NNBF

International Guidelines on Natural and Nature-Based Features for Flood Risk Management

Beaches and Dunes

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Beaches and Dunes

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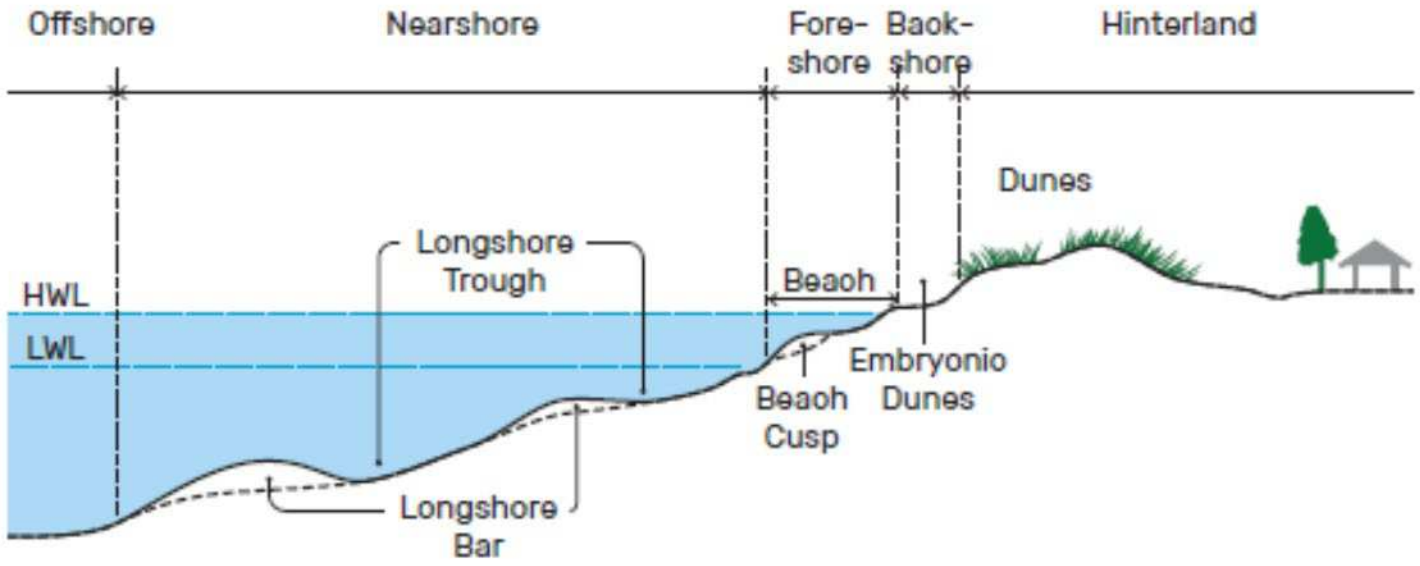
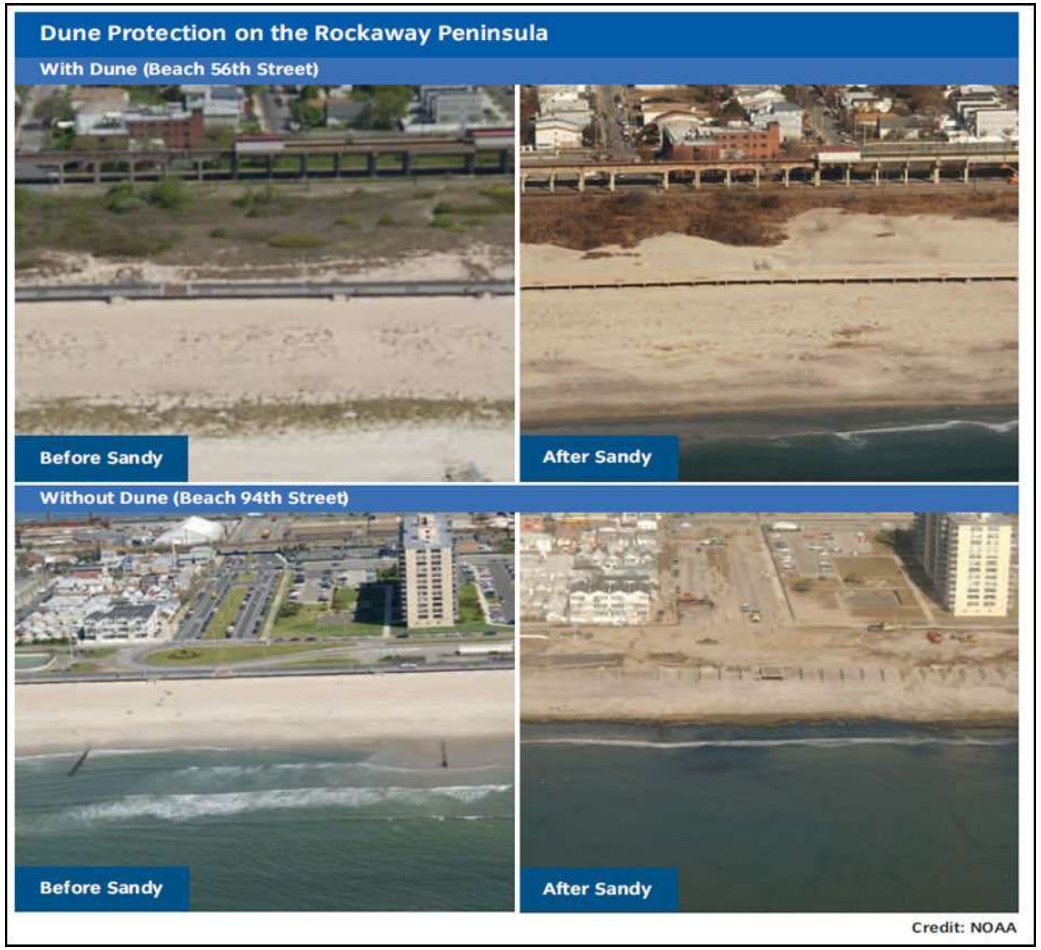
Beaches and Dunes

- Beaches and dunes are dynamic systems and actively change
- For many communities beaches and dunes are the only protection from surge and waves
- The volume and height of the beach berm and dunes (beach profile) are often nourished to provide storm damage reduction, recreational, and ecological benefits



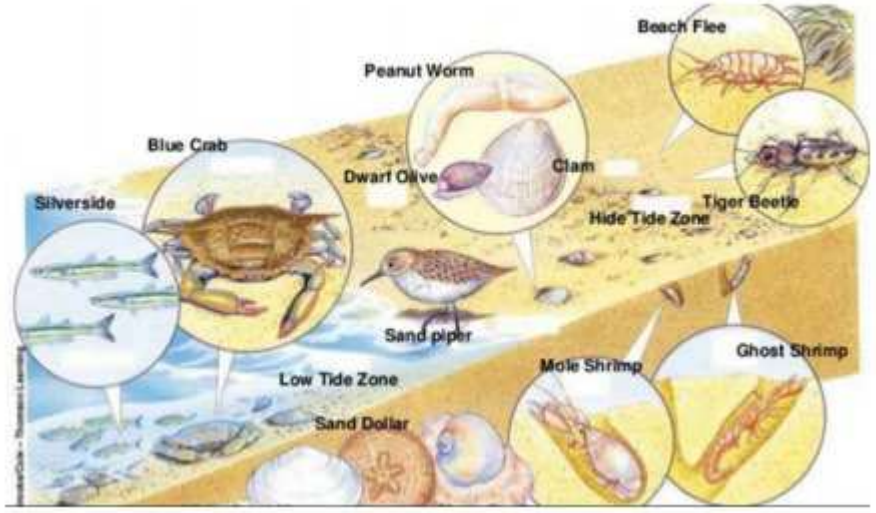
Storm Damage Reduction

- Observed to provide coastal protection during storm events
- Population has historically encroached into areas resulting in “coastal squeeze”
- Vulnerable coastal populations due to increasing threats
- Beach nourishment has been found to be the most cost-effective, socially and environmentally suitable way to reduce storm damages and coastal flooding (ASCE 2016)



City of New York. 2013. *planNYC: a stronger, more resilient New York*. New York, NY: The City of New York. http://www.nyc.gov/html/sirr/html/report/report.shtml.

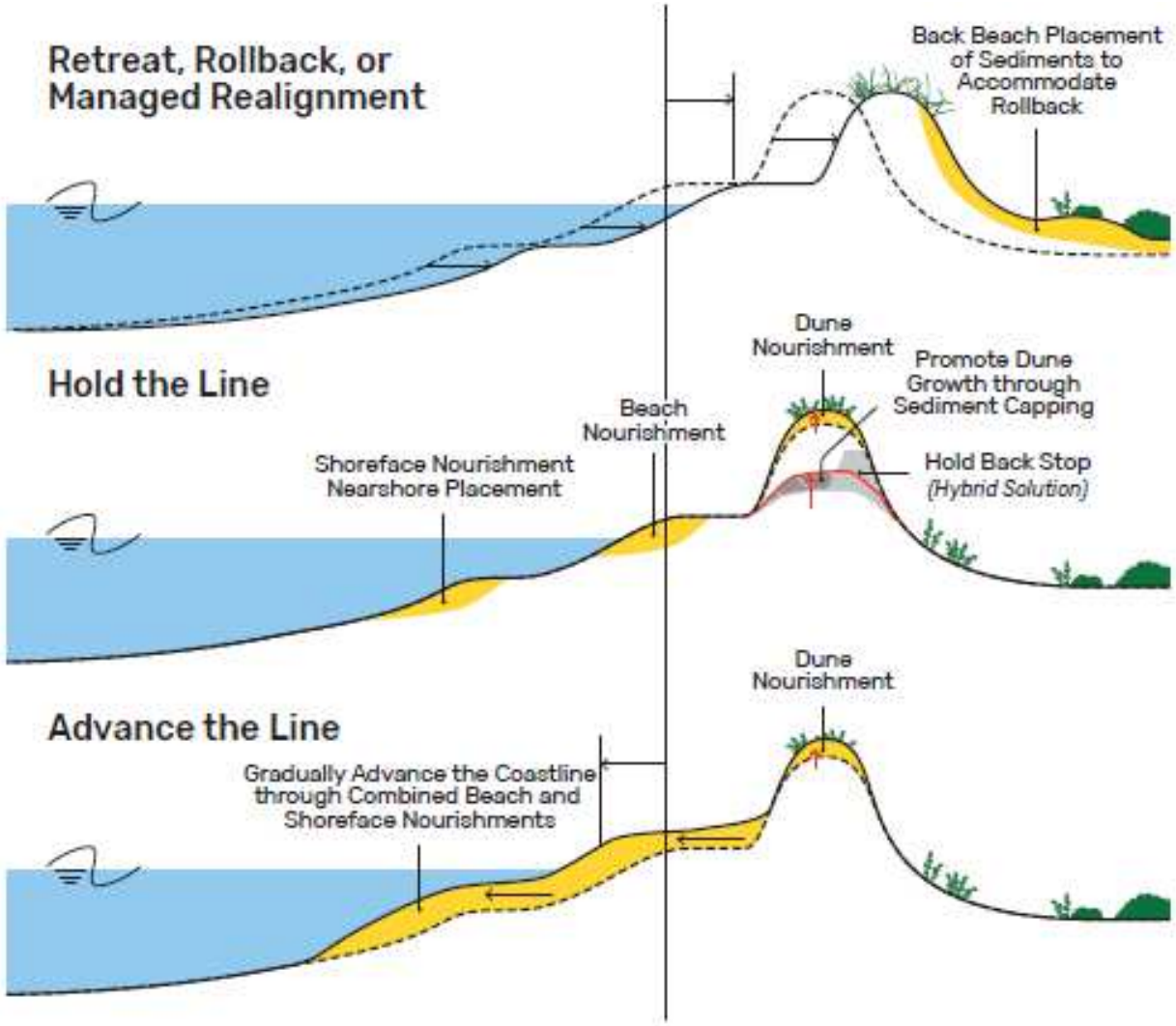
Ecosystem Services



- Beach nourishment increases habitat
- Reduces impacts from human encroachment (coastal squeeze)

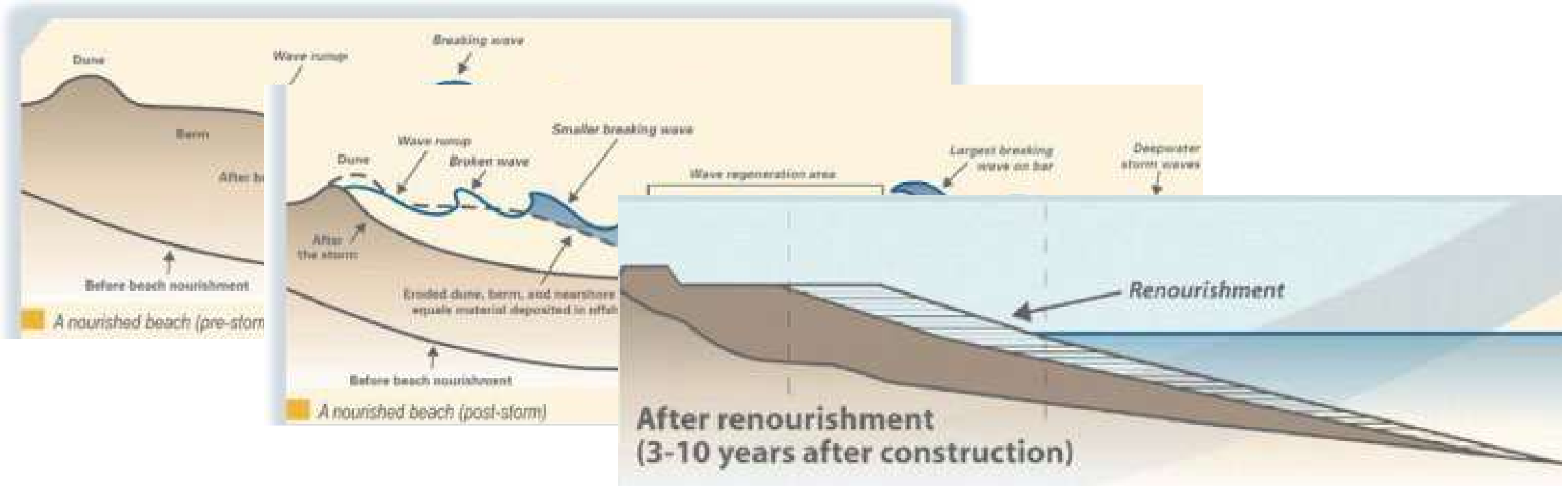
Beach and Dune Management

- Retreat, rollback, or managed realignment requires space and is typically not applicable to most coastal communities
- Hold the line approach is the most common coastal management strategy given the “coastal squeeze” paradigm
- Advance the line requires a large and continuous sediment supply that might not be available or affordable



Dunes and Beach Nourishments

- Over 300 beaches in Puerto Rico
- Dunes are often built as part of a beach nourishment or grow following nourishment
- Dunes serve as sediment storage (engineering service) increasing coastal resilience



Investments in Nourishments

- Between 2010 and 2020 - 250 dredging projects involved beach nourishments at a cost of $1.4 billion
- Numbers don't include local or state funded nourishments that do have an impact on coastal storm risk reduction
- Clear recreation benefits from nourishments

FEMA 540 SF Criterion

- Primary frontal dunes will not be considered as effective barriers to base flood storm surges and associated wave action where the cross-sectional area of the primary frontal dune, as measured perpendicular to the shoreline and above the 100-year stillwater flood elevation and seaward of the dune crest, is equal to, or less than, 540 square feet. (FEMA)

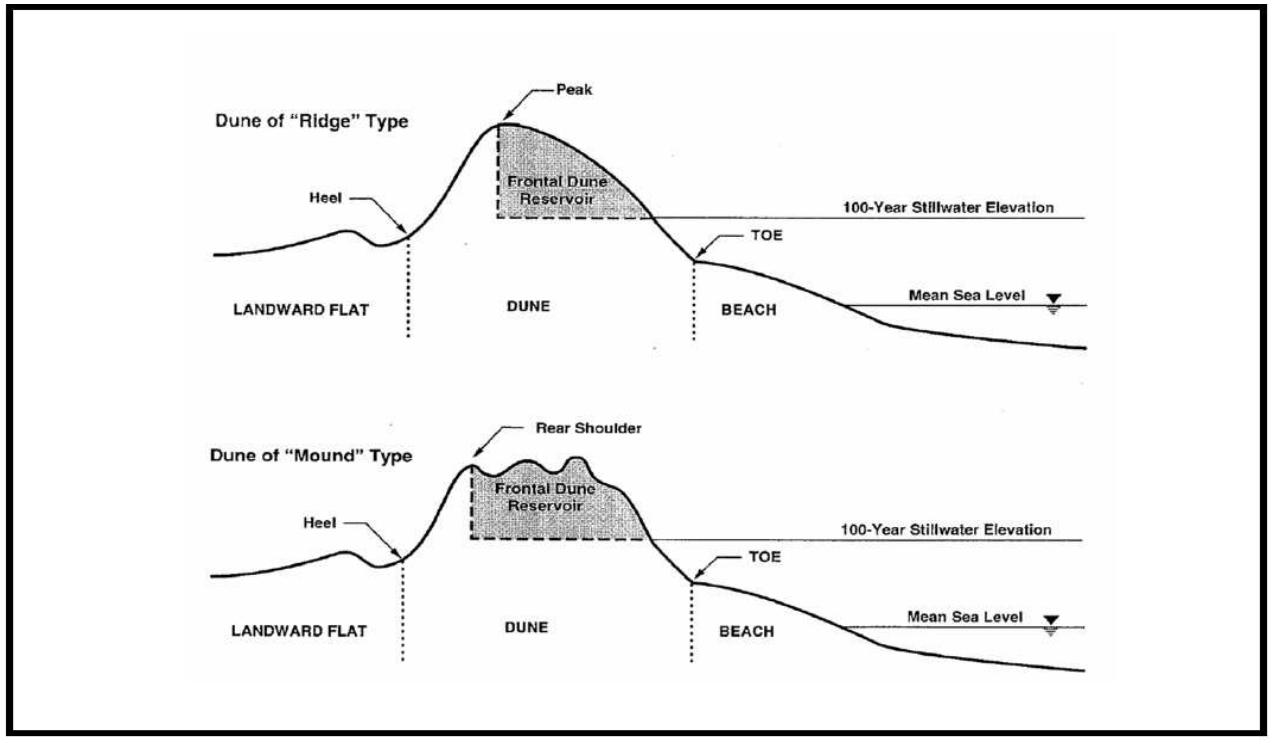
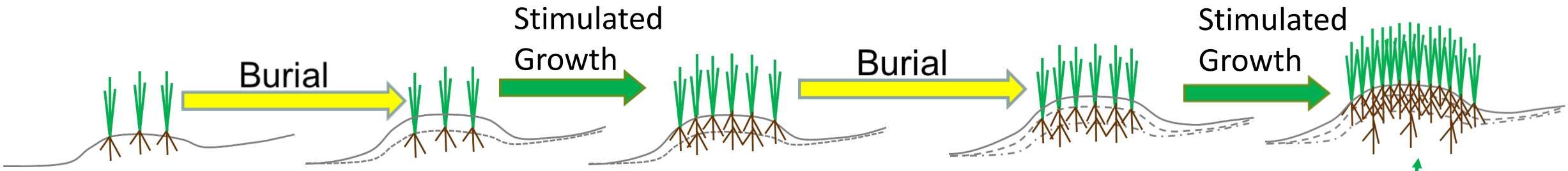
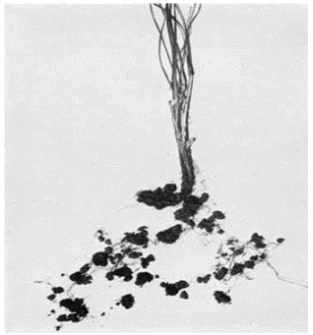


Figure 7. Frontal dune reservoir.
(from Appendix D, FEMA, 2003)

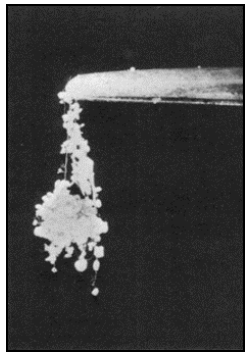
Basics of Natural Dune Growth



Arbuscular Mycorrhizal [AM] Fungi



Tisdall and Oades 1982

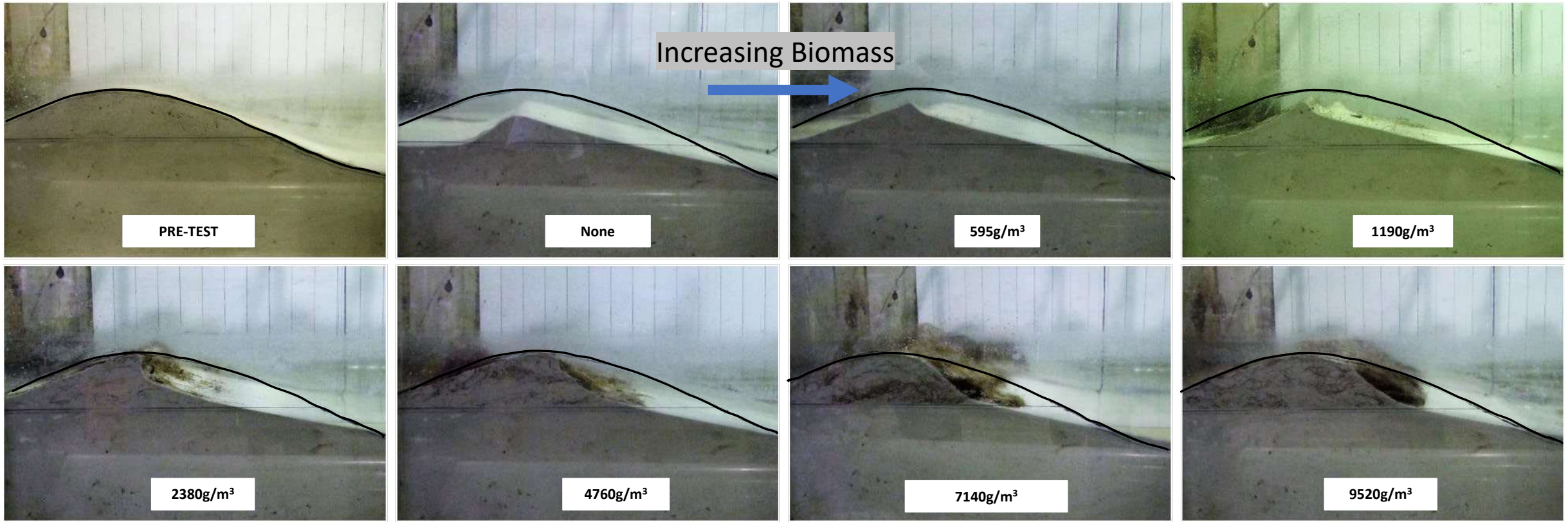


Koske and Polson 1984

- Most pioneering dune building vegetation belongs to the Family *Poacea (flowering grasses)*
- **Growth stimulated due to sand burial**
- Drought and salt tolerant
- **Abundant belowground biomass**
- **Symbiotic relationship with arbuscular mycorrhizal (AM) fungi**
- Many have poor or slow growth from seed – require plantings

Biomass distributed throughout dune vertically

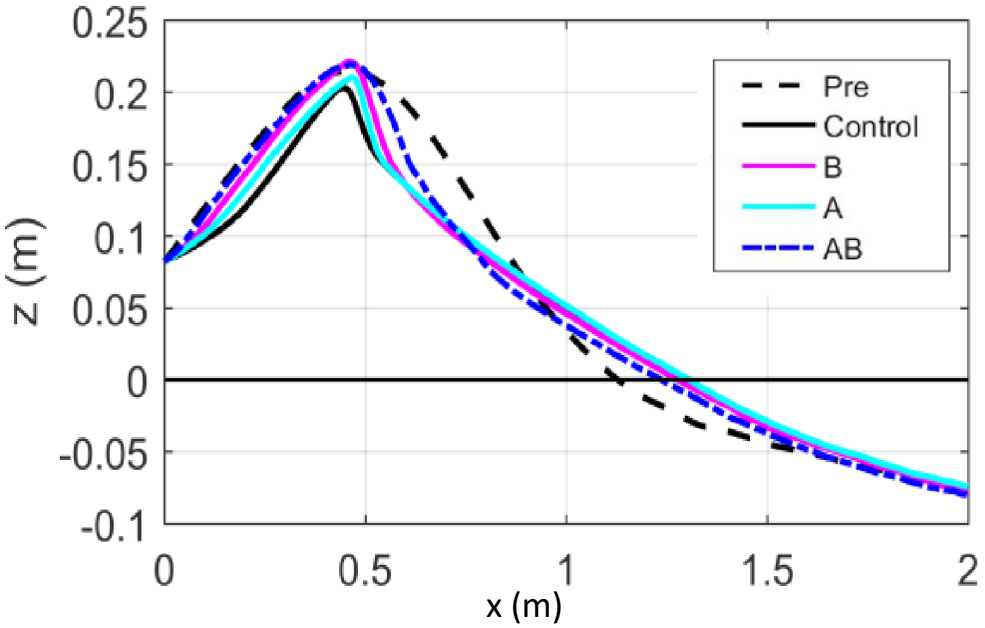
Benefits of Vegetation: Observed Differences



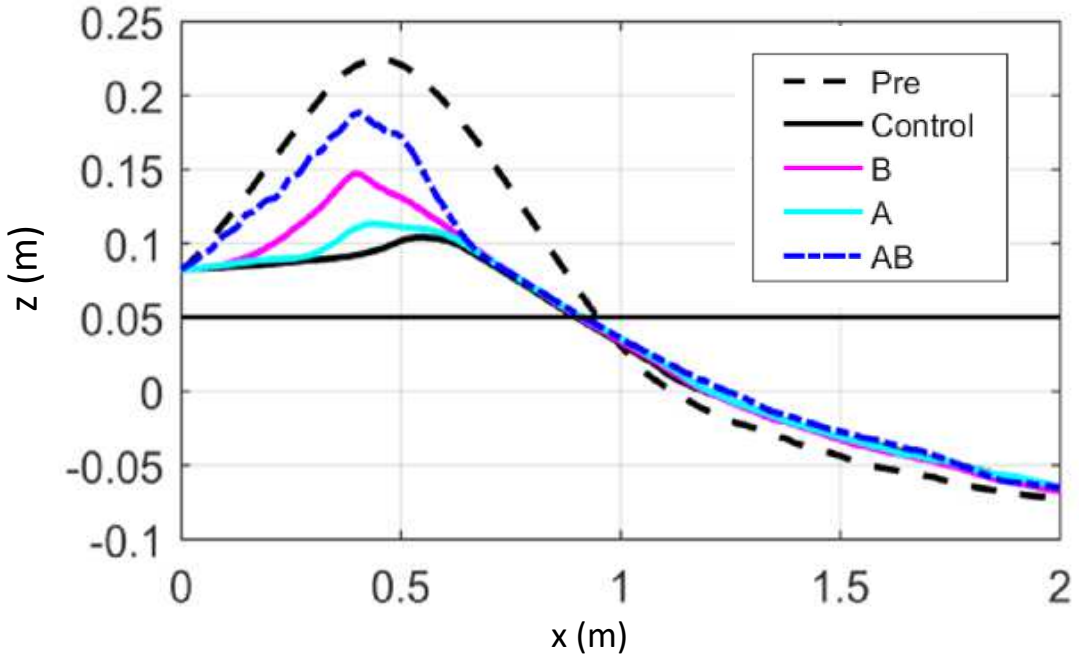
- Clear reduction in dune loss from added biomass

Results – Dune Profile Changes

Overwash Condition 1

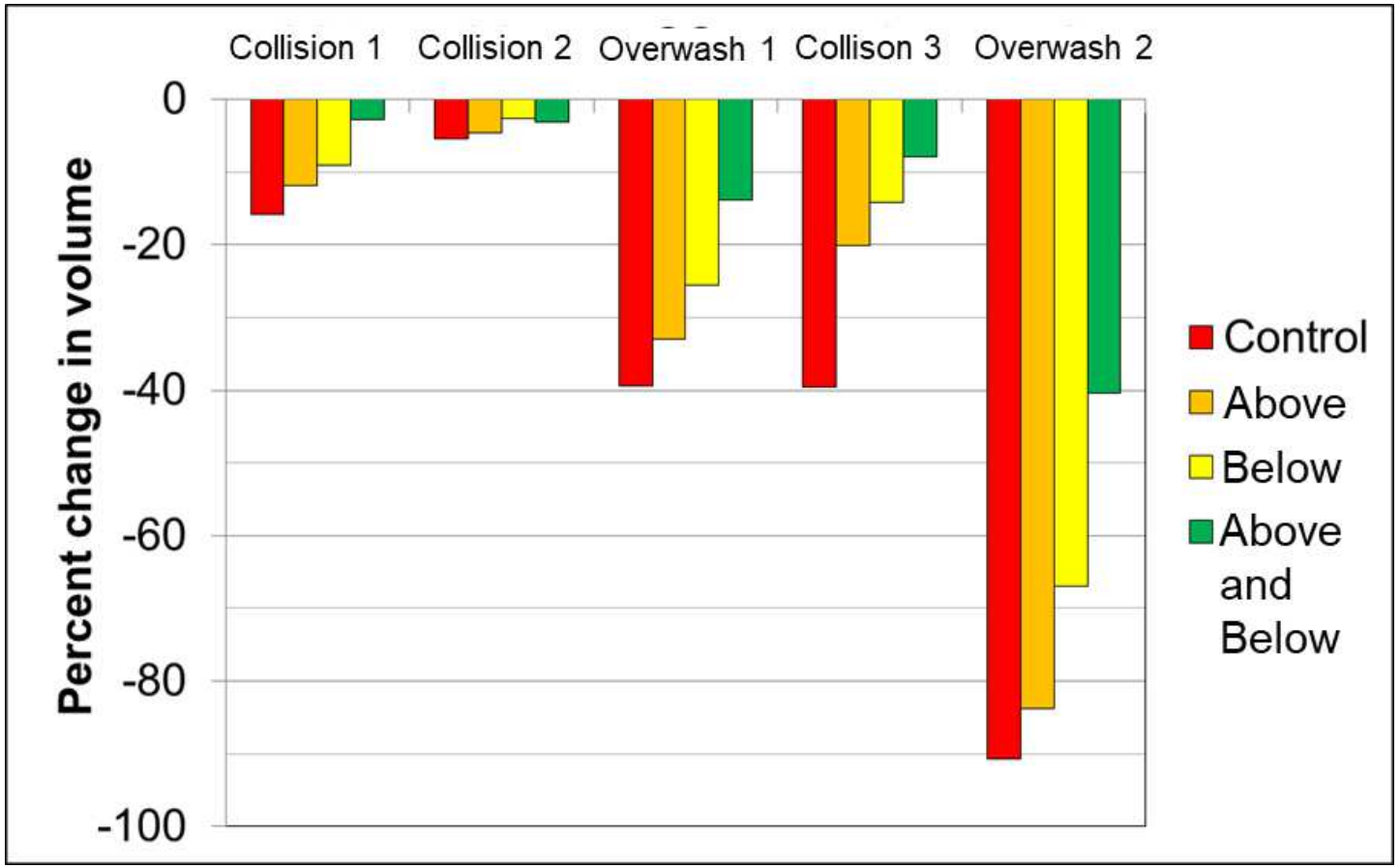


Overwash Condition 2



- Without biomass dunes suffered more erosion
- Biomass regardless of form decreased erosion
- Sediment eroded from the dunes deposited in the surf zone or deposited in the overwash

Results – Dune Volume Changes



- Result indicate that increasing dune biomass as quickly as possible to a natural level will increase dune storm performance and resiliency

Dune Vegetation for Puerto Rico

Grasses

- Saltmeadow cordgrass (*Spartina patens*) – perennial, common on dunes composed of broken shell and coquina rock.
- Seashore dropseed (*Sporobolus virginicus)* – low growing perennial and dominant on many coastal dunes.

Other Herbaceous plants

- Beach Morning Glory (*Ipomoea pes-caprae)* and Fiddle-leaf morning glory *(Ipomoea stolonifera*) – spreading perennial vine.
- Sea purslane (*Sesuvium portulacastrum)* - creeping plant that forms sprawling mats

Dune Vegetation for for Puerto Rico

Trees

- Baycedar quitarán (*Suriana maritima)* – Small tree, small seedlings transplant well
- Cocoplum (*Chrysobalanus icaco)* – Small evergreen with dense foilage, 12 feet tall
- Coconut palm (*Cocos nucifera)* – naturalized palm that can grow up to 80 ft tall
- Seagrape (*Coccoloba uvifera*) – Evergreen shrub. Grows lower on primary of frontal dunes.
- Spanish-bayonet (*Yucca aloifolia*) – Woody plant with daggerlike leaves.

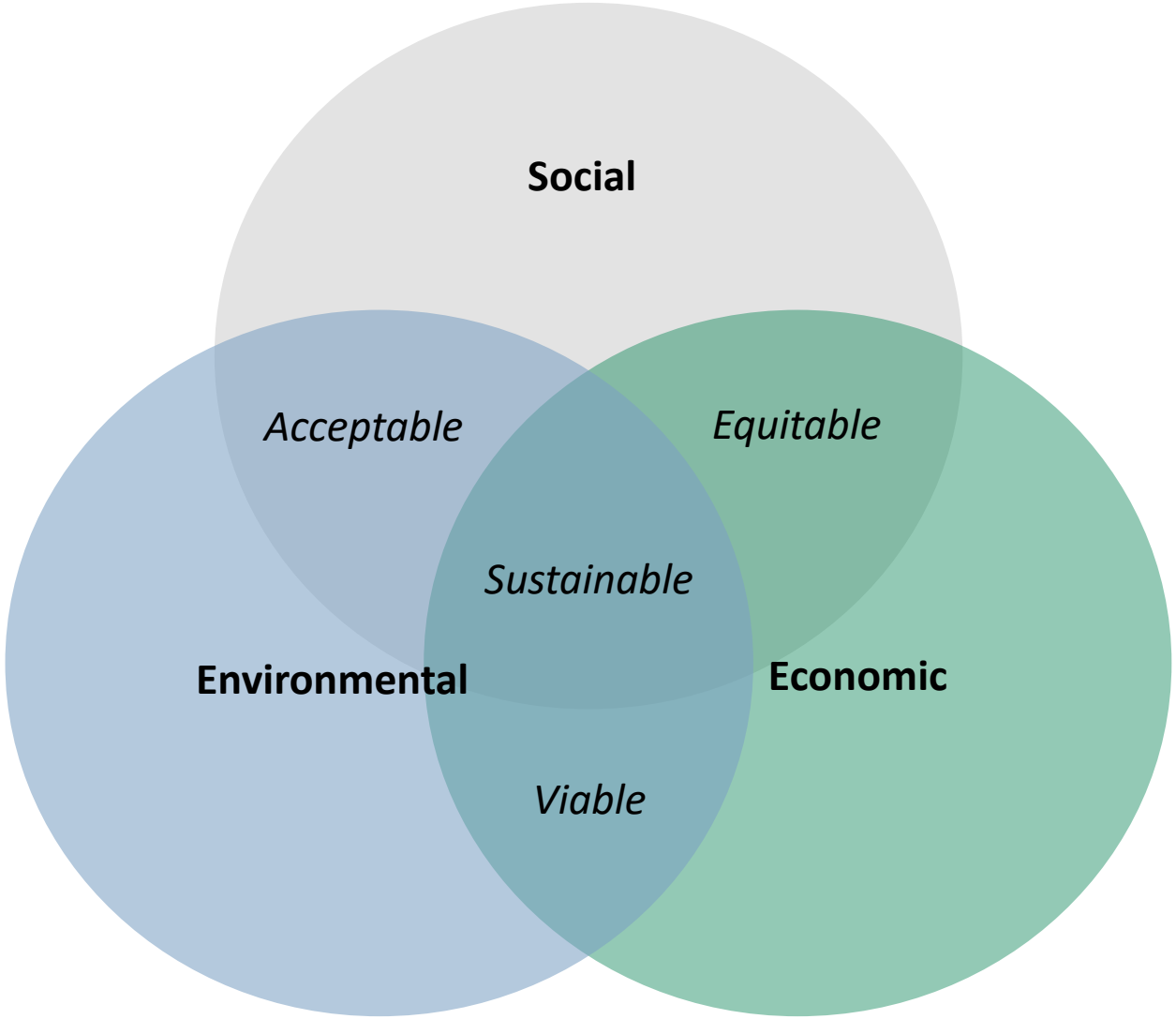
Shrubs

- Coin vine (*Dalbergia ecastaphyllum*) – Spreading shrub that creates thick impenetrable thicket
- Inkberry (*Scaevola plumieri)* – Shrub forming dense clumps

Allowing for Natural Processes

- Results show that dunes with fully integrated biomass throughout the depth will be more resistance to erosion
- These results fit well with field observations that showed:
  - Artificial dunes may not respond as natural dunes to storm processes despite being planted with native species, resulting in more rapid erosion. (Morton et al., 1994)

Beaches and Dunes “Triple Win”



Dunes and Beach Nourishments provide one of the most sustainable methods to

1. Increase Coastal Resiliency
2. Increase Environmental Habitat
3. Provide Recreational Areas that have measurable economic impacts

- Vegetation is critical in trapping and maintaining sand during wind transport events
- Vegetation provides added benefits in reducing storm erosion
- Vegetation is key is post-storm recovery and dune re-growth

Questions?

EngineeringWithNature.org

Download

- Executive Summary (70 pages)
- International Guidelines on NNBF for Flood Risk Management (1,000 pages)