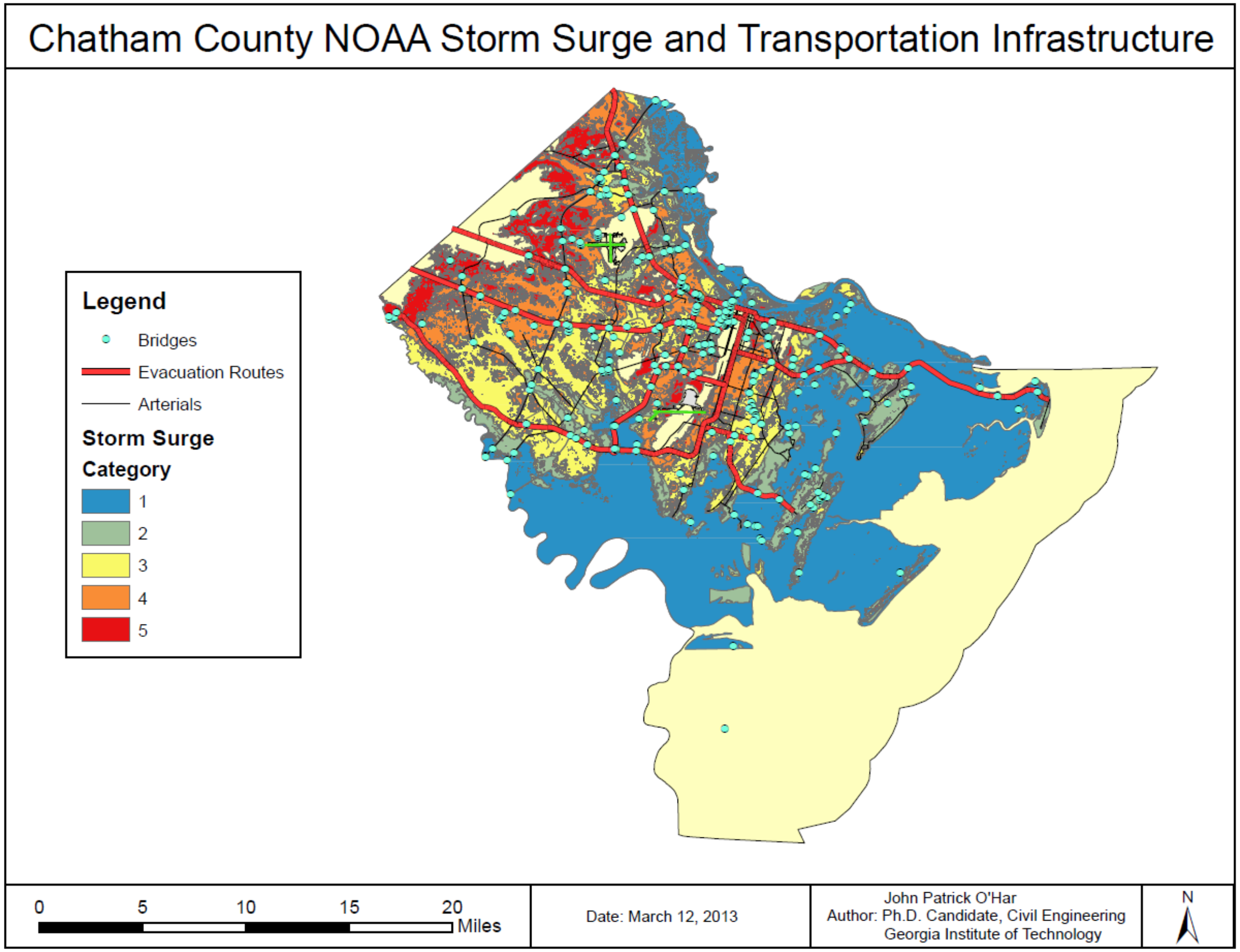
Source: NPR

SLR MLLW & Transpo Infra

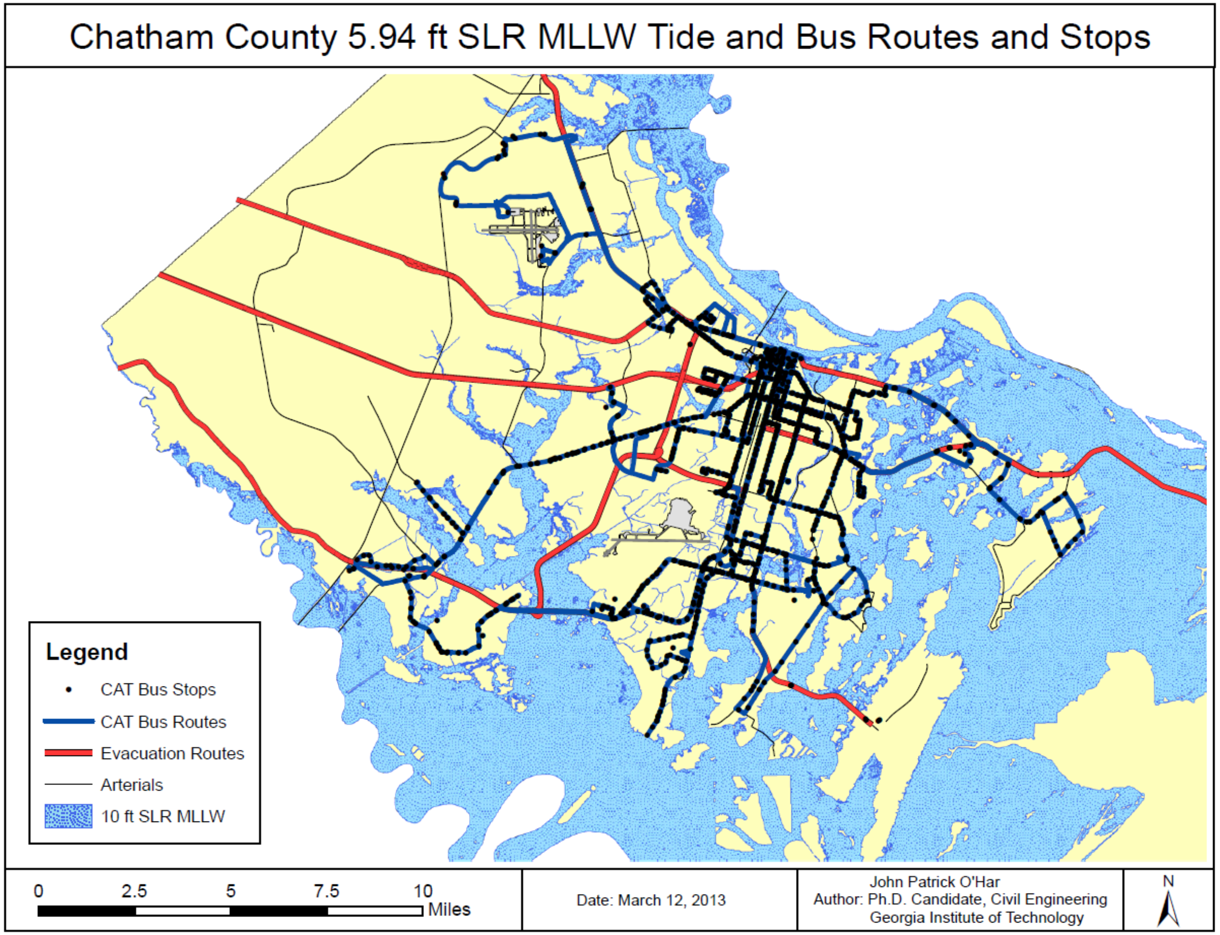

Chatham County 14.34 ft SLR MLLW Tide and Transportation Infrastructure


Chatham County 5.94 ft SLR MLLW Tide and Transportation Infrastructure

Storm Surge/Hurricane Categories & Transpo Infra



5.94 ft SLR MLLW & Bus Routes and Stops

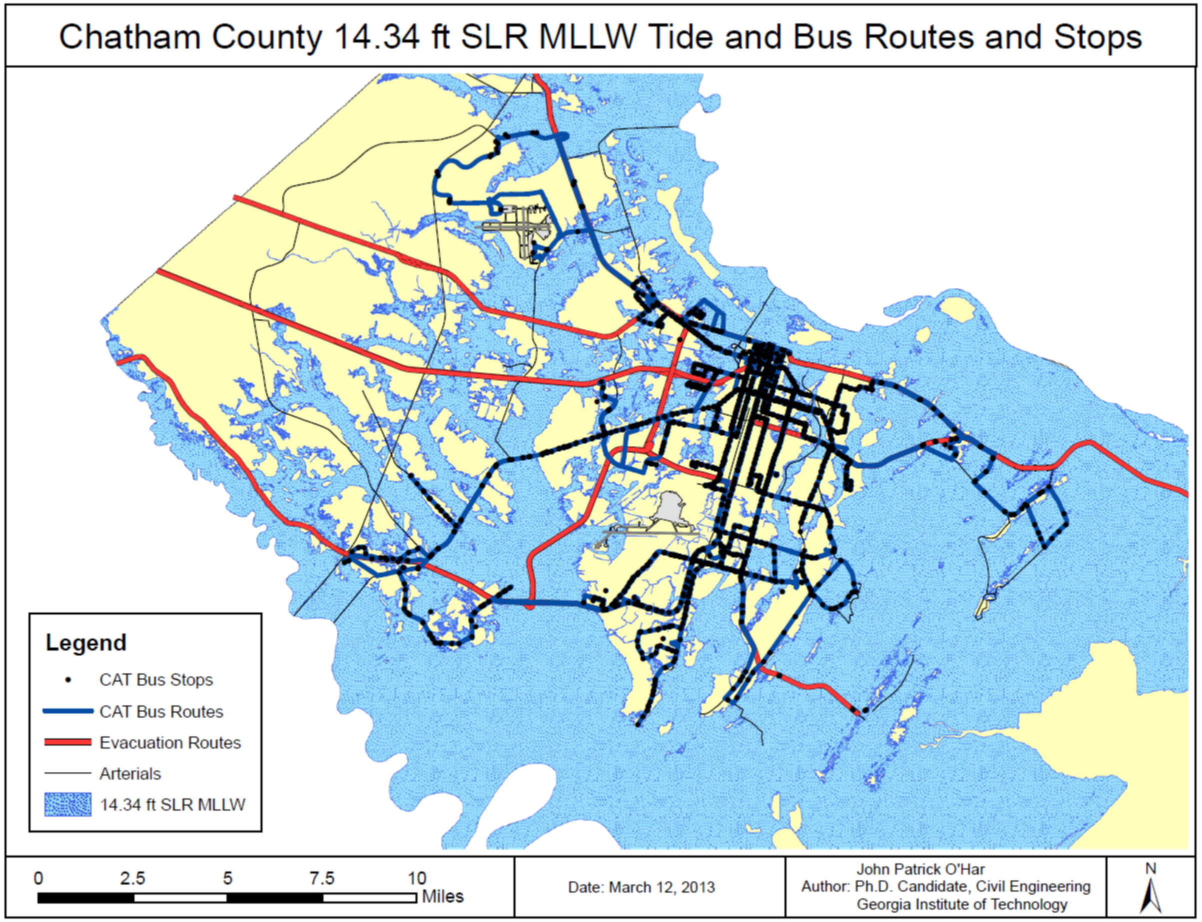


Chatham County 5.94 ft SLR MLLW Tide and Bus Routes and Stops

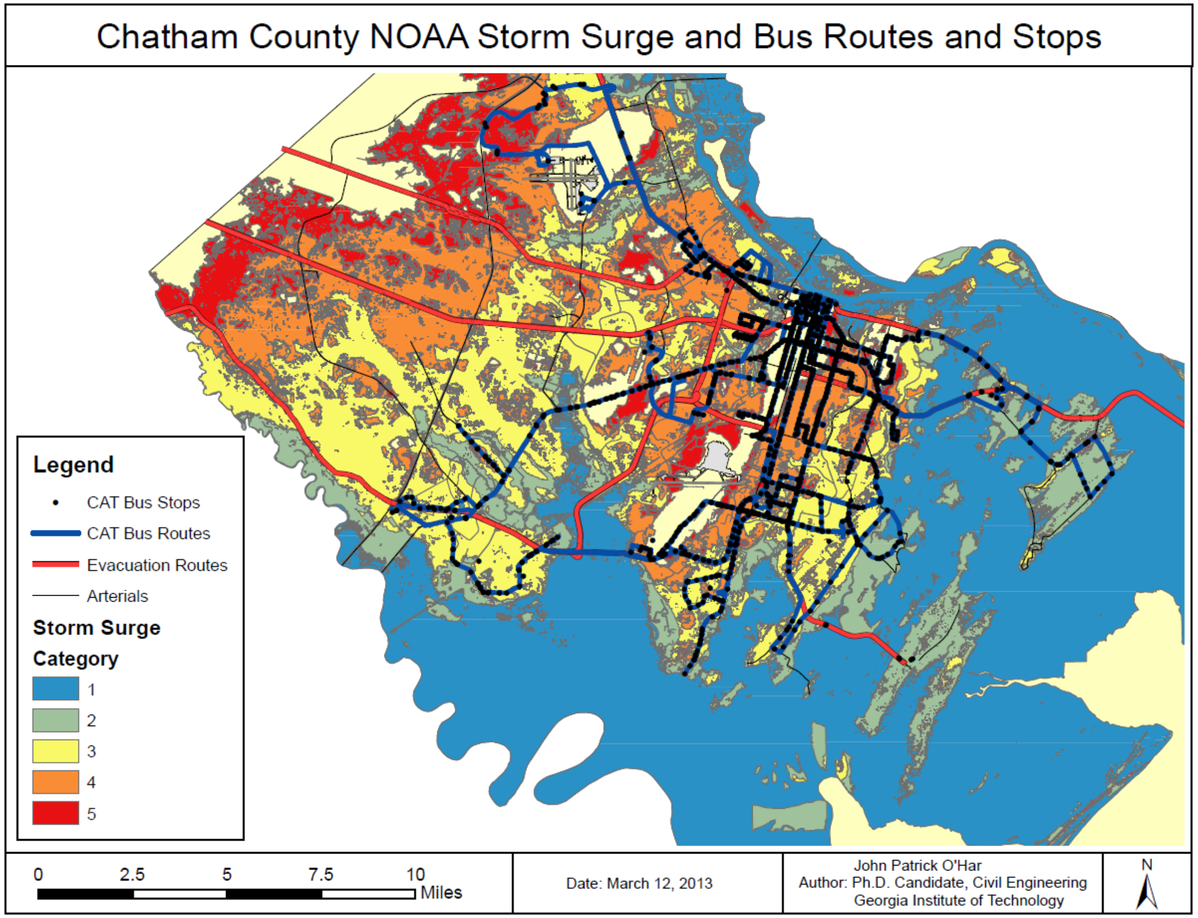
Date: March 12, 2013

John Patrick O'Har
Author: Ph.D. Candidate, Civil Engineering
Georgia Institute of Technology

14.34 ft SLR MLLW & Bus Routes and Stops



Storm Surge and Bus Routes and Stops



Chatham County NOAA Storm Surge and Bus Routes and Stops

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Temperature & Precipitation Projections for Chatham County

Savannah (Chatham County) Summer (June, July, & August)
Temperature & Precipitation Projections

A1FI Emissions Scenario Ensemble “High Emissions”

Time Horizon	1981-2010	2010-2039	2040-2069	2070-2099
Mean Temp °F	81.3	83.3	86.4	88.7
Mean Days Over 90°F	56.3	90.8	92.0	92.0
Mean Max Consecutive Days Over 90°F	N/A	66.5	91.0	91.0
Mean Days Over 100°F	1.8	10.20	37.80	70.8
Mean Max Consecutive Days Over 100°F	N/A	3.25	6.80	33.8
Mean Max Daily (cumulative 24 hr.) precip (in.)	5.41	6.35	7.26	6.64
Mean Days with 1" or more precip	5.4	18.0	22.1	25.1

A2 Emissions Scenario Ensemble “Moderate Emissions”

Time Horizon	81.3	83.2	85.2	87.1
Mean Temp °F	56.3	91.9	92.0	92.0
Mean Days Over 90°F	N/A	89	91.0	91.0
Mean Max Consecutive Days Over 90°F	1.8	27.30	57.2	85.0
Mean Days Over 100°F	N/A	5.60	17.2	32.4
Mean Max Consecutive Days Over 100°F	5.41	6.43	6.84	6.64
Mean Max Daily (cumulative 24 hr.) precip (in.)	5.4	33.6	36.7	35.60
Mean Days with 1" or more precip	81.3	83.2	85.2	87.1

B1 Emissions Scenario Ensemble “Low Emissions”

Time Horizon	81.3	83.3	84.0	84.6
Mean Temp °F	56.3	92.0	92.0	92.0
Mean Days Over 90°F	N/A	91.0	91.0	91.0
Mean Max Consecutive Days Over 90°F	1.8	30.0	39.2	54.3
Mean Days Over 100°F	N/A	9.50	8.00	22.00
Mean Max Consecutive Days Over 100°F	5.41	7.29	6.27	7.28
Mean Max Daily (cumulative 24 hr.) precip (in.)	5.4	33.9	35.1	35.70
Mean Days with 1" or more precip	81.3	83.3	84.0	84.6

Savannah Region (Chatham County) Winter (December, January, & February)
Temperature & Precipitation Projections

A1FI Emissions Scenario Ensemble “High Emissions”

Time Horizon	1981-2010	2010-2039	2040-2069	2070-2099
Mean Temp °F	51.4	52.3	54.2	56.2
Mean Freezing Days (Low <= 32°F)	19.5	52.1	41.2	30.2
Mean Max Consecutive Freezing Days	N/A	18.5	2.16	9.6
Mean Max Daily (cumulative 24 hr.) precip (in.)	3.30	3.17	3.14	3.08
Mean Days with 1" or more precip	2.6	9.41	7.97	7.79

A2 Emissions Scenario Ensemble “Moderate Emissions”

Time Horizon	1981-2010	2010-2039	2040-2069	2070-2099
Mean Temp °F	51.4	52.4	53.8	55.7
Mean Freezing Days (Low <= 32°F)	19.5	76.0	67.1	55.0
Mean Max Consecutive Freezing Days	N/A	19.6	19.3	11.5
Mean Max Daily (cumulative 24 hr.) precip (in.)	3.30	3.78	3.82	3.66
Mean Days with 1" or more precip	2.6	17.5	19.6	21

B1 Emissions Scenario Ensemble “Low Emissions”

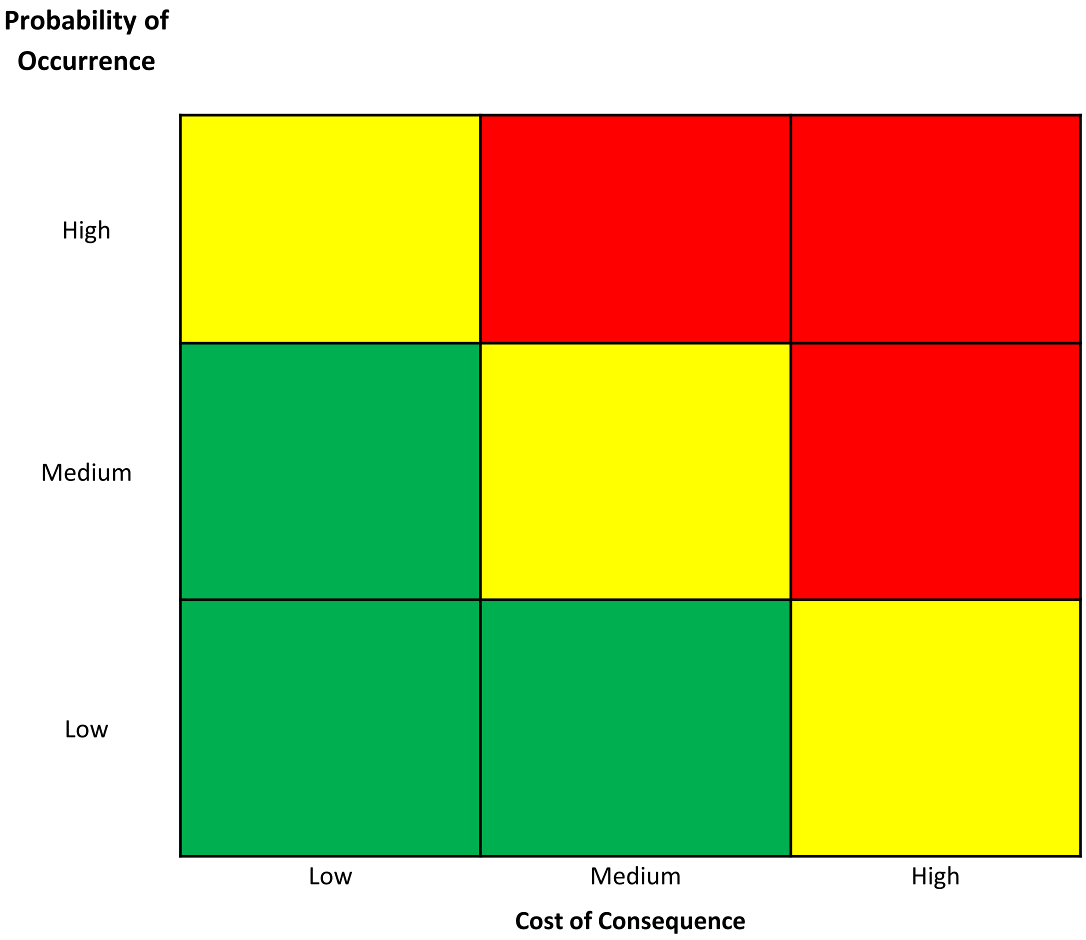
Time Horizon	1981-2010	2010-2039	2040-2069	2070-2099
Mean Temp °F	51.4	52.2	53.0	53.5
Mean Freezing Days (Low <= 32°F)	19.5	76.5	72.7	69.9
Mean Max Consecutive Freezing Days	N/A	16.7	39.8	15.7
Mean Max Daily (cumulative 24 hr.) precip (in.)	3.30	3.37	3.49	3.70
Mean Days with 1" or more precip	2.6	20.4	20.0	20.4

Illustrative Listing of Climate Impacts

Impact Category	Adaptation Strategies
Precipitation: accelerated asset deterioration	• Conduct early vulnerability assessments • Give greater weight to potential for ground subsidence in design of infrastructure • Accelerate replacement cycles • Shift to materials with greater resistance to moisture and heat/cold cycles • Incorporate design features such as increased pavement sloping to improve resistance to precipitation
Precipitation and sea level rise: Increased incidence of flooding events	• Re-site or floodproof infrastructure • Greater protections and construction limitations for floodplains and coastal areas.
Precipitation: Water scarcity and loss of winter snowpack	• Shift to less water-intensive construction methods • Shift ROW plantings to drought-resistant species and designs that reduce runoff
Precipitation: Increased incidence of wildfires	• Vulnerability assessments incorporated in infrastructure location decisions • Use of fire-resistant construction materials and landscaping
Precipitation: Shift in ranges of endangered species	• Keep abreast of ecological studies on a regional basis to detect observed shifts in habitat.
Temperature: Arctic asset and foundation deterioration	• Install insulation or cooling systems in roadbeds to prevent thawing • Relocate facilities to more stable ground • Remove permafrost before construction for new facilities
Temperature: Increase in the frequency and severity of heat events	• Plan for more frequent maintenance • Use of heat-resistant roadway materials • Greater use of expansion joints in roadways, bridges, and rail guideways.
Temperature: Reduction in frequency of severe cold	• Capitalize through the extension of construction and maintenance season

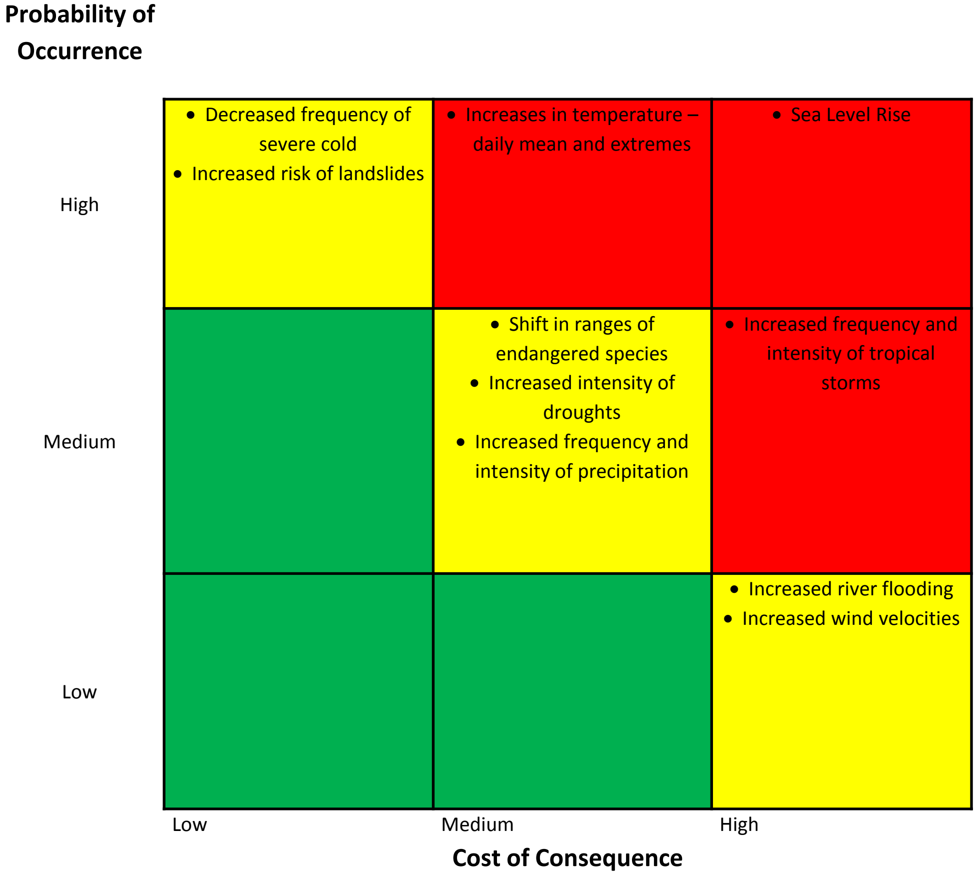
Impact Category	Adaptation Strategys
Sea level rise: Inundation of infrastructure	• Relocate assets • Develop redundancy in travel routes near the shoreline • Disinvest in infrastructure too costly to protect • Elevate or hardscape the most critical infrastructure • Expand drainage and pumping capacity
Sea level rise: Storm surges	• Protective designs] • Relocation of facilities
More intense weather events: Damage to assets	• Retrofit assets early for greater resistance to extreme weather • Incorporate storm resistant features into future designs • Minimize water-impervious surfaces in designs and design infrastructure to slow run-off from heavy rain events
More intense weather events: Increased frequency of road traffic disruption, including interruption of emergency routes	• More stringent design, operations standards • Develop redundancy in travel routes near the shoreline • Elevate or hardscape the most critical infrastructure • Create Transportation Management Centers, improve monitoring of conditions and real-time information made available to the public • Greater emphasis on emergency evacuation procedures, making them routine
Increased planning, construction, or operating costs due to climate change legislation	• Early adoption of energy-saving measures to minimize the impacts of rising energy costs
Organizational adjustments (replace outmoded procedures, acquire new competencies)	• Conduct early reevaluation of procedures in advance of new requirements

Climate Impacts Risk Matrix



Probability of Occurrence			
High	🟨	🟥	🟥
Medium	🟩	🟨	🟥
Low	🟩	🟩	🟨
	Low	Medium	High
		Cost of Consequence	

GDOT Workshop Examples



Probability of Occurrence	Low	Medium	High
High	🟨 - Decreased frequency of severe cold - Increased risk of landslides	🟥 - Increases in temperature – daily mean and extremes	🟥 - Sea Level Rise
Medium	🟩	🟨 - Shift in ranges of endangered species - Increased intensity of droughts - Increased frequency and intensity of precipitation	🟥 - Increased frequency and intensity of tropical storms
Low	🟩	🟩	🟨 - Increased river flooding - Increased wind velocities

Cost of Consequence

Potential Climate Impacts	Adaptation Strategies	
	Short-term	Long-term
- **Sea Level Rise** - **Increased frequency and severity of coastal storms**	- Retrofit existing bridges with deeper foundations and shear keys - Improve drainage/increase culvert capacity	- Elevate new bridges and build with deeper foundations
- **Increased Temperatures** - **Wider temperature ranges**	- Utilize materials with greater thermal capacity	- Research materials that can better withstand heat
- **Increased Wind Velocities**		
- **Shift in Endangered Species**		
- **Decrease in frequency of extreme cold**		

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