Dasymetric Population Mapping at the Residential Building Scale for Improved Decision Making

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Map and Analysis: Buildings and populations with probable[1] vulnerability to sea-level rise (SLR) in Boca Raton, FL. A 1.5m SLR is expected[2] by the end of the century.

Legend

Boca Raton City Limits

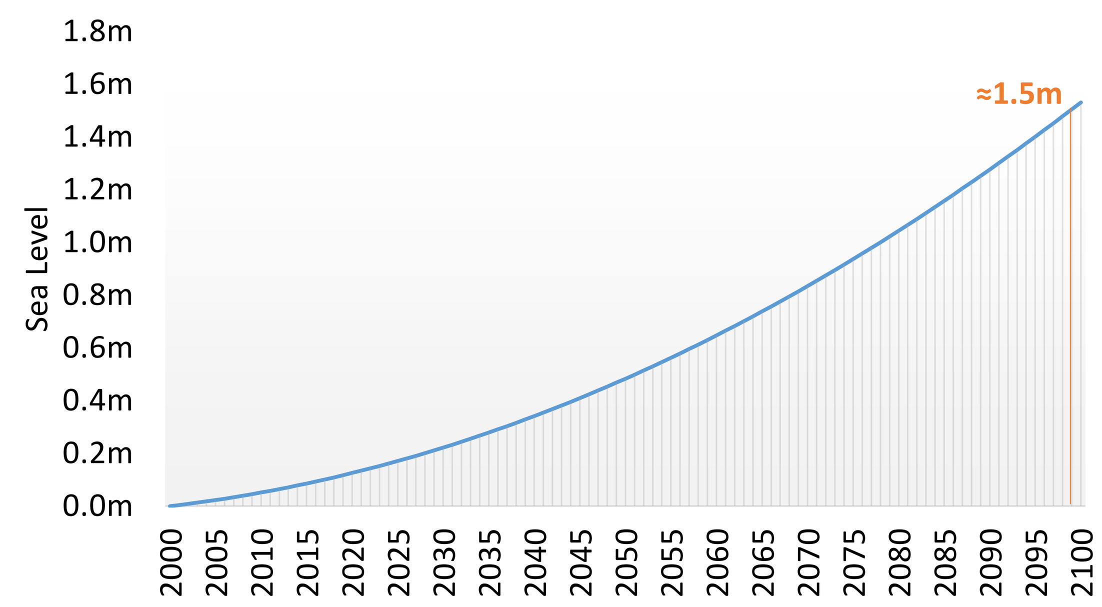
Inundation Uncertainty

- 0 - 2.5%
- 2.5 - 25%
- 25 - 75%
- 75 - 97.5%
- 97.5 - 100%

[1] Areas shown may flood once per day, probability based on Schmidt et al. (2014).

$$Pr = \frac{1}{2} * \left[1 + \text{erf}\left(\frac{(SLR_t + TS) - E_{xy}}{SD_{Tot}\sqrt{2}}\right)\right]$$

Estimated SLR 2000-2100 in Meters

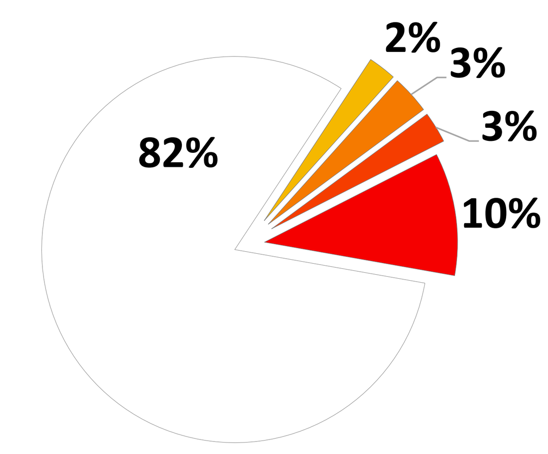


[2] USACE high curve, Key West, FL. Adjusted from base year 1992 to 2000.

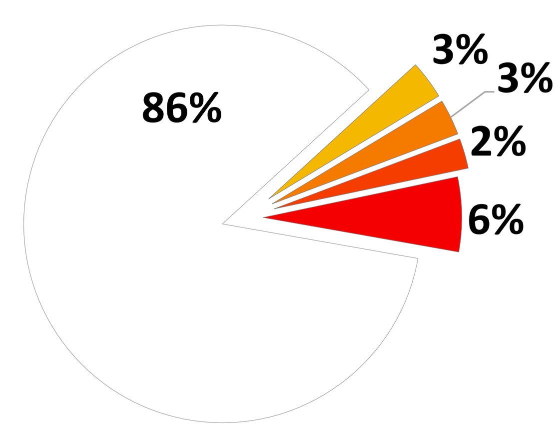
$$SLR_t = 0.0022\,[(Y - 1992) - 8] + 0.000113[(Y - 1992)^2 - 64)]$$

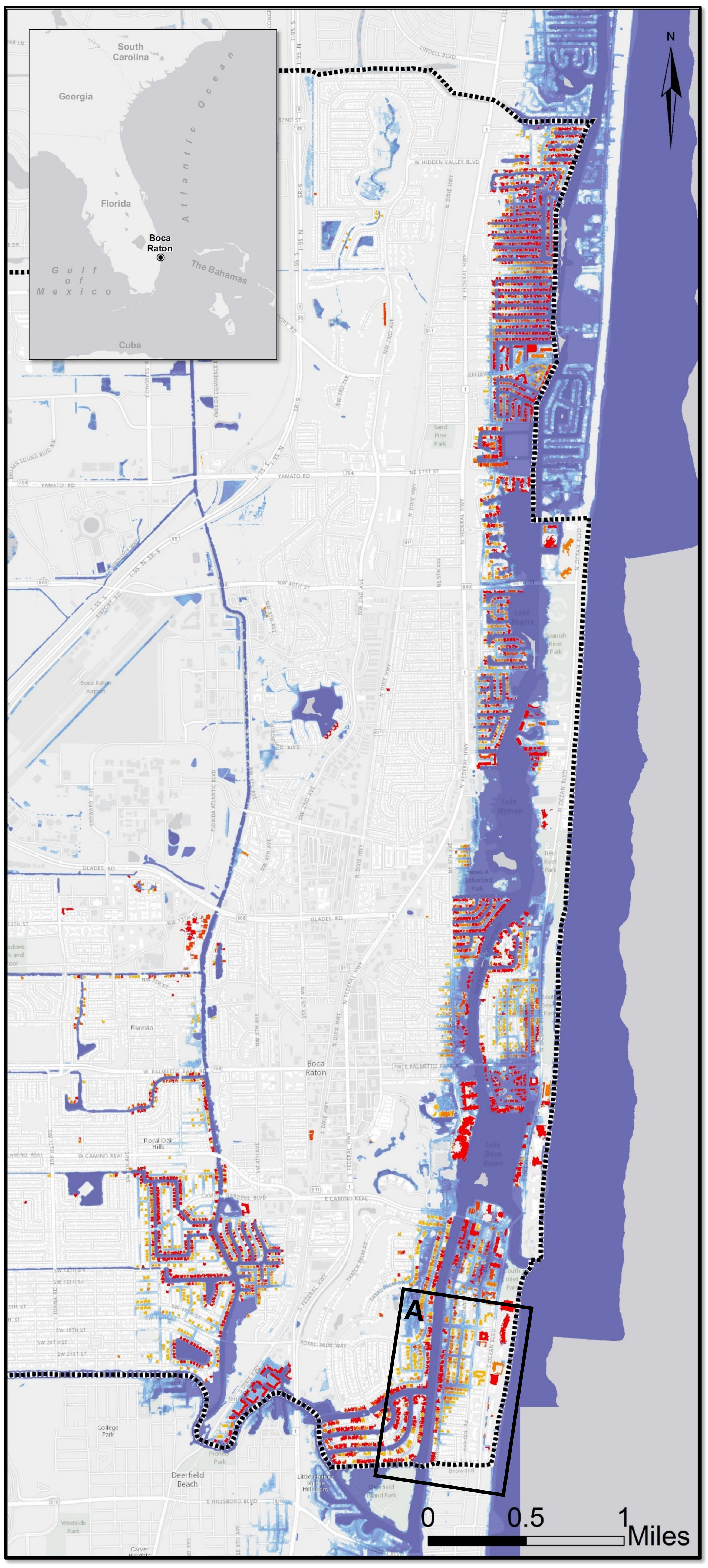
Building Risk	Uncertainty	# Buildings	%	# People	%
Very Low Risk	0 - 2.5%	17,510	85%	61,105	82%
Low Risk	2.5 - 25%	641	3%	1,769	2%
Moderate Risk	25 - 75%	599	3%	2,419	3%
High Risk	75 - 97.5%	500	2%	1,966	3%
Very High Risk	97.5 - 100%	1,243	6%	7,705	10%

Population at Risk



Residential Buildings at Risk





Data Sources: Labins, U.S. Census Bureau, FIU International Hurricane Center. Service Layer Credits: Esri, HERE, DeLorme, MapmyIndia, OpenStreetMap contributions, and the GIS user community.

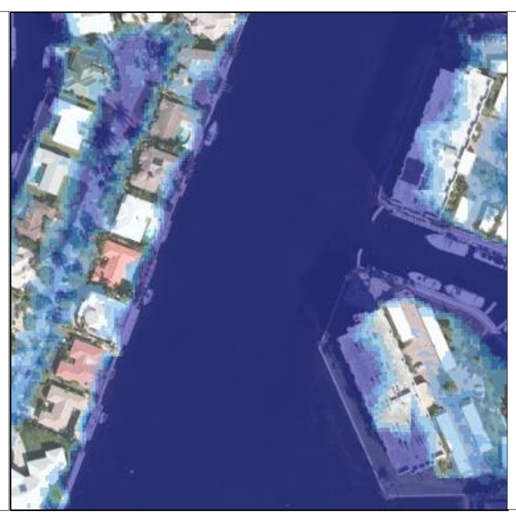
Abstract

Decision makers often require high resolution population distribution data as a foundation for making informed decisions. One important application is, for example, in the analysis of SLR vulnerability (Mitsova, Esnard, & Li, 2012). Physical and social vulnerabilities to SLR are often studied at the scale of census data, but enumeration units are coarse and have arbitrary boundaries due to administrative and privacy concerns (1993; Jia, Qiu, & Gaughan, 2014). For these reasons, internal variations in population distribution are poorly represented. The integration of image classification and dasymetric mapping with areal interpolation can provide detailed small area population estimates below the scale of the census enumeration units, down to the scale of individual residential buildings (Xie, 2006). This study incorporates elevation, spectral, and ancillary parcel data to extract residential buildings, and then applies a dasymetric areal interpolation technique based on housing units to estimate residential building populations. In a case study of Boca Raton, FL, an SLR inundation uncertainty grid based on mapping methods by NOAA (Schmidt, Hadley, & Waters, 2014) is overlaid on the highly detailed population distribution data to identify vulnerable residences and estimate population displacement. Mapped future sea levels show areas which may flood at least once per day given a 1.5m sea level rise that is possible by the end of the century.

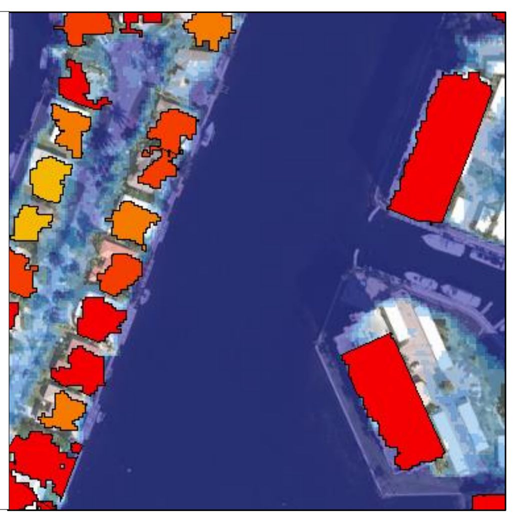
Object-Based Image Classification To Extract Building Footprints

Dasymetric Areal Interpolation to Estimate Building Population

Inundation Mapping Incorporating Uncertainty



Estimate Population and Building Risk Using Inundation Uncertainty



References

Jia, P., Qiu, Y., & Gaughan, A. (2014). A Fine-Scale Spatial Population Distribution on the High-Resolution Gridded Population Surface and Application in Alachua County, Florida. Applied Geography, v. 50, p. 99-107.

Mitsova, D., Esnard, A., & Li, Y. (2012). Using Enhanced Dasymetric Mapping Techniques to Improve the Spatial Accuracy of Sea Level Rise Vulnerability Assessments. *Coastal Conservation, v. 16*, p. 355-372.

Schmidt, K., Hadley, B., & Waters, K. (2014). Mapping and Portraying Inundation Uncertainty of Bathtub Type Models. Journal of Coastal Research, 30, 548-561.

Xie, Z. (2006). A Framework for Interpolating the Population Surface at the Residential-Housing-Unit Level. GIScience & Remote Sensing, v. 43, p. 1-19.