# A Coastal Geo-Economic Model for Artificial Dune Management in New Jersey

Jesse Kolodin[1], Jorge Lorenzo-Trueba[1], Porter Hoagland[2], Di Jin[2], Andrew Ashton[3]

1. Earth and Environmental Studies Department, Montclair State University, Montclair, New Jersey
2. Marine Policy Center, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts
3. Geology and Geophysics Department, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts

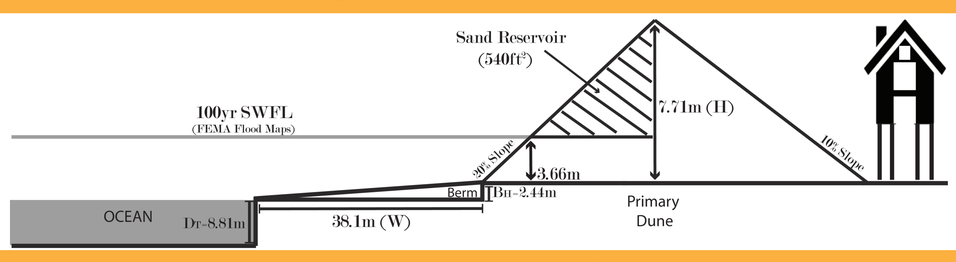
## MOTIVATION & KEY QUESTIONS

**Since Superstorm Sandy hit the New Jersey coast in October 2012, the US Army Corps of Engineers (USACE) has constructed several homogeneous artificial dune-and-berm features along the coastline to protect New Jersey beachfront communities from future storm-surge impacts. Initially, these projects were entirely funded by the Sandy Recovery Act.**

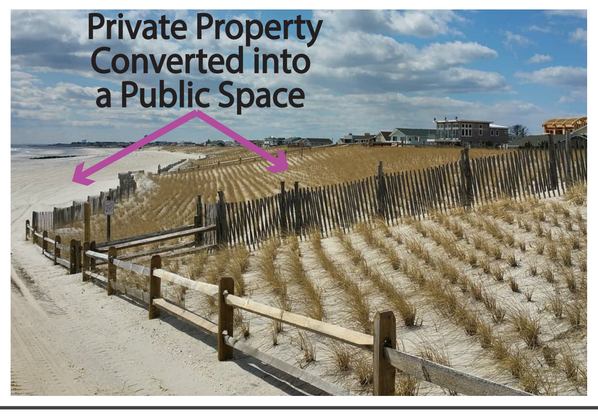
KEY QUESTIONS

- *What is the feasibility for a beachfront community to maintain a berm-dune system, as sources of external funding potentially decrease in the long-term?*
- *Do the benefits generated by these projects justify their costs?*
- *Dune construction has become the main action for coastal resiliency in New Jersey, does a relationship exist between dune geometry and property values?*

## BERM-DUNE CONSTRUCTION DESIGN



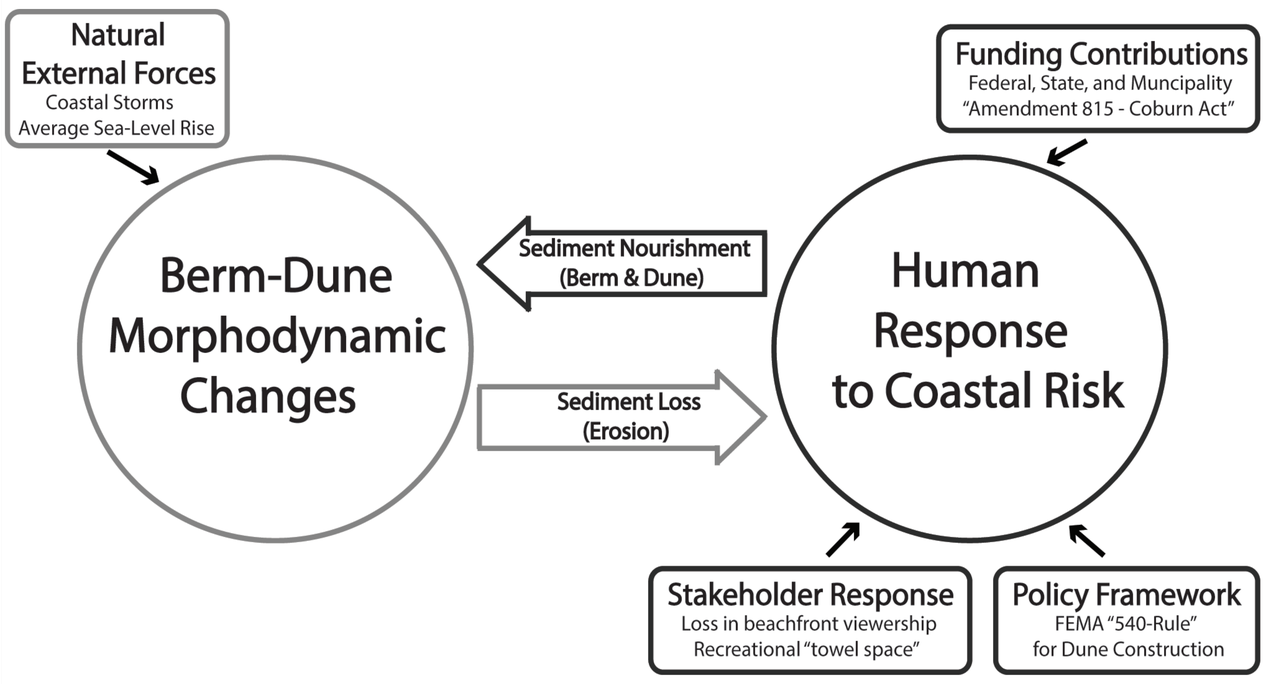

## Negative Responses Towards Dune Protection



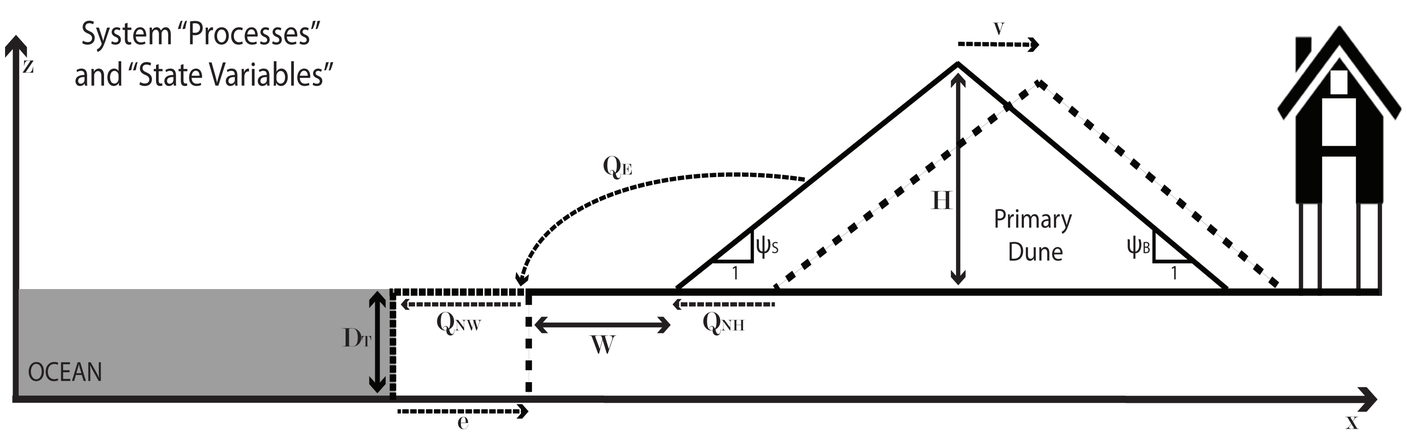


## COUPLED NATURAL-HUMAN MODEL

**To tackle these questions, we have developed a morphodynamic model of the evolution of these coastal berm-dune systems.**




## MODELING FRAMEWORK

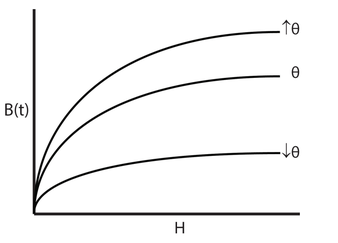



$$(1)\ \frac{dH}{dt} = \frac{Q_{NH} - Q_E}{pH} \qquad (2)\ \frac{dW}{dt} = -e + \frac{Q_{NW}}{D_T} + \frac{Q_E}{D_T} + \frac{Q_E}{H} + v - \frac{Q_{NH}}{H}$$

$$Max_{Q_{NW},Q_{NH}} \int_0^{\infty} e^{-\delta t}\,(B(t) - C(t))\,dt$$

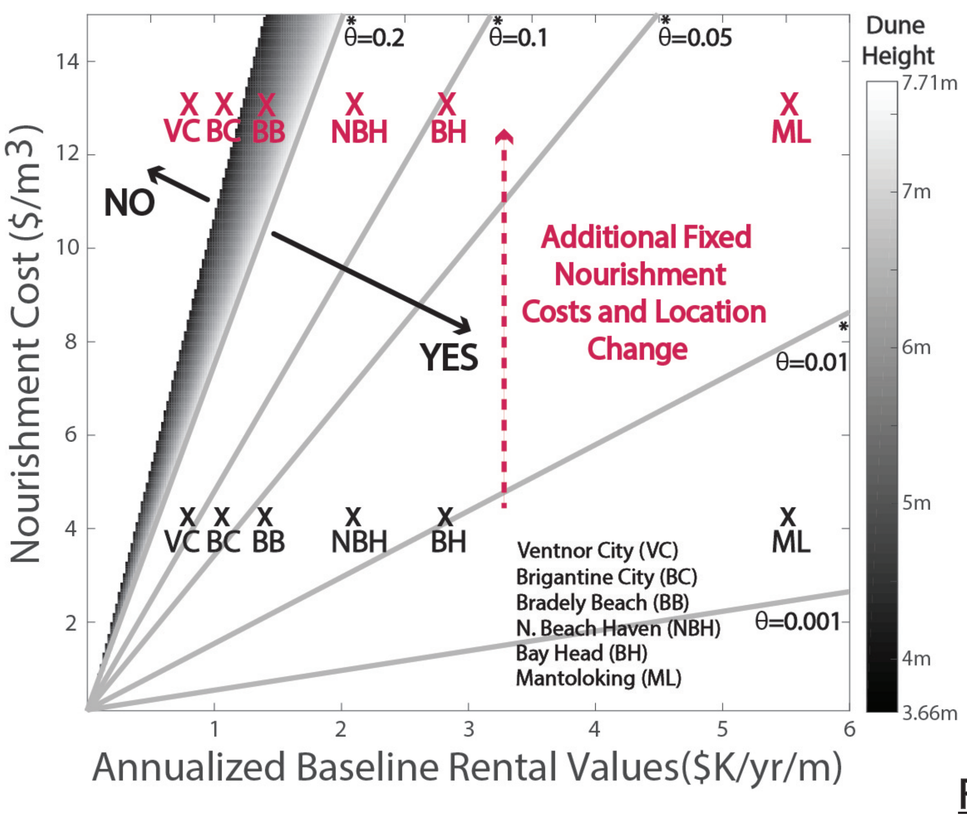
$$B(t) = \alpha \cdot (W/W_\alpha)^{\beta} \cdot (H/H_\alpha)^{\theta}$$

$$C(t) = \phi_N (Q_{NH} + Q_{NW})$$




| Symbol Used | Symbol Name |
|---|---|
| α | **Annualized Baseline Property Value** per meter alongshore beach |
| $\phi_N$ | **Yearly Nourishment Cost** per meter of alongshore beach |
| β | **Hedonic Value of Beach Width (W)** captures community preference for protection and "towel space" |
| θ | **Hedonic Value of Dune Height (H)** captures community preference for protection versus losses in ocean views and private beachfront property |

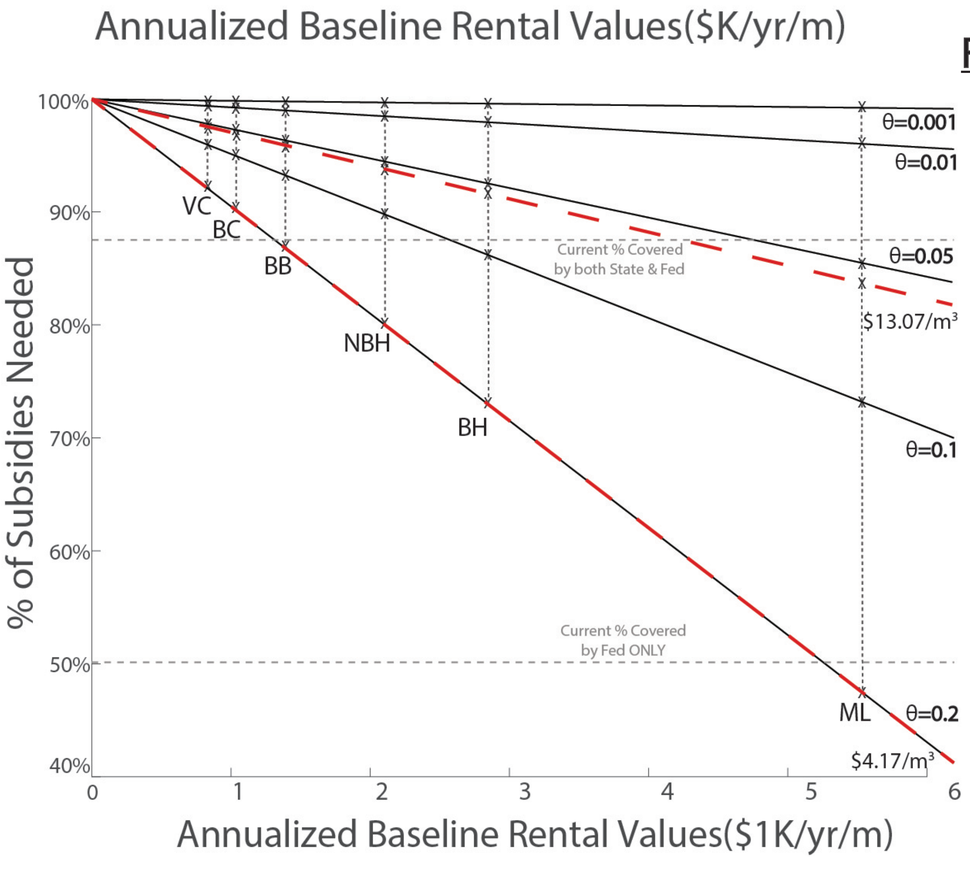
## RESULTS & DISCUSSION




### Sustainability of Dune Construction

- **Results suggest that the most affluent beachfront communities are able to afford most dune construction actions, but have the lowest preference towards protection.**
- **North Beach Haven, Bay Head, and Mantoloking have all taken the state of New Jersey to court over the implementation of these artificial berm-dune systems. All lawsuits cited a possible loss in property value due to an obstructed ocean view and losses in private property (Schapiro, 2015; Zernike, 2013).**

### Future Government Subsidies Needed

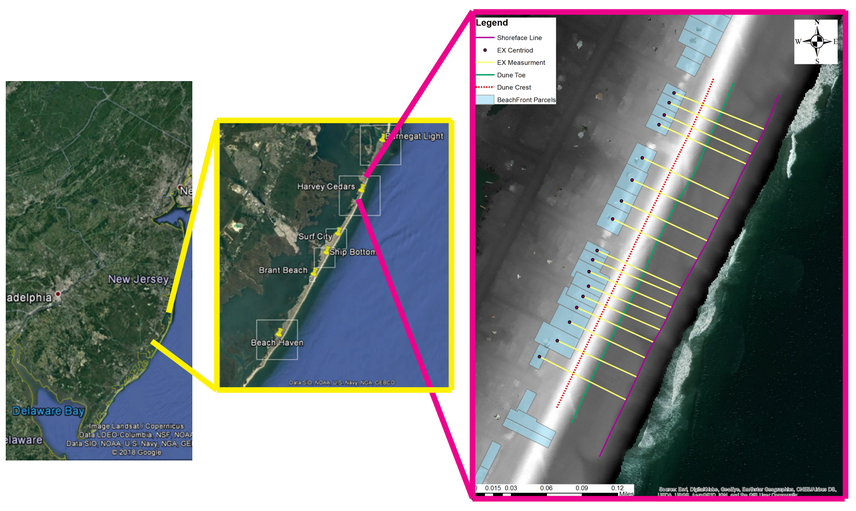



- **Under current law, the cost-share for ongoing coastal re-nourishment projects are distributed 50% Federal, 50% State & Local. In NJ the remaining 50% is split 3/4 State, 1/4 Local (12.5%).**
- **As some coastal communities value viewership and private property over protection, our model suggests more government (state & federal) subsidies would be needed in the long-term.**
- **However, federal funding in the long-term is not guaranteed (e.g. Amendment #815 to "Stop Federal Subsidies for Ongoing Beach Re-nourishment")**

## FUTURE WORK

### STUDY REGION - Long Beach Island (LBI), NJ

(18miles of coastline & 5 Different Beachfront Communities)




- **Our results suggest the affordability of a beachfront community to maintain an adequate FEMA "540-Rule" dune geometry strongly depends on the θ-parameter, which captures a beachfront community's preference between protection versus losses in ocean views & private property.**
- **Run a linear regression analysis to determine how Dune Height (H) affects local property values in LBI, amongst other housing characteristics (i.e. Beds, Baths, SqFt, Acre, etc.)**
- **Constrain our θ-value and determine how added Dune Height is valued within LBI communities that had the FEMA "540-Rule" dunes installed prior to Superstorm Sandy and those with dune installations more recently.**

## REFERENCES


- Bates, Todd B. (2015). "WATCH OUT! Oceanfront property values could crash." Report for the Asbury Park Press (APP). March 30th, 2015.
- Beavers, Rebecca; Babson, Amanda; Schupp, Courtney (2016). Coastal Adaptation Strategies Handbook. NPS Report 2016. 106-107.
- Dewberry & Davis. (1989). "Basis of Assessment Procedures for Dune Erosion in coastal Flood Insurance Studies." Report to the Federal Emergency Management Agency.
- Dundas, Steven J. (2014). "The Benefits and Ancillary Costs of Constructed Dunes: Evidence from the New Jersey Coast." Job Market Paper – North Carolina State University. October 22nd, 2014.
- Gopalakrishnan, S.; Smith, M.D.; Slott, J.M.; Murray, A.B. (2011). The value of disappearing beaches: A hedonic pricing model with endogenous beach width. Journal of Environmental Economics and Management, 61(3), 297-310.
- MacArthur, B., Coulton, P. E., Dean, B., Hatheway, D., Honeycutt, M., Johnson, J., Seymour, D. (2005). FEMA Coastal Flood Hazard Analysis and Mapping Guidelines Focused Study Report, pp 84.
- Schapiro, Rich (May 23, 2015). "Hurricane protection plans delayed on Jersey Shore as towns divided over sand dunes." New York Daily News.
- Senate Republican Conference (May 15, 2013). "Vote Results (Coburn Amendment #815): WRDA bill (S. 601)." Senate Republican Conference.
- USACE 2014 Feasbility Report - Barnegat Inlet to Little Egg Inlet (Long Beach Island), New Jersey. Storm Damage Reduction Project
- Zernike, Kate (September 4, 2013). "Trying to Shame Dune Holdouts at Jersey Shore." The New York Times.


## ACKNOWLEDGEMENTS

1. Funding through the National Science Foundation "The Dynamics of Coupled-Natural-Human System Program"
2. Montclair State University EAES Coastal Research Group: Arye Janoff, Dan Ciarletta, Chris Tenebruso, Isamar Cortes, Will Anderson