Conference Paper, Published Version

Bolter, Keren

Assessing the Threat of Sea Level Rise to Vulnerable Populations in Southeast Florida

ASSESSING THE THREAT OF SEA LEVEL RISE TO VULNERABLE POPULATIONS IN SOUTHEAST FLORIDA

Keren Bolter[1]

The increase in Earth's sea level is a truly tangible and visible consequence of changes in climate. Eustatic sea level rise (SLR) occurs on a global level, but the local impacts vary. Southeast Florida (SE FL) is among the world's most vulnerable regions, due to its low-lying topography and highly permeable limestone substrate (Nicholls, Hanson & Herweijer 2007). Coastal populations are particularly at risk due to their increased probabilities for erosion, inundation and storm surge impact. Interior populations are also susceptible to rising water tables and flooding amplified by SLR. Because of the region's high population density and substantially valued properties, most SLR studies focus only on financial risk, and do not consider whether the inhabitants of coastal and interior areas have the means to relocate (Yohe et al.,1996; Neumann et al., 2011). This study examines socioeconomic patterns at low elevations in the counties of Palm Beach, Broward, and Miami-Dade, and distinguishes vulnerable communities that lack of ability to respond to SLR. Using GIS, highly accurate LIDAR elevation data was overlaid with block census data to pinpoint clusters that have vulnerable populations, low elevations, and proximity to the coast. A spatial vulnerability index was generated based on likelihood of inundation as well as socioeconomic impacts. This technique is based on the objective and traditional method used to quantify risk: to multiply probability by consequence. This vulnerability analysis considers the ability of a potentially displaced population to relocate.

Risk is a physical factor that only depicts the probability or frequency of an event's occurrence and the damage that can be inflicted. Assessing the vulnerability of a population requires socioeconomic attributes to be linked to risk (Boruff, Emrich, & Cutter, 2005). The results provide information important for incorporating SLR into planning efforts, not just to account for financial risk, but also to identify elderly, low-income earners, and minority communities that are most vulnerable to increased flooding and permanent inundation. The current decisions that planners make about development will impact the future, as SLR continues to exacerbate coastal hazards.

ArcMap was used to examine 2000 block groups from census data with 10-foot horizontal resolution LIDAR digital elevation maps (DEMs), a mean higher high water (MHHW) surface, and storm surge zones. An index was created to consider both physical (likelihood) and social (consequence) vulnerabilities. The vulnerability index (I_n) for population density, African American density, Hispanic population density, and median age is the ratio of each census block's value (V_n) to the maximum value (V_{max}) (eq. 1). For median household income and median home value, eq. 2, was used (both from Wu, 2002). Index vulnerabilities were averaged to give a consequence rating from 0-1. Proximity to a storm surge area caused the block group to be considered in a higher class of likelihood.

This study identifies residents that may lack the ability to respond to SLR. Results indicate that the most vulnerable populations to SLR are those living near the coast, particularly in Miami Dade County. However, there are significant inland populations in Broward and Miami-Dade

[1] PhD Student, Department of Geosciences, Florida Atlantic University, and Research Assistant for Center for Environmental Studies, Boca Raton, FL 33431, USA (kbolter@fau.edu)

LIKELIHOOD					
0-1 ft	M	MH	H	H	H
1-2 ft	ML	M	MH	H	H
2-3 ft	L	ML	M	MH	H
3-4 ft	L	L	ML	M	MH
4-5 ft	L	L	L	ML	M
	0-.20	.20-.40	.40-.60	.60-.80	.80-1
	CONSEQUENCE				

Figure 1: Vulnerability Index

counties that have a medium to medium high risk of inundation and flooding due to SLR. A caveat to the study is the uncertainty that is inherent with known errors relating to elevation and tidal surface data, along with the averaging for census blocks.

$$I_n = \frac{V_n}{V_{max}} \quad (1)$$

$$I_n = 1 - \frac{V_n}{V_{max}} \quad (2)$$

The vulnerability index (Fig. 1) took storm surge and average elevation into account as well as the average of all of the social indicator consequence ratings to assign each block one of five relative vulnerabilities that increased from low (L) to high (H). Table 2 breaks down and quantifies the resulting proportions of each county for each social indicator. There is a statistical significance between occurrence of low income and minorities. Broward had the highest proportion of residents at the medium vulnerability level by a wide margin. Each rating was indicated on the vulnerability map's symbology (Fig. 2). The results support the conclusion that Miami-Dade is by far the most vulnerable.

Table 1 Percent of total county population living in blocks with median elevation between 0-5 ft above sea level

	Palm Beach	Broward	Miami-Dade
Median Income <30k	0.3%	4.9%	10.9%
Median Age >60	3.2%	2.3%	0.2%
Storm Surge Area	9.10%	14.0%	71.0%
Hispanic	8.20%	24.6%	62.5%
Total Population	957749	1704622	2375339

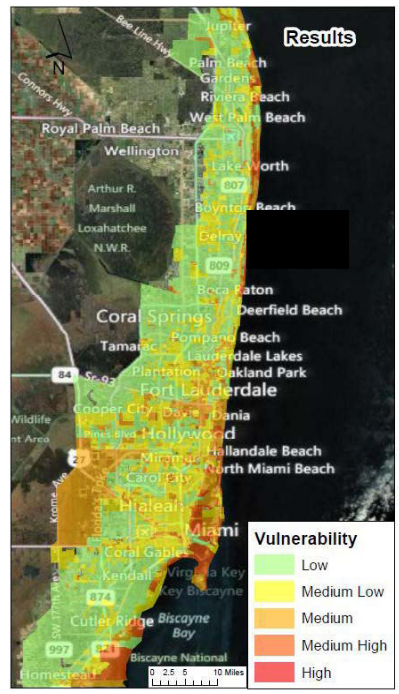

Figure 2: Map of Results

REFERENCES

Boruff, B.J., Emrich, C. and Cutter, S.L., 2005. Erosion hazard vulnerability of US coastal counties. Journal of Coastal Research 21(5), 932–942.

Neumann, J., Hudgens, D., Herter, J. and Martinich, J. 2011. The economics of adaptation along developed coastlines. Wiley Interdisciplinary Reviews: Climate Change, 2: 89–98

Nicholls, R.J., S. Hanson, and C. Herweijer. 2007. Ranking of the world's cities most exposed tocoastal flooding today and in the future. OECD Executive Summary Report.

Wu Shuang-Ye, Yarnal, B., and Fisher, A., 2002 Vulnerability of coastal communities to sea-level rise: A case study of Cape May County, New Jersey. Climate Research 22: 255–70

Yohe, G., J. Neumann, P. Marshall, and H. Ameden. 1996. "The economic cost of greenhouse-induced sea-level rise for developed property in the United States." Climatic Change 32 (4):387–410.