Local community verification of sea-level rise exposure risks in the North Atlantic Region: Insights from an assessment of property tax exposure in coastal New Jersey

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I. Introduction

This study projects municipal tax exposure to sea-level rise (SLR) in four New Jersey counties: Monmouth, Ocean, Atlantic, and Cape May. According to Kopp et al. (2014), it is **likely** (67% probability) that relative SLR at Atlantic City, New Jersey will exceed **1'** by 2050, **3'** by 2110, and **6'** by 2170 under representative concentration pathway (RCP) 8.5, corresponding to continued fossil fuel-intensive growth (IPCC 2013). In the figure below from R.E. Kopp, larger areas correspond with higher probability that the respective SLR exceedance will occur within the consistently color-coded year range.
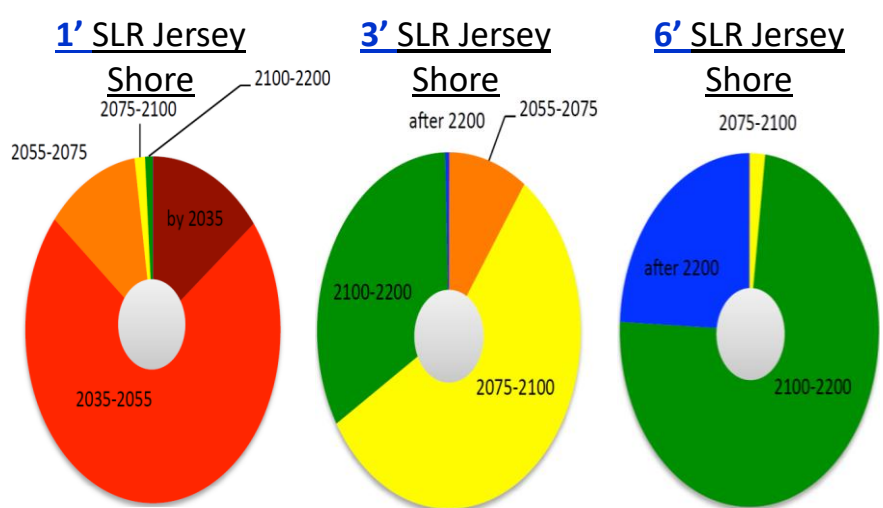
The figure shows SLR exceedance probabilities for RCP 8.5 at Atlantic City. See Kopp et al. (2014) for RCP 2.6 and 4.5 projections.
Figure Source: R.E. Kopp (pers. comm.)

Concern about economic exposure to sea level rise and storm surge is a topic of growing public and policy concern (Neumann et al. 2014), and there is a need for more local level assessments of property value and tax base exposure like the Frazier et al. (2010) study in Sarasota County, Florida. This paper describes a new method to do this including verification using Superstorm Sandy observations such as local knowledge about inundation impacts.

II. Methods

Methods include spatially overlaying NOAA Coastal Services Center sea-level rise data (SLR) with State of New Jersey parcels data for 1', 3', and 6' sea level rise scenarios, in all assessing about one million parcels for exposure.

The study projects net property value and annual municipal tax revenue exposed to rising seas by linking New Jersey tax records with the parcel exposure data. Parcels with greater than 0 percent physical exposure were considered exposed. The 0 percent threshold is supported by preliminary verification methods based on Superstorm Sandy inundation derived from high water marks, an effort organized by FEMA. As part of our SLR exposure verification, we also visited places where parcel-level aerial damage assessments disagreed with the Sandy inundation extents for further insight.

III. Results

Total property value for the four counties is roughly $290 billion with $261 billion being taxable. Total annual property tax revenue for all four counties is about $4.7 billion. Property value and annual property tax revenue exposed to 3 feet of sea-level rise (SLR) for the four counties is roughly $58 billion and $662 million, respectively. **Figure A** and **Table B** provide exposure information for 1', 3', and 6' of SLR for the four counties. **Figure C** through **Figure G** illustrate preliminary local verification methods supporting the 0% physical exposure threshold.

B. Sea-Level Rise Property Value and Tax Exposure

	Monmouth	Ocean	Atlantic	Cape May
Property Value:	$105,557,936,942	$91,854,287,854	$42,197,052,540	$49,902,945,788
Taxable Property Value	$96,250,285,205	$83,747,512,293	$34,940,361,299	$46,013,579,900
Property Tax Revenue	$1,950,625,544	$1,484,860,565	$836,823,732	$416,627,374
Property Value Exposed to 1' SLR	$4,622,882,700	$14,875,589,675	$5,187,387,545	$6,562,959,700
Property Value Exposed to 3' SLR	$6,439,511,200	$25,103,720,257	$9,805,949,625	$16,202,960,000
Property Value Exposed to 6' SLR	$9,980,958,300	$35,151,111,500	$24,188,447,265	$36,892,291,088
Property Tax Revenue Exposed to 1' SLR	$63,461,495 (3%)	$208,982,614 (14%)	$63,192,699 (8%)	$40,877,547 (10%)
Property Tax Revenue Exposed to 3' SLR	$94,223,012 (5%)	$335,372,583 (23%)	$119,890,785 (14%)	$112,610,801 (27%)
Property Tax Revenue Exposed to 6' SLR	$160,806,886 (8%)	$463,970,777 (31%)	$403,490,840 (48%)	$275,285,145 (66%)

A. Property Value Exposure

Property Value Exposure to 3 Feet Sea Level Rise
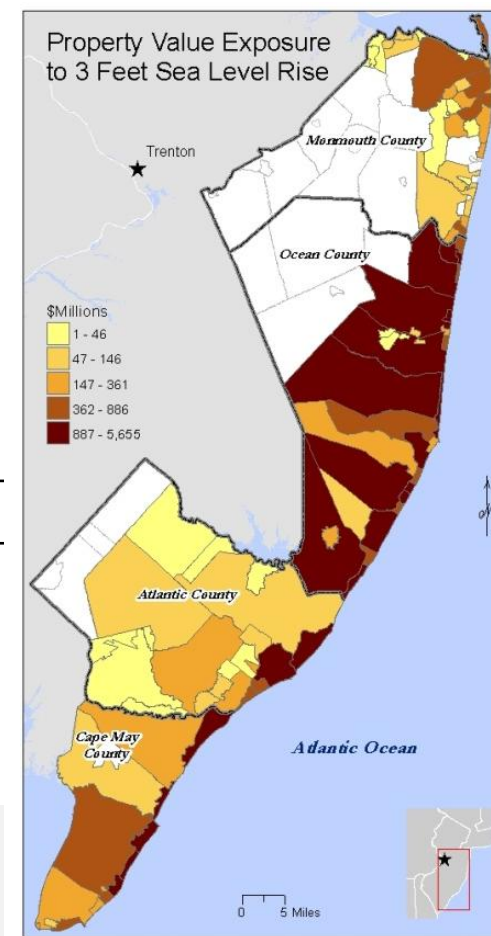
C. Sandy Parcel Physical Exposure Levels

Sandy Surge County Parcel Exposure Estimates

County	Monmouth	Ocean	Atlantic	Cape May
Total County Parcels	250,262	421,209	170,245	148,741
Parcels Exposed	30,156 (12%)	98,395 (23%)	39,638 (23%)	79,526 (54%)
Parcels Fully Exposed	18,283	73,985	24,127	56,063
Parcels Partially Exposed	11,873	24,410	15,511	23,463
Parcels Not Exposed	220,106	322,814	130,607	69,215

D. Local Verification at Sandy Model Discrepancy Areas in Brick, NJ

F. Sandy Model Accuracy Based on Exposure Levels (with Mask)
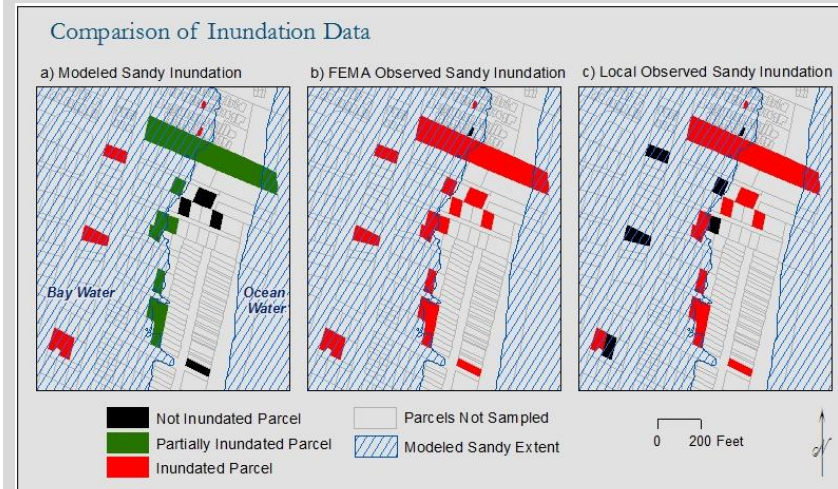
E. Sandy Predicted and Observed Inundation and Local Verification-Based Analysis Mask in Brick, NJ
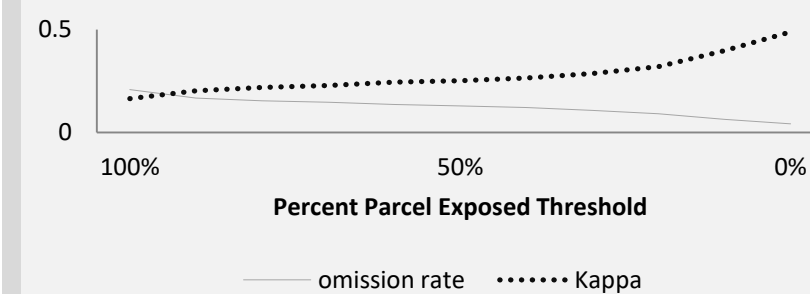
G. Masked Sandy Model Error Matrix (>0% Exposure)

		FEMA-Observed:			
		Not Inundated:	Inundated:	Total	User's Accuracy
NOAA-Modeled:	Not Inundated:	**51**	86	137	0.37
	Inundated:	12	**1959**	1971	0.99
Total:		63	2045	2108	
Producer's Accuracy:		0.81	0.96		

Total Correct: 2010 Total Samples: 2108 Overall Accuracy: 0.95 κ Statistic: 0.49

IV. Conclusion

This study finds that annual property tax revenue exposed in Ocean County ranks highest under 1', 3', and 6' sea-level rise (SLR) scenarios among the four counties, up to about $464 million under the 6' scenario. However, percentage tax revenue exposed in Ocean County is only highest under the 1' scenario at 14% exposed. Cape May has the highest percent tax exposed under the 3' and 6' scenarios at 27% and 66%, respectively.

Preliminary verification methods support the 0 percent physical exposure threshold applied to derive the above SLR tax exposure estimates. Next steps include using the more recent, FEMA-verified, aerial damage assessment dataset and accounting for protection and accommodation measures in FEMA flood zones by analyzing parcels with differing requirements separately. An exposure assessment based on building footprint data is recommended for future work.

V. References

Frazier, T. G., Wood, N., Yarnal, B., & Bauer, D. H. (2010). Influence of potential sea level rise on societal vulnerability to hurricane storm-surge hazards, Sarasota County, Florida. *Applied Geography, 30*(4), 490-505.

Intergovernmental Panel on Climate Change (IPCC). (2013). Summary for Policymakers, In: *Climate Change 2013: The Physical Science Basis. Edited by T.F. Stocker, D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex, and P. Midgley, pp. 3029, Cambridge Univ. Press, Cambridge, U.K.*

Kopp, R. E., Horton, R. M., Little, C. M., Mitrovica, J. X., Oppenheimer, M., Rasmussen, D. J., ... & Tebaldi, C. (2014). Probabilistic 21st and 22nd century sea-level projections at a global network of tide-gauge sites. *Earth's Future, 2*(8), 383-406.

Meinshausen, M., Smith, S. J., Calvin, K., Daniel, J. S., Kainuma, M. L. T., Lamarque, J. F., ... & Van Vuuren, D. P. P. (2011). The RCP greenhouse gas concentrations and their extensions from 1765 to 2300. *Climatic change, 109*(1-2), 213-241.

Neumann, J. E., Emanuel, K., Ravela, S., Ludwig, L., Kirshen, P., Bosma, K., & Martinich, J. (2014). Joint effects of storm surge and sea-level rise on US Coasts: new economic estimates of impacts, adaptation, and benefits of mitigation policy. *Climatic Change*, 1-13.

VI. Acknowledgments