The Cost of Ensuring Salt Marsh Migration Under Sea Level Rise

A Property Value Model to Ensure Ecosystem Service Conservation

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Supported by U.S. National Oceanic and Atmospheric Administration Grant NA160AR4310153

ACES—A Community on Ecosystem Services 2018: Implementation Advances and Challenges. Washington, DC, December 3-6

Estimating Preservation Cost

- Planning for salt marsh ecosystem service preservation via land purchases requires information on the expected benefit and cost of acquisition.
- The use of simpler cost measures are often poor predictors of the actual acquisition cost.
- This presentation illustrates a novel hedonic model designed to forecast the cost of preserving land to ensure the provision of salt marsh related ecosystem services.
- Hedonic property value models predict the price of land purchases as a function of parcel and area attributes.

Research Objectives

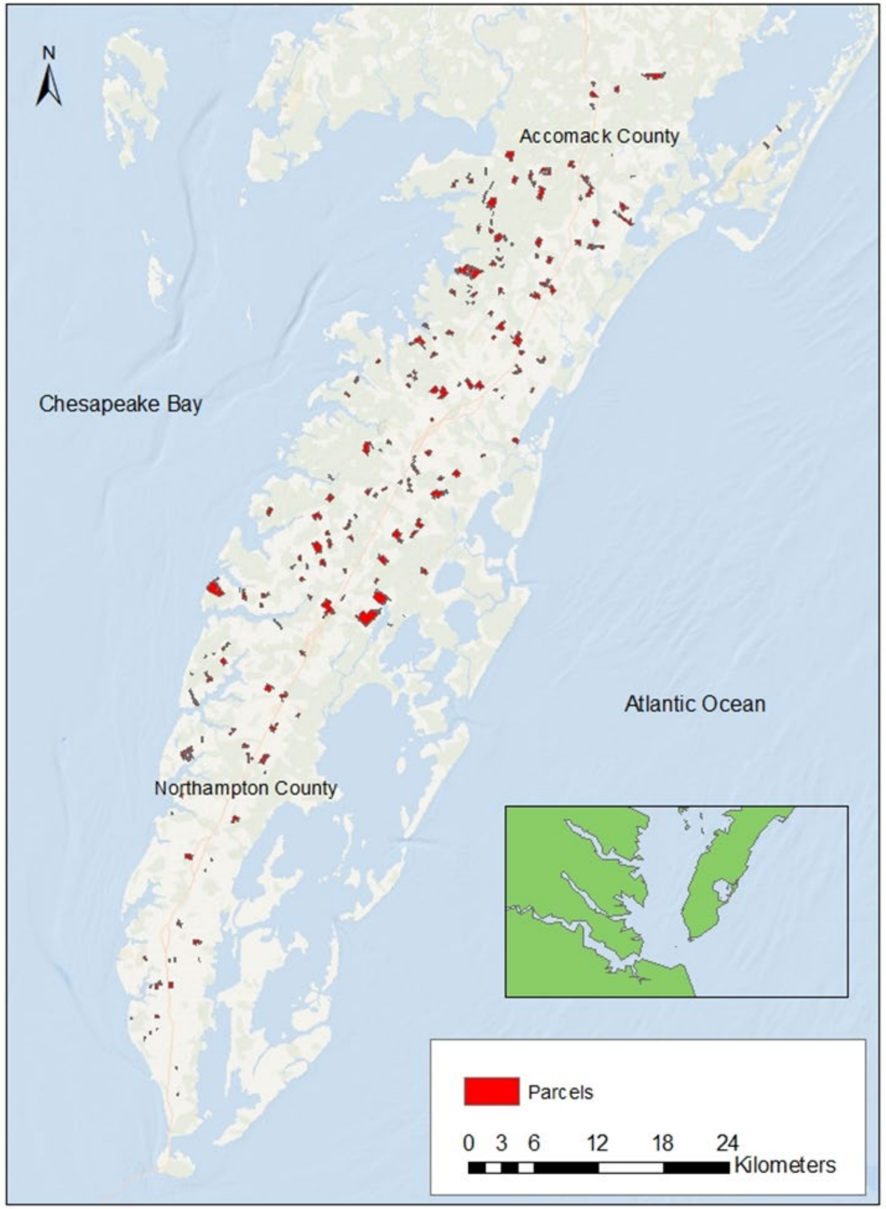
- This research focuses on coastal land conservation for salt marsh migration, and:
  - Develops a hedonic model of vacant land prices, emphasizing land attributes that affect marsh migration suitability.
  - Model identifies opportunities for cost effective marsh conservation via implicit price estimates.
  - Demonstrates how simpler measures of land cost lead to poor estimates.

Importance of Salt Marsh & Transgression Zones

- Salt marsh habitats provide many valuable ecosystem services.
  - Erosion control, flood defense, water purification, & habitat for aquatic species.
- However, these habitats are likely to shrink over time due to:
  - Rapidly rising sea levels as a result of global warming.
  - The armoring of land from unwanted salt marsh encroachment
- Marsh sustainability often requires the conservation of transgression zones (land suitable for landward marsh migration as seas rise)

The Hedonic Model

- This model is designed to incorporate characteristics relevant to salt marsh migration.
- $P = P(N,\ C,\ M)$
  - N = neighborhood characteristics (e.g., distance to CBD, distance to closest park)
  - C = all other characteristics unrelated to marsh migration suitability (e.g., airport zoning)
  - $M = (Coastal\ Distance,\ Elevation,\ Land\ Cover)$



The Data and Site Selection

- Data was collected from sales of vacant land in Accomack County and Northampton County between January 2014 and June 2017.
- This data was coupled with information relating to the parcel's geospatial environment.
  - Land cover information was taken from the National Land Cover Database.
  - Elevation information was taken from the U.S. Geological Survey.

Selective Descriptive Statistics

Variable	Description	Min	Max	Mean	Std. Dev.
Adj. Price Per Acre	Price per acre adjusted to 2017$	309.8	87542	5113	7818
Acreage	Parcel size measured in acres	5	326.5	40.08	50.01
Forestland	Percentage of parcel classified as forestland	0	100	38.56	34.04
Wetland	Percentage of parcel classified as wetland	0	96.63	7.316	17.83
Farmland	Percentage of parcel classified as farmland	0	100	50.34	36.48
Elevation	The midpoint between the highest and lowest elevation points on the parcel measured in meters	0.100	15.40	6.562	4.419
Coastal Distance	Distance of the parcel to the coast measured in meters	29	5437	1504	1246

Hedonic Model Results

Dependent Variable = Natural Logarithm of Adjusted Sales Price			
Variables	Coefficient (S.E.)	Variables	Coefficient (S.E.)
Forestland	-0.0448*** (0.0158)	Developed Open Space	-0.0691*** (0.0201)
Wetland	-0.0509*** (0.0162)	Log(Elevation)	0.309** (0.133)
Farmland	-0.0410*** (0.0157)	Log(Coastal Distance)	-0.174** (0.0866)
Barren Land	-0.0447** (0.0173)		
N	223		
R^2	0.633		

** $p < 0.05$, *** $p < 0.01$

- These results control for other neighborhood and environmental characteristics (location, zoning, proximity to the highway), not shown above.

Implicit Price Results

Implicit Price Using Mean Values	
Elevation	$3,605/m
Distance to Coast	-$9/m

- The implicit price for elevation is interpreted as the extra cost to an average parcel for an additional meter of elevation.
- The implicit price for distance to the coast is interpreted as the reduced cost to an average parcel when located an additional meter further from the coast.

Cost Prediction Comparisons

	Elevation = 0.58 meters		
Coastal Distance (meters)	250	200	100
Predicted Forest Cost	$2,739/acre	$2,847/acre	$3,211/acre
% Error w. All Vacant	87%	80%	59%
% Error w. Coastal Vacant	116%	108%	84%
% Error w. Mostly Forest	34%	29%	14%

- The top row shows the model predicted cost per acre of preserving coastal forestland suitable for marsh migration under an optimistic SLR scenario by 2100.
- ‘All Vacant’ is the mean cost per acre of all vacant land.
- ‘Coastal Vacant’ is the mean cost per acre of vacant land within 1 km of the coast.
- ‘Mostly Forest’ is the mean cost per acre of vacant land with at least 75% forest cover.

Leave-one-Out Prediction Comparisons

	Model Prediction	All Vacant Land	All Coastal Vacant Land	Mostly Forest
Avg. Abs. % Error	174%	952%	895%	362%
Standard Dev.	236%	1993%	1881%	838%
Min. Abs. % Error	1%	19%	24%	13%
Max. Abs. % Error	908%	9624%	9083%	4029%

- The analysis is based on predictions in the cost of parcels suitable for marsh migration.
- Suitability was based on:
  - The parcel being within 100 meters of current salt marsh habitats.
  - The parcel having an elevation of at most 2 meters.
- Results show the relative gains in accuracy when using a predictive model of cost that incorporates salt marsh migration suitability criterion.

Conclusion

- Some features related to marsh migration suitability are associated with price premiums (closer coastal proximity) while other features are associated with price discounts (lower elevation).
    - Land type (forest vs. farm) is also an influential factor in marsh migration and conservation cost.
- Simulations show significant errors in conservation cost predictions with the use of simpler measures.
- Accurate predictions in the cost of land purchases for the conservation of salt marsh ecosystem services requires cost information related to marsh migration suitability.

Questions?

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