The 4th IACP Annual Conference

海平面上升引起的交通网络脆弱性分析

Vulnerability Analysis of Transportation Networks as a Result of Sea Level Rise

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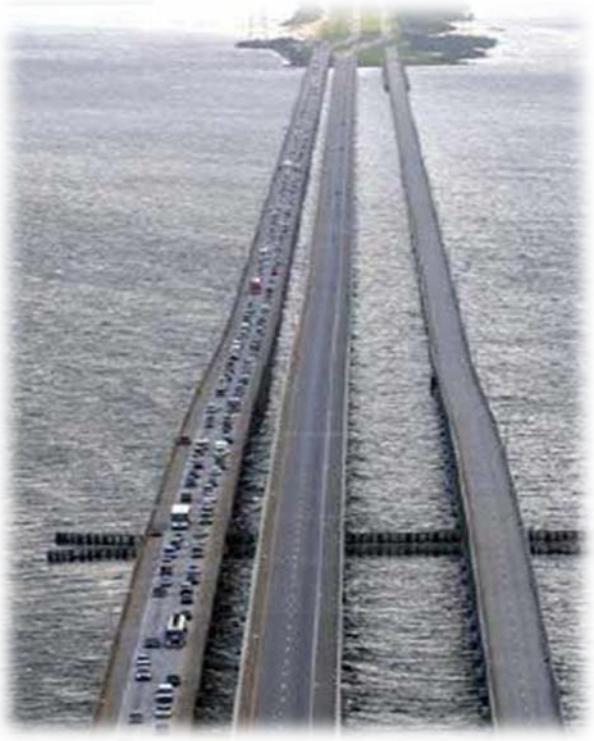
1. Introduction

- Human activities have contributed to climate changes and that climate change will have important impacts on the environment and quality of life (IPCC, 2007)

- Sea level will continue to rise in the 21st century with an occurrence probability of more than 99 percent (TRB, 2008)



1. Introduction

The impacts of climate change on transportation network and how to quantify these impacts so as to make a better decision.

Transportation network vulnerability analysis measures the impact of disasters on transportation system and finds the most vulnerable areas as well as the most important links.

2. Sea Level Rise Impact Analysis

- Study area: the south Miami area
- Elevation data: Light Detection and Ranging (LiDAR) data from NOAA

  Better than 30 centimeters at the 95 percent confidence level
- Transportation network: the Florida Statewide Model (FLSWM) of Florida Standard Urban and Transportation Model Structure (FSUTMS)
- Target year: 2060 (Florida Transportation Plan)

2. Sea Level Rise Impact Analysis

Table 1 Sea level rise scenarios used in the study

Sea level rise (m)	Probability (%)	Projection year	Source
0.3	50	2060	US Global Change Research Program
1.0	95	2060	FHWA

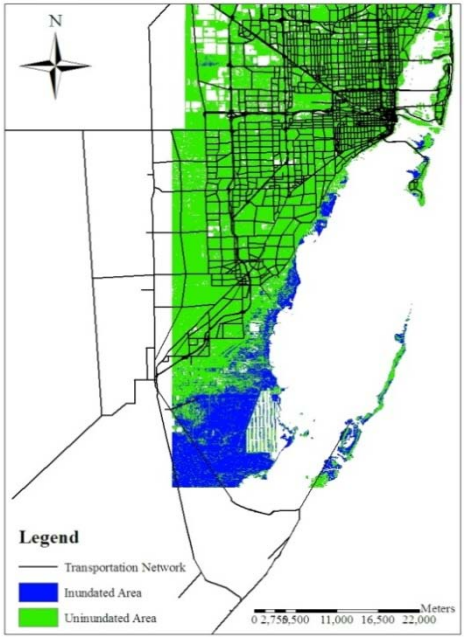


Figure 1 Inundation map of 0.3 meter SLR

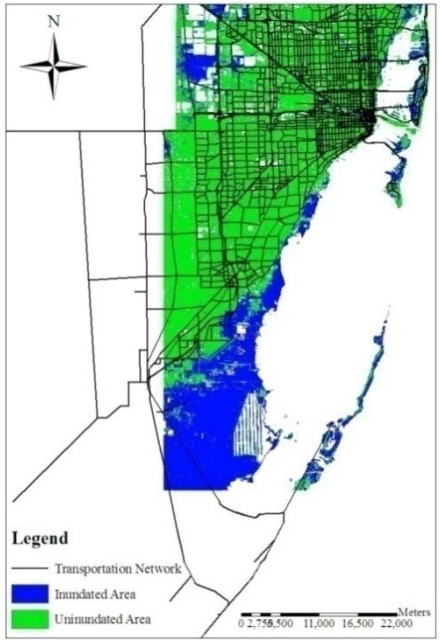


Figure 2 Inundation map of 1.0 meter SLR

3. Transportation Network Vulnerability Analysis

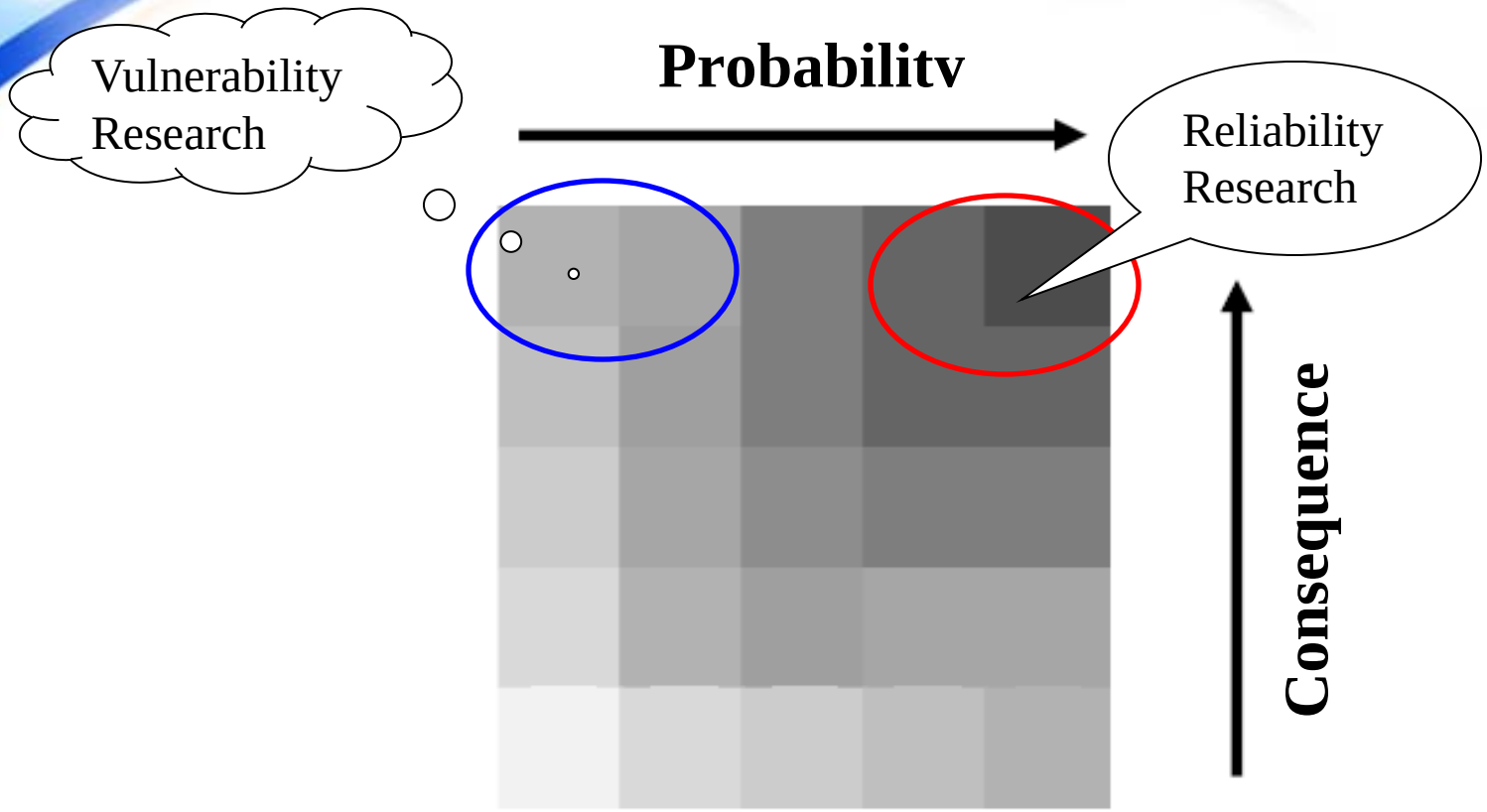


Figure 3 Probability and consequence combination
(Source: Berdica, 2002)

3. Transportation Network Vulnerability Analysis

Berdica (2002) vulnerability in the road transportation system is a susceptibility to incidents that can result in considerable reductions in road network serviceability.

- **Definition**: *the susceptibility and degree of inability of transportation system to resist to natural or manmade incidents*.

susceptibility=probability of incident ×probability of failure

inability= accessibility reduction rate

3. Transportation Network Vulnerability Analysis

- **Methodology**

  Location (TAZ)-based accessibility index:

$$A_i = w_i^p \sum_{j=1}^{n-1} w_j^r \frac{f(t_{ij})^{-\alpha}}{f^0(t_{ij})^{-\alpha}} \qquad (i \neq j)$$

A_i accessibility of zone i;

w_i^p population weight of zone i which equals to the ratio of population in zone i over all the population in the study area;

w_j^r weight of residence in zone j which equals to the ratio of residence in zone j over all the residence in the study area except for residence in zone i;

$f^0(t_{ij})$ original travel cost between region i and j without network degradation;

$f(t_{ij})$ travel cost between region i and j after network degradation;

α travel cost decay parameter;

3. Transportation Network Vulnerability Analysis

Degree of transportation network degradation:

$$DD^j = \sum_{i=1}^{n} A_i^0 - \sum_{i=1}^{n} A_i^j$$

DD^j degree of network degradation if link (or link set) j is failed;

A_i^0 accessibility of zone i without network degradation;

A_i^j accessibility of zone i if link j is failed.

Accessibility reduction ratio of zone i with the failure of link (or link set) j

$$ARR_i^j = \frac{A_i^0 - A_i^j}{A_i^0}$$

3. Transportation Network Vulnerability Analysis

Transportation system vulnerability is formulated as below:

$$V_d = prob_d \times DD^j$$

V_d vulnerability of the network with the network degradation probability;

$prob_d$ probability of network degradation d.

3. Results

Case study

The south Miami area which has 130 traffic analysis zones (TAZs) in the Florida Statewide Model.

Travel time between TAZs is calculated in Cube

The vulnerability calculation is coded in Matlab

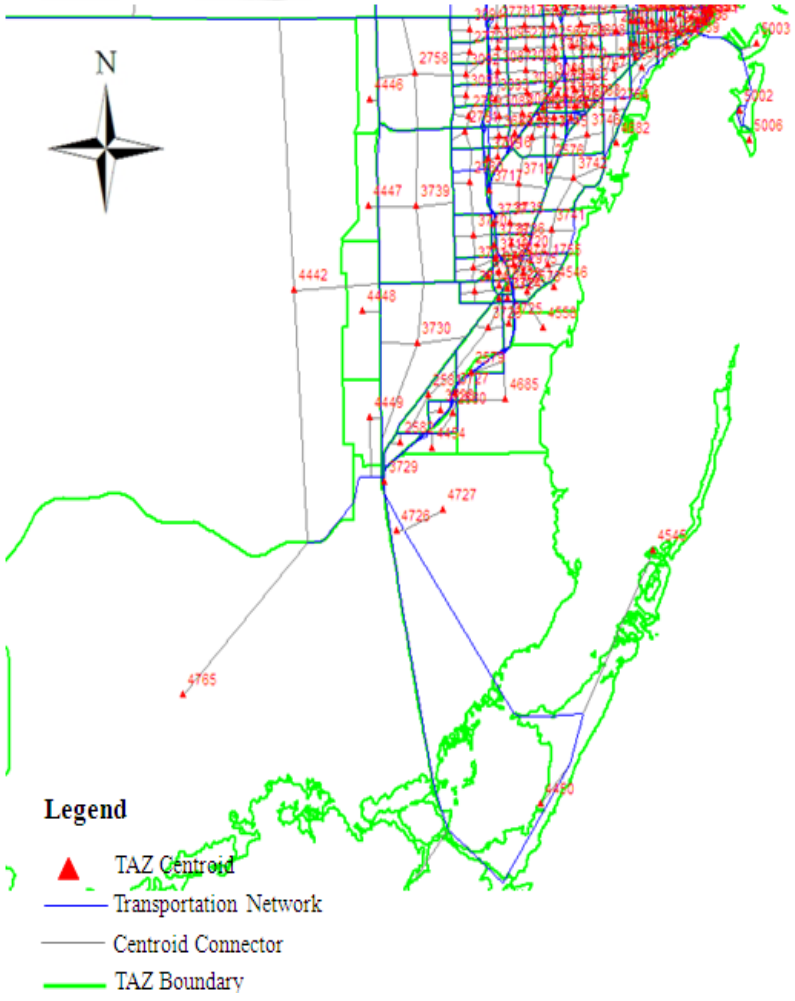


Figure 4 TAZ distribution of south Miami area

3. Results

Table 2 Transportation network vulnerability of two sea level rise scenarios

SLR scenario (m)	Probability (%)	Overall accessibility reduction	Vulnerability (%)
0.3	50	0.0409	2.05
1.0	95	0.0812	7.71

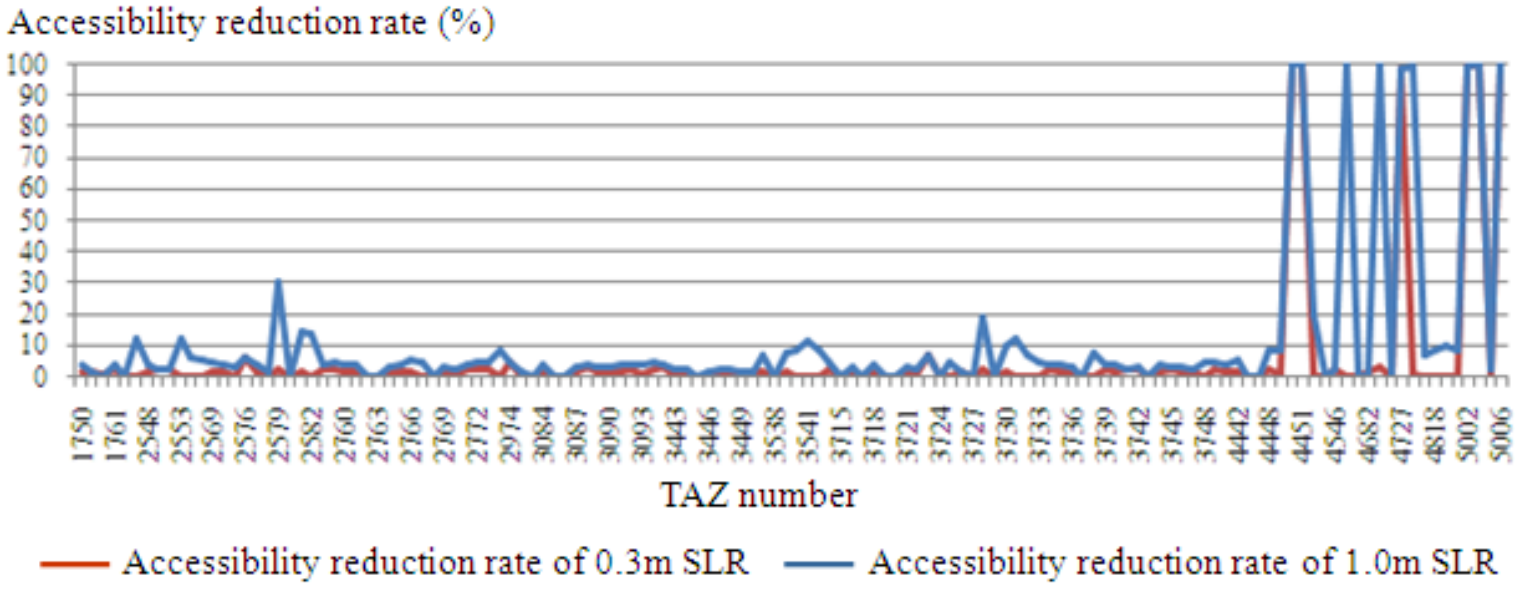
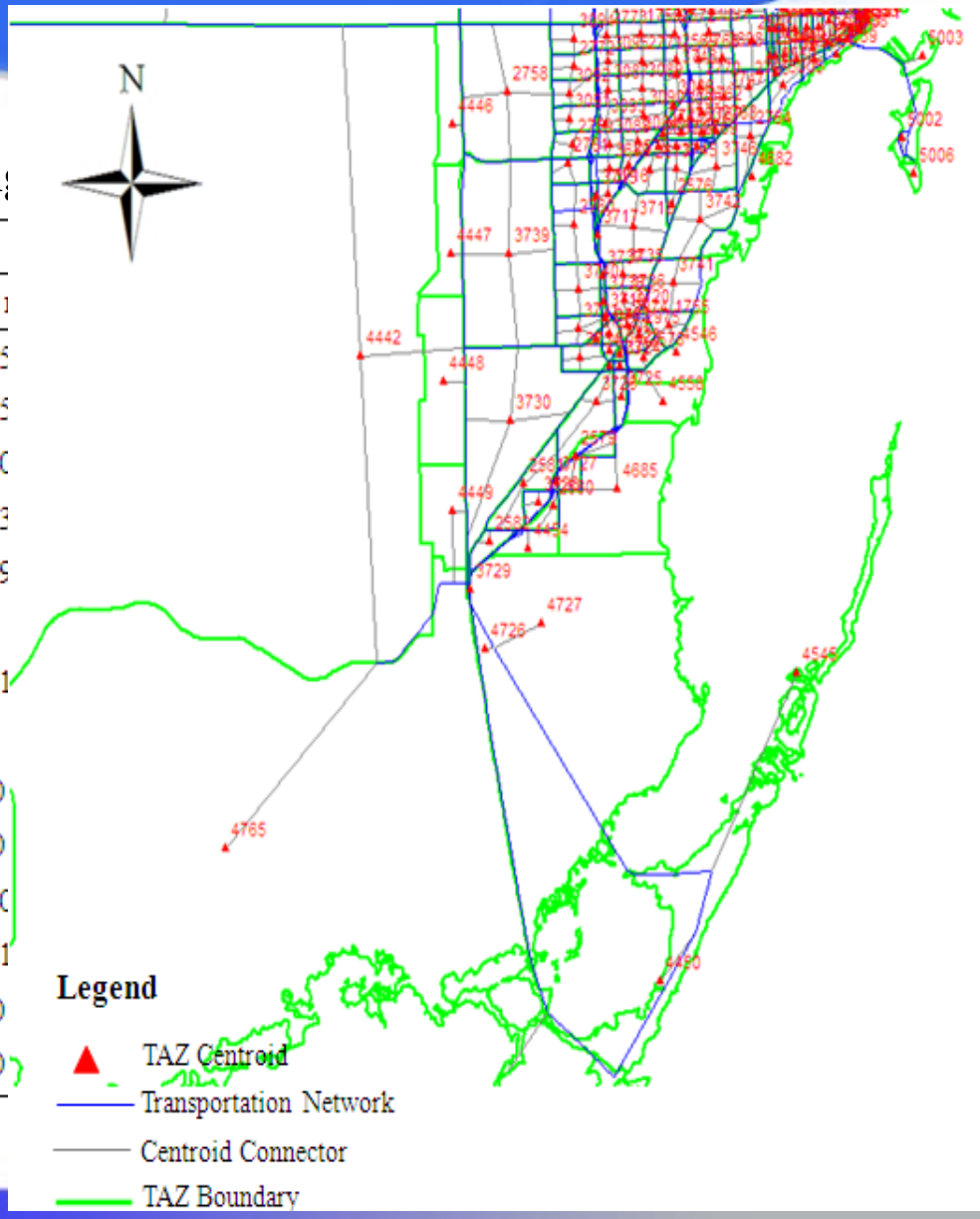


Figure 5 Accessibility reduction rate of individual TAZ under two scenarios

3. Results

Table 3 Accessibility chan

TAZ numbers	Accessibility reduction	
	0.3 m SLR	1.0
2547	0.0	12.5
2553	0.0	12.5
2579	2.5	30.0
2581	1.8	14.3
2582	0.0	13.9
3540	0.0	8.3
3541	0.0	11.1
3739	2.2	3.9
4450	100.0	100
4451	100.0	100
4765	1.0	99.0
5002	99.13	99.1
5003	100.0	100
5006	100.0	100



Q & A

Thank You!

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