Strengthening Puerto Rico's Natural Coastal Systems Through Ecological Restoration, Education and Community Engagement

Robert J. Mayer *, Patricia Chardón-Maldonado **, Erick Soto-Calvente *, Cheryl Bauer-Armstrong ***

Vida Marina: **Center for Ecological Restoration and Conservation, University of Puerto Rico at Aguadilla ***

Department of Marine Sciences, University of Puerto Rico at Mayaguez **

Latino Earth Partnership - University of Wisconsin – Madison ***

Motivation

Dune systems are natural landforms that protect the coast from the effects of severe weather and sea level rise.

25.85 km of the 501 km of coastline of the main island of the Archipelago of **Puerto Rico** consists of **coastal dunes.**

In Puerto Rico these landforms have multiple **conservation threats**, most of them **anthropogenic** (heavy foot and vehicular traffic, illegal sand extraction and invasive species).

Figure 1. Tire tracks on the Secret Spot Beach, Isabela (left) and the image of a breached dune in Isabela Puerto Rico. The breach formed in an area of high foot traffic (right).

In addition to these threats the dunes of the north coast of Puerto Rico were severely damaged by **recent hurricanes** and **winter storms**. Some were totally flattened leaving the coast very vulnerable to future extreme weather events.

We are using **ecological restoration** practices to help stabilize these landforms in order to increase the resiliency of **coastal communities** to future storms at the same time improving the **habitat** of many **wildlife** species such as sea turtles.

The participation and increased awareness of different sectors of local **communities** are very important for these projects to be successful.

Objectives

For each of the restoration sites we are seeking to:

- increase the accumulation of sand
- increase percent vegetation cover
- improve wildlife habitats
- increase community "buy-in", participation and awareness

Methods

We captured **aerial imagery** (using a UAS) from 20 sites located in 7 municipalities on the north coast of the island.

The imagery was analyzed using **Pix4D, Litchi** and **Sample Point** software.

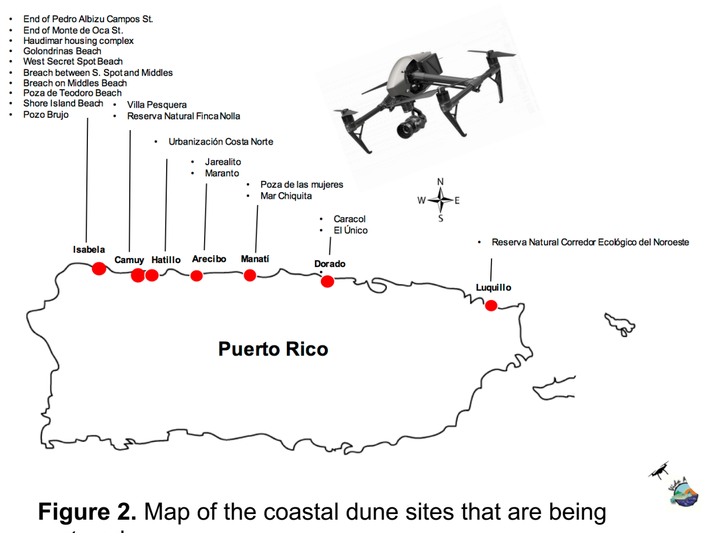

Figure 2. Map of the coastal dune sites that are being restored.

We periodically measure **shoreline position**, **beach width**, **elevation, volume**, **shoreline**, **backshore**, **dune width**, **dune height**, **dune volume** on georeferenced maps (generated from aerial imagery) and determine **grain size** using sieves and a shaker**.** This helps us monitor and adjust the effectiveness of our restoration activities.

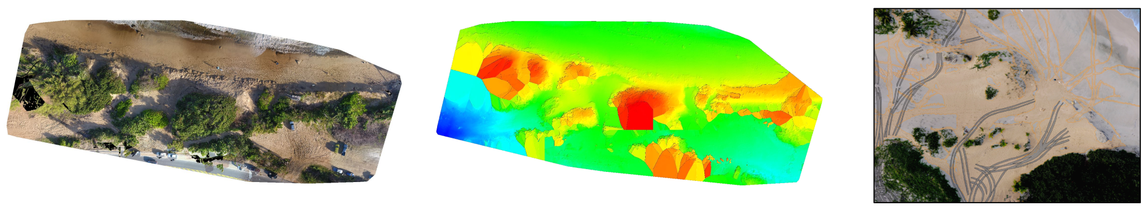

Figure 3. Orthomosaic model (left) and density surface model (center) of Middles Beach, Isabela and an aerial picture of Secret Spot Beach in Isabela showing an anthropogenic impact analysis (right). Black = tire tracks and yellow = foot prints.

Figure 4. Biomimicry matrix in a breached dune in Poza de Teodoro, Isabela Puerto Rico.

Figure 5. Workshop on the importance of dune restoration offered to a group of middle school students from the municipality of Loiza where communities were isolated by the floods that the damaged dunes could not prevent.

Figure 7. UPR students working on the construction of a wooden boardwalk in the Isabela sand dune system.

Figure 8. High school students working on the planting of dune vegetation that is propagated from cuttings and scarified seeds in the UPR at Aguadilla green-house.

We use **biomimicry** matrices to promote the accumulation of sand that is transported by the wind.

Workshops, on the importance of the ecological restoration of sand dunes, as well as training of K-12 teachers are offered using a 10-step process developed by the UW-Madison.

Figure 6. Flooding of road PR-187 in Loiza. Water entered the roadway through breaks in the dune caused by heavy foot traffic (left). These breaks can be reduced by re-directing foot traffic away from these areas by installing wooden boardwalks in sensitive areas of the dunes (right).

Community volunteers, K-12 students and undergraduate students plant dune vegetation to stabilize the dunes after sand starts accumulating.

Foot traffic is a very important threat to the stability of dunes. Re-directing it with wooden boardwalks, signage and exclusion fencing is key to the recovery of a damaged dune.

Results

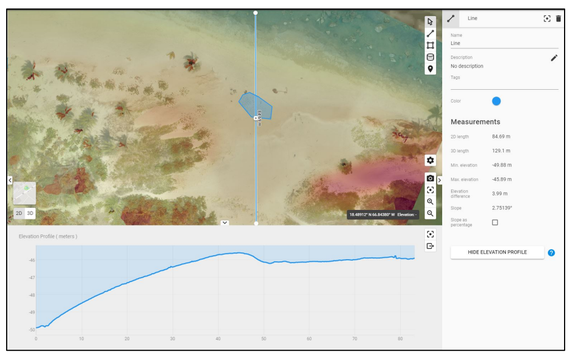

Figure 9. Elevation transect of the Finca Nolla dune restoration site. This product allows us to monitor the volume and accumulation of sand in restored areas.

Figure 10. Accumulation of sand by a biomimicry matrix easternmost dune restoration site in Finca Nolla Camuy, PR.

Sand accumulation is significant in areas of the north coast of Puerto Rico where these techniques have been applied.

Conclusions

Breaks in coastal dunes must be repaired immediately and foot traffic should be redirected away from vegetated areas to prevent erosion and future breaching. In addition to these techniques law enforcement is very important to prevent trampling of vegetation and sand extraction. Displaced sand relocation plans are also necessary in our region and education is key to getting the buy-in and participation from communities. Using nature based infrastructure instead of traditional hard structures can buy us time and increase our resilience to sea level rise and the effects of future storms.

Acknowledgements

This work is supported by a National Fish and Wildlife Foundation Coastal Resilience Grant (62384)

robert.mayer@upr.edu **Facebook** : Vida Marina UPR