



Framework for Implementing Sustainable Shorelines

Summary of Social Science Investigations: Shoreline Modification Econometric Analysis

Project Activity: Shoreline Modification Econometric Analysis – Stafford

Objective: Identify factors that influence property owners when making shoreline management decisions.

Methods: This analysis uses the VMRC permit database of shoreline modification permit applications to assess the factors that drive property owners to make particular shoreline modification decisions. The analysis combines the VMRC permit data with cadastral data which includes property assessments and building information. Using geographic information systems (GIS) data, these data can be combined with data on shoreline length, the distance from the primary building to the shoreline, land use cover, bank height, fetch, special flood hazard areas, and hurricane storm surge inundation.

I conduct a number of econometric regressions on this database: 1) a simple cross-sectional analysis of whether a property owner has requested any shoreline modification since 1990; 2) a multinomial logit analysis of the particular type of modification adopted; and 3) a pooled cross-section analysis of the effect of neighbors' previous modifications and weather and flooding events on the type of modification.

Progress to date: The analysis has been completed and has been presented at several conferences. The results have been published in Stafford, S.L., 2020. Encouraging Living Shorelines over Shoreline Armoring: Insights from Property Owners Choices in the Chesapeake Bay. *Coastal Management*, pp.1-18. <https://doi.org/10.1080/08920753.2020.1823667>

Findings: With respect to the shoreline modification decision, owners of properties that have higher wave energy and are thus more likely to experience erosion are more likely to modify their shorelines, as are property owners in higher Hurricane Storm Surge categories. Similarly, the farther the primary structure on a parcel is from the shoreline, the less likely the owner is to modify the shoreline. Owners of land in conservation zones and with a higher percentage of natural cover are less likely to modify their shoreline. Property value is also positively correlated with the decision to modify the shoreline, although one has to be careful in interpreting that result, as property value may also be influenced by the shoreline modification decision.

With respect to the type of modification chosen, parcels in Hurricane Storm Surge Category 1 are significantly more likely to have defensive modifications while parcels in Hurricane Storm Surge Category 2 are significantly more likely to have either offensive or defensive modifications. Parcels in Hurricane Storm Surge Category 3 are significantly less likely to have offensive modifications while parcels in Hurricane Storm Surge Category 4 are more likely to have offensive modifications and less likely to have living shorelines. Additionally, parcels with longer shorelines are more likely to be protected by offensive structures. With respect to wave energy, moderate wave energy increases the likelihood of a living shoreline more than high wave energy while the opposite is true for offensive and defensive shorelines. Parcels with low banks are more likely to implement offensive measures and less likely to implement defensive

structures. Finally, parcels in conservation districts are less likely to implement defensive modifications, which is consistent with the spirit behind the conservation zoning which seeks to protect wetlands. While the model does identify factors that impact the choice of modification, it does not do a particularly good job of predicting the type of modification that will be implemented for most observations. This suggests that there are many other non-modeled factors that are important in determining which type of modification will be selected.

The final analysis is able to pinpoint one of these key factors, the type of modifications that neighbors have implemented on their property. Consistent with findings from other studies, the results of a pooled cross-section analysis that exploits the temporal nature of the data show that the type of modifications already in place on neighboring properties can significantly impact the modification that an owner implements, with owners typically preferring to implement similar modifications. Thus, owners who have neighbors with bulkheads are more likely to choose bulkheads and less likely to choose revetments while owners who have neighbors with revetments are more likely to choose revetments and less likely to choose bulkheads. Unfortunately, these results do not provide insight into why neighbors' choices matters. It could be that neighbors share similar physical environmental factors that are not included in the model (i.e., beyond wave energy, bank height, and storm surge category) that make one modification preferred over another. It could also be that owners prefer to have the same type of modifications for aesthetic reasons or because they get advice or referrals from their neighbors. Given the impact that neighbors' decisions make, further research into this part of the property owner's decision making process is warranted.

Overall, the results of this analysis provide an increased understanding of the factors that influence a shoreline property owner's decision to modify their shoreline in an estuarine setting. The results also show that there is a significant amount of variation in the decision of whether or not to modify the shoreline, and if so, how to modify it. Because there are significant differences in the impact of various shoreline modifications on both erosion at neighboring properties and ecosystem services and health and we expect shoreline modification to increase as sea level rise, governments will need to more closely consider the impact of property owner's modification decisions on other properties and ecosystems. These results suggest that there is a role for guidance, outreach, and public policies to play in influencing the modification choice.

Visuals:

Option	Property Owner Costs	Property Owner Benefits	External Costs	External Benefits	
Bulkheads	Most expensive. Reduces access to water.	Durable. Stabilizes shoreline.	Interrupts shoreline ecosystems. Increases erosion at neighboring properties.		
Revetments	Relatively expensive. Reduces access to water.				
Groins	Relatively expensive.	Durable. Minimizes beach erosion. Maintains access to water.			
Breakwaters	Relatively expensive.	Maintains access to water.	Increases erosion at neighboring properties.		Maintains shoreline ecosystems. Maintains water quality and runoff.
Living Shorelines	Least expensive, but requires ongoing maintenance. May take time to establish.	Maintains some access to water. Maintains natural habitat.			Maintains/enhances shoreline ecosystems. Maintain water quality and runoff.

