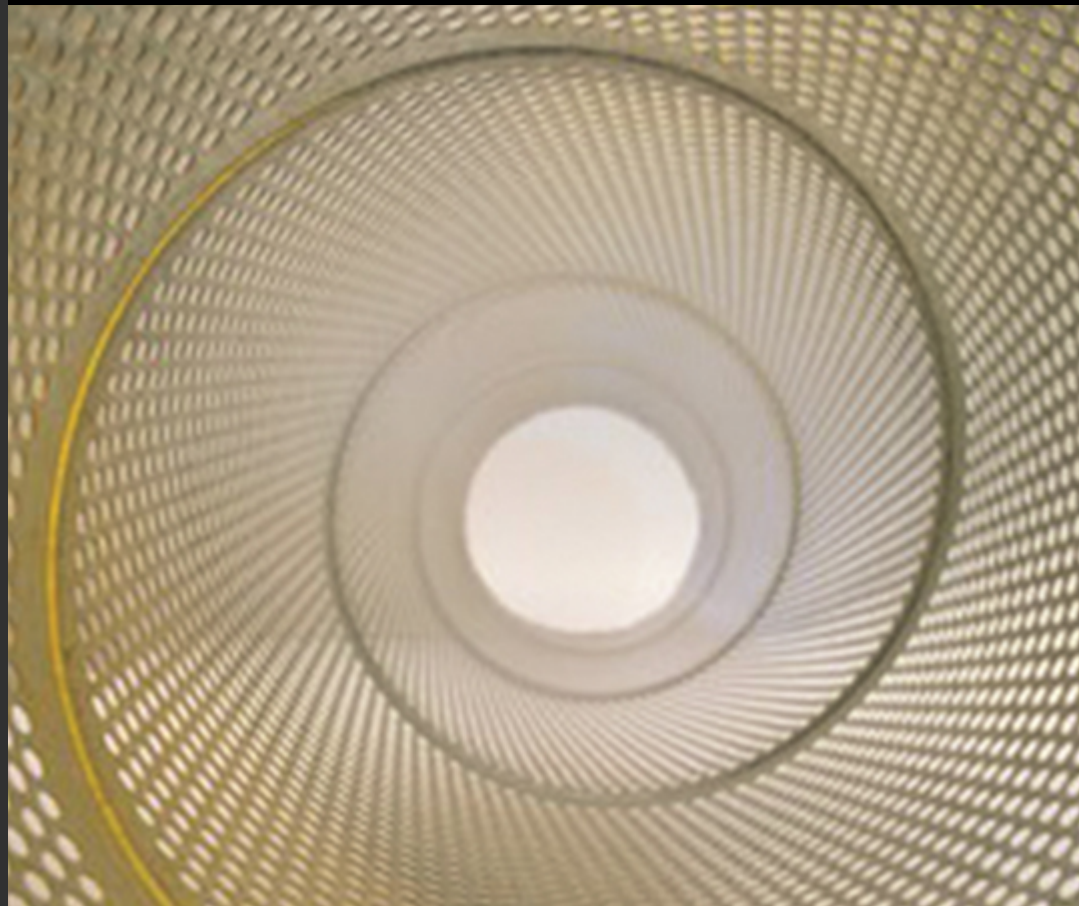


consulting engineers and scientists



Coastal Processes

Presented by: Varoujan Hagopian, P.E. F.ASCE
Senior Consultant, Waterfront Engineer

January 9, 2015



Living Shoreline Workshop

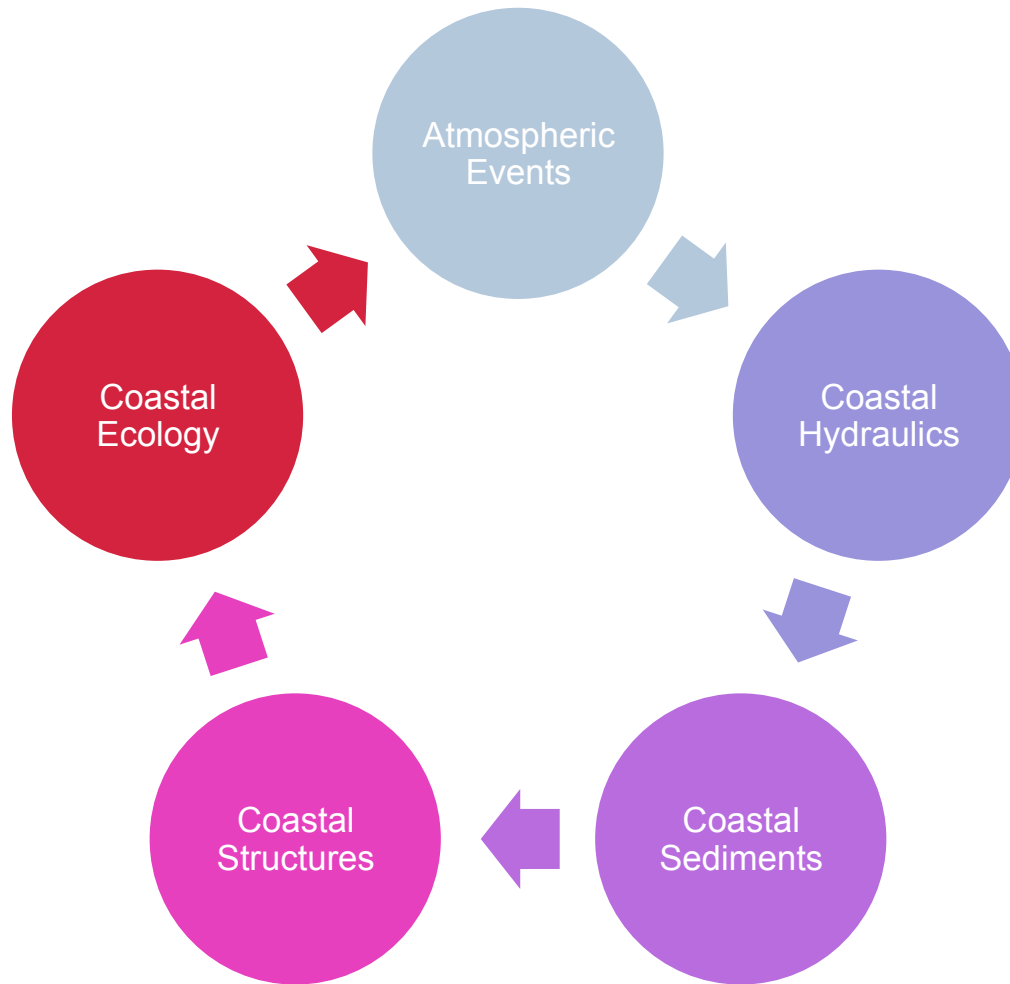


Lets Remember Why We Choose to Live Near the Water





Coastal Processes





What Influences The Coastal Processes

Basic components are:

Hurricanes, Nor'easters, Wind & Waves

- The above are created by the rotation of the earth & the influence of the sun and thermal differential around the earth.
- Let us review the basics of these events and see how they influence our coastal environment



Atmospheric Events: Storms That Shape our Coasts

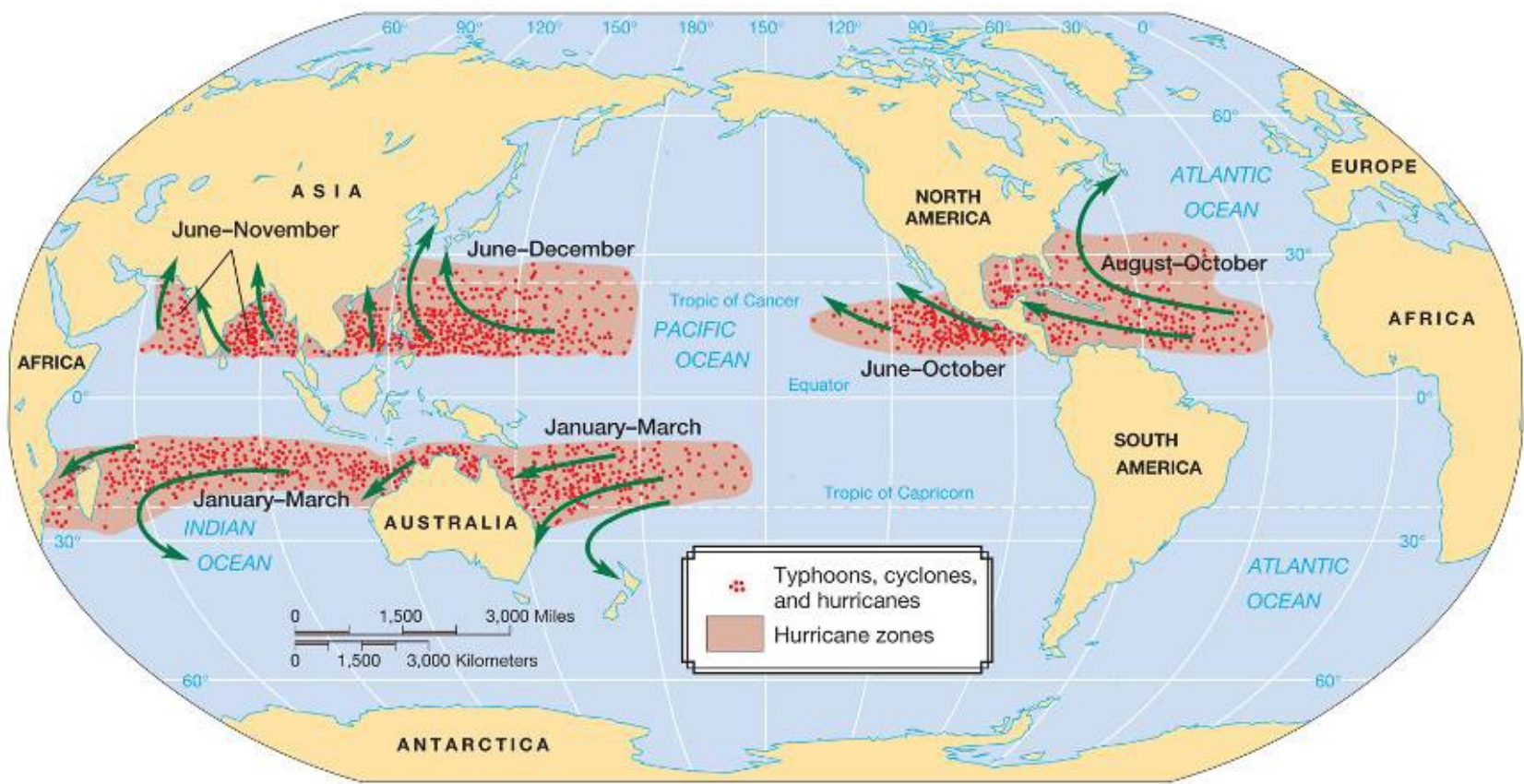
- Hurricanes

- Their characteristics are:
 - ***Common season, on the east coast, July to October***
 - Form over tropical oceans
 - Move south to north in the northern hemisphere
 - Low pressure system
 - Rotates counter clockwise in northern hemisphere
 - Have rotary circulation
 - Eye, center of storm; 20 miles in diameter
 - When the eye shrinks, hurricane intensifies
 - Generate damaging wind speeds > 75 mph
 - Its fueled by warm ocean temperature
 - Diameter ranges between 75 – 1000 miles across
 - Create massive storm surge
 - Heavy rain and coastal flooding
 - Tornadoes



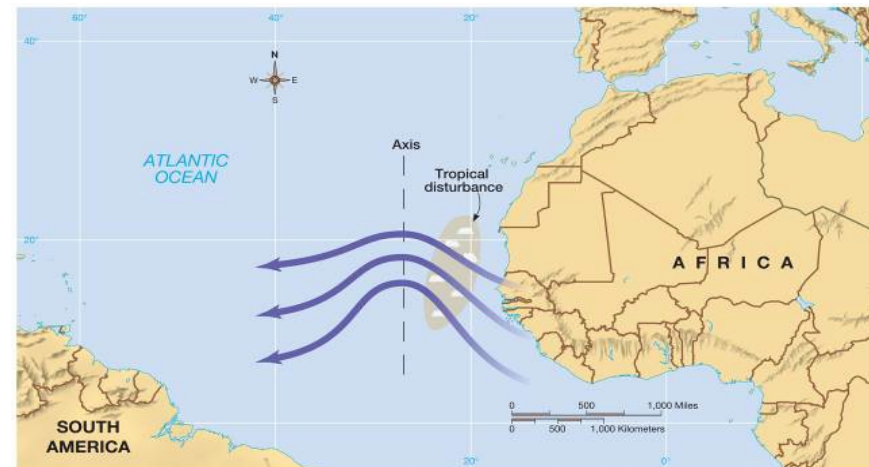
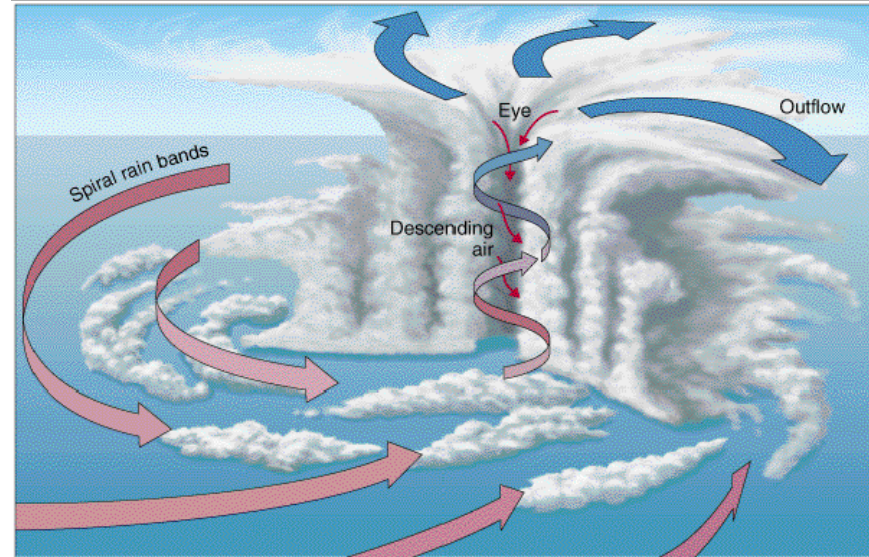
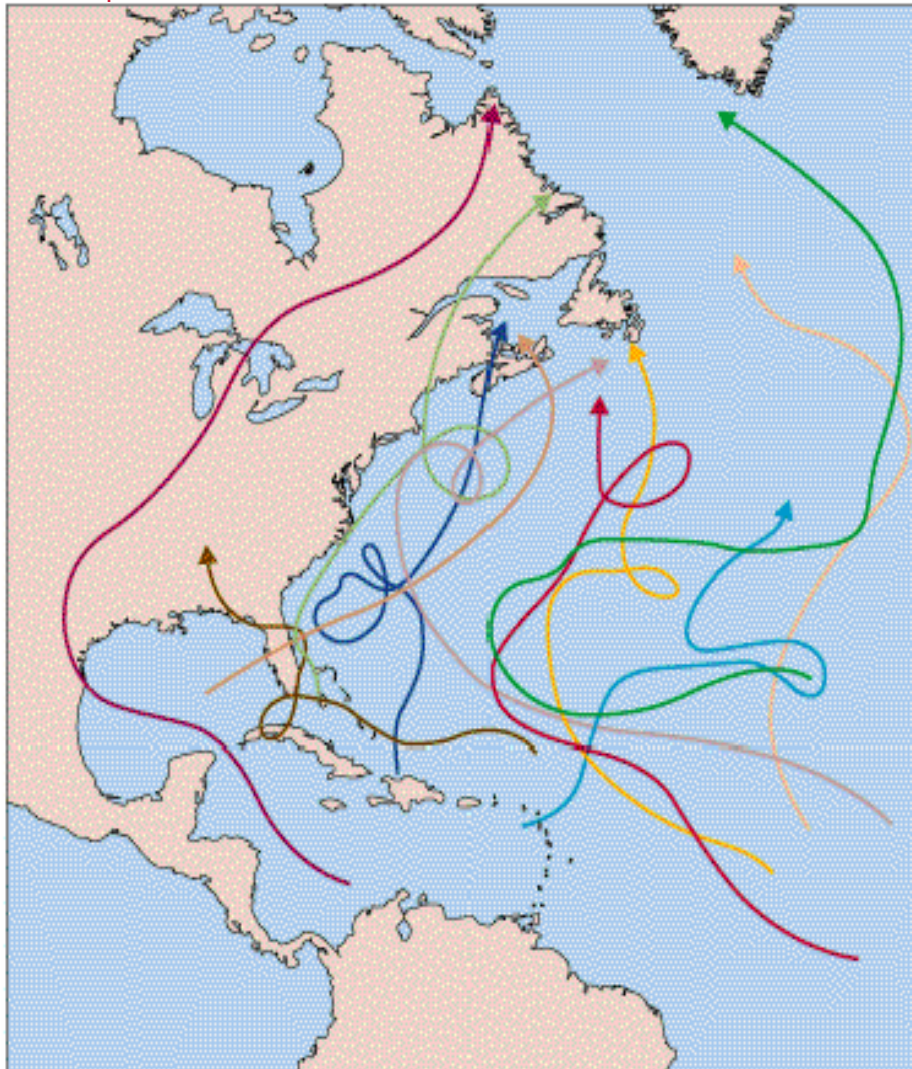


Hurricanes Around The World





How Hurricanes Develop and Migrate



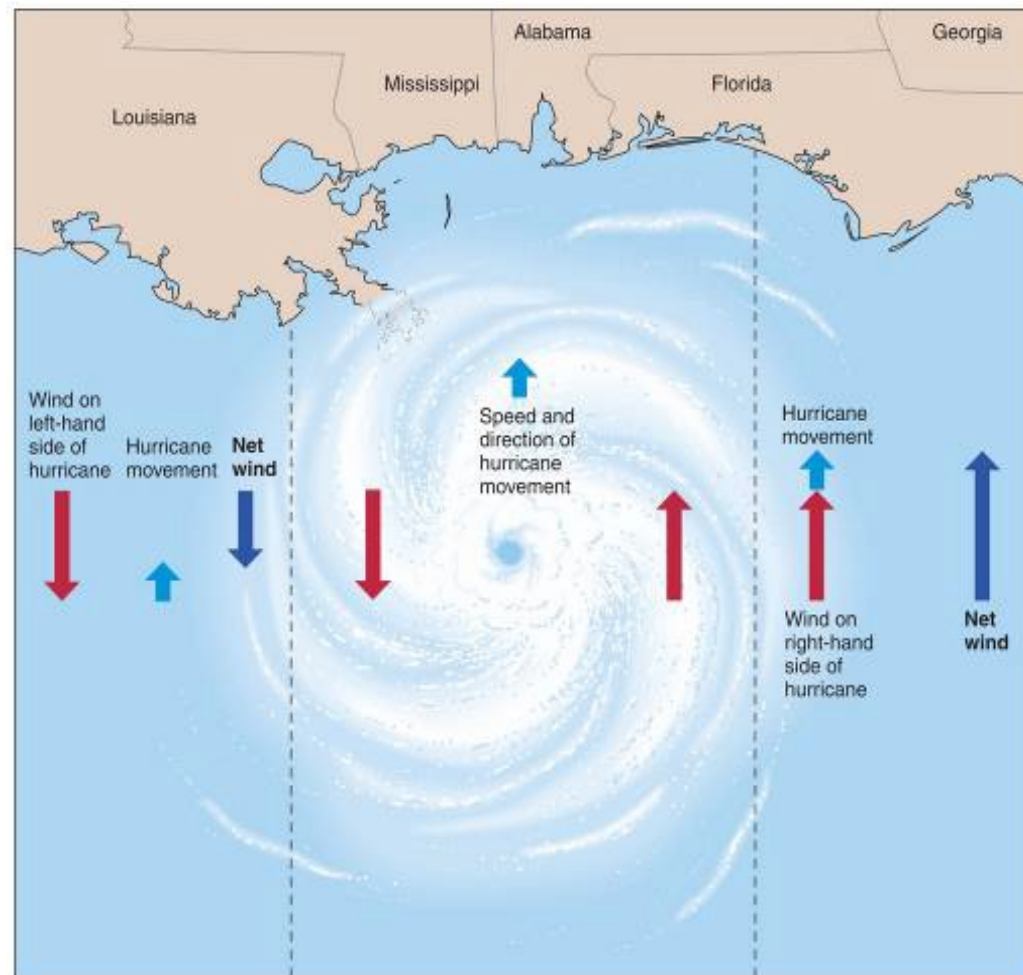


Movement & Wind Speed

Saffir-Simpson scale classifies hurricanes into five categories
Based on highest wind speed sustained for 1 minute or longer

- Category 5, > 155 MPH**
- Category 4, 130 - 155 MPH**
- Category 3, 110 - 130 MPH**
- Category 2, 95 - 110 MPH**
- Category 1, 75 - 95 MPH**

• **Only six Category 5 hurricanes have occurred in the western Atlantic or Gulf of Mexico, since 1969**





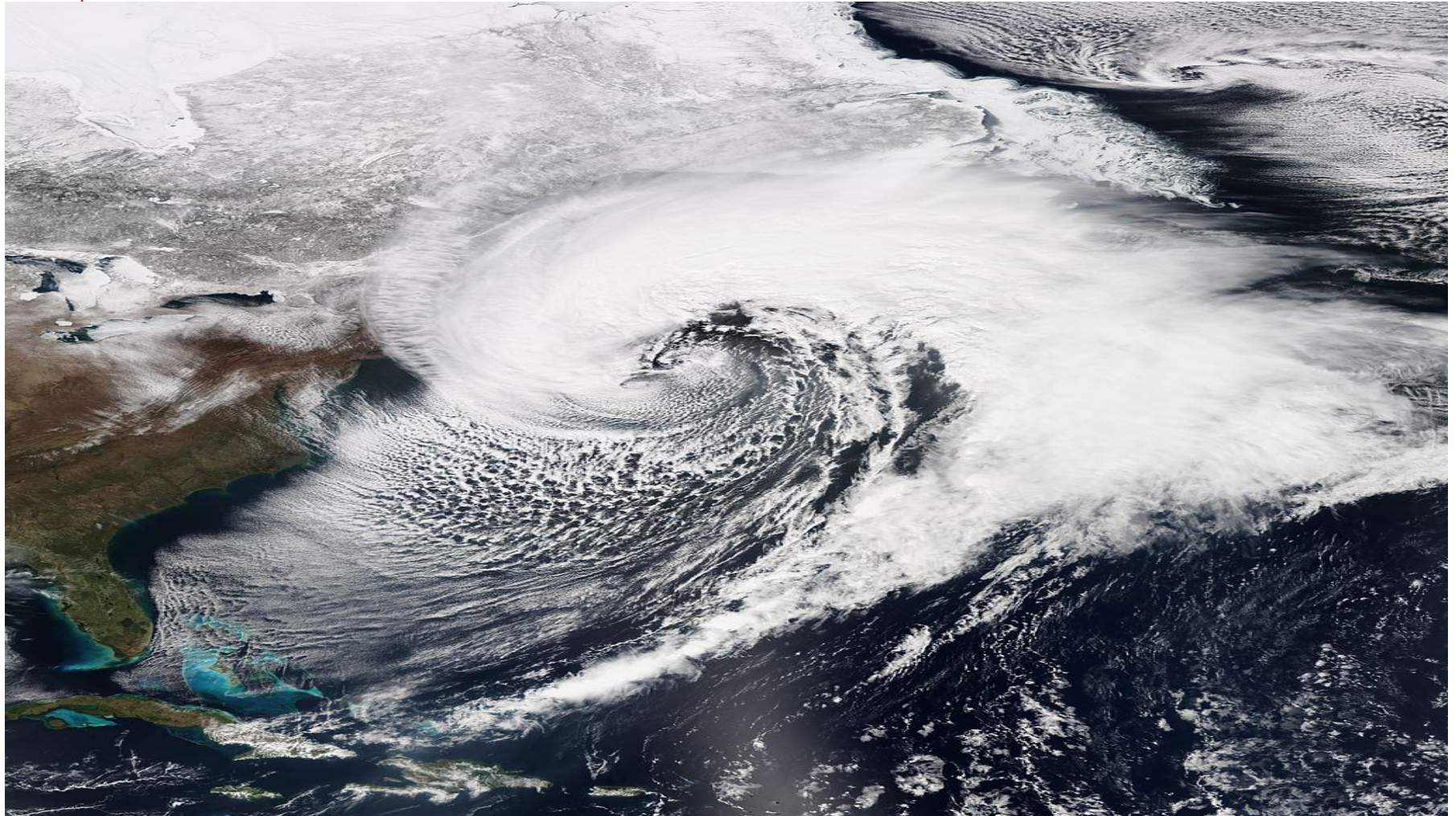
Other Major Storms That Shape our Coasts

- Nor'easters
- Their characteristics are:
 - **Can occur any time of the year. Although more common September - April**
 - Massive cyclonic storms
 - Two fronts colliding together
 - Cold air from Atlantic/warm air from gulf stream
 - Travel inland and northward
 - Generate strong northeasterly winds
 - Generate hurricane force winds
 - Create coastal flooding
 - Create coastal erosion
 - Can spin occasional tornados
 - Create massive coastal flooding & erosion
 - Creates blizzard conditions
 - They introduce frigid temperatures in winter





Powerful Nor'easter March 2014





Effects of Hurricanes & Nor'easters On The Coast

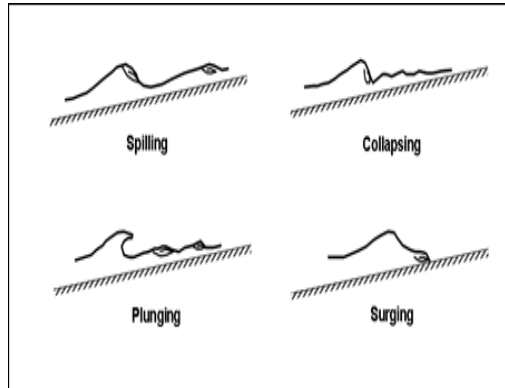
- Direct effects on the coastal region

1. Shoreline inundation
2. Sediment budget change
3. Tidal Surge
4. Strong currents
5. Effect local salinity
6. Change in Eco System
7. Damaging winds
8. Loss and breach of barrier beaches
9. Shoreline erosion and over wash
10. Wetland damage
11. Loss of property
12. Economic impact (negative)
13. Impact on Marine commerce
14. Increase in level of badness is predicted for the future



Coastal Hydraulics; Various Types of Coastal Waves

Spilling Waves
Collapsing Waves
Plunging Waves
Surging Waves



Exploding Waves



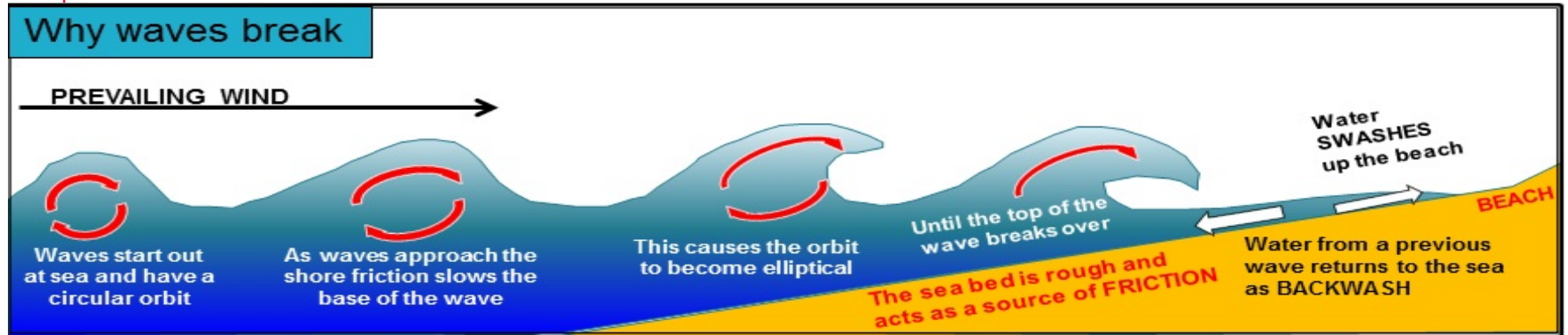
Breaking Waves



Vanda Rita Photography



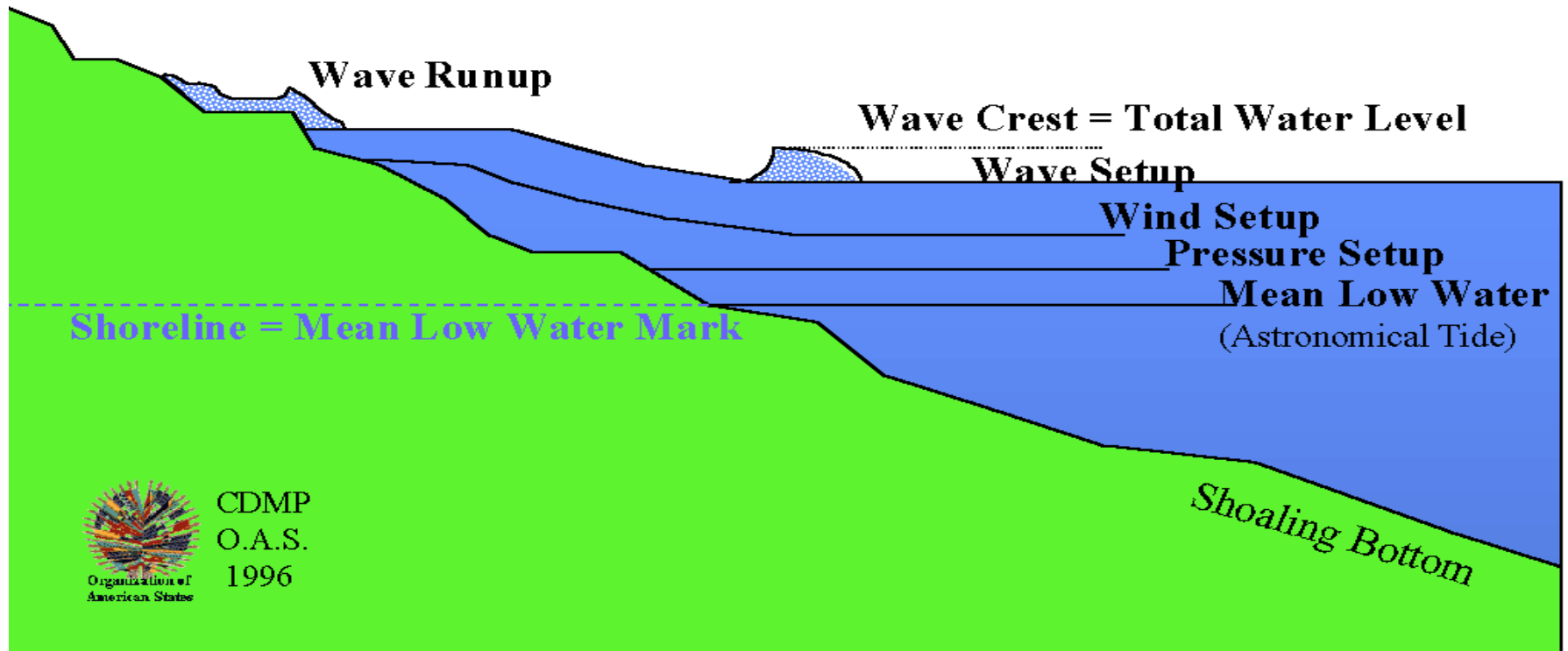
Various Types of Coastal Waves





Wave Propagation in Coastal Environment

Profile: Components of the Storm Surge

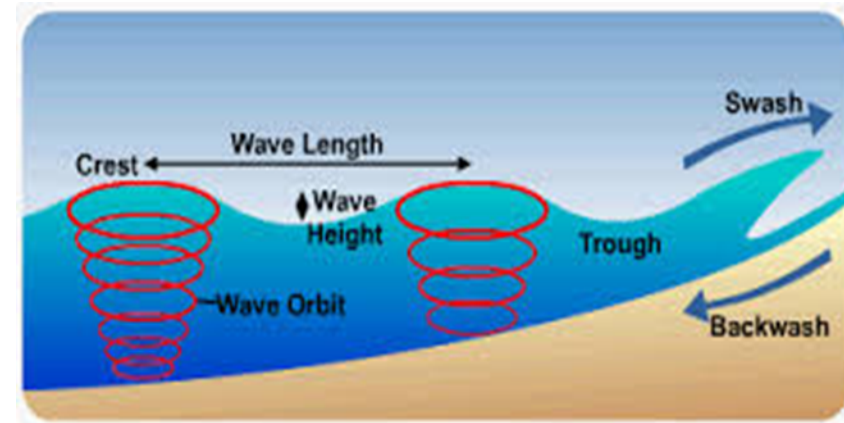
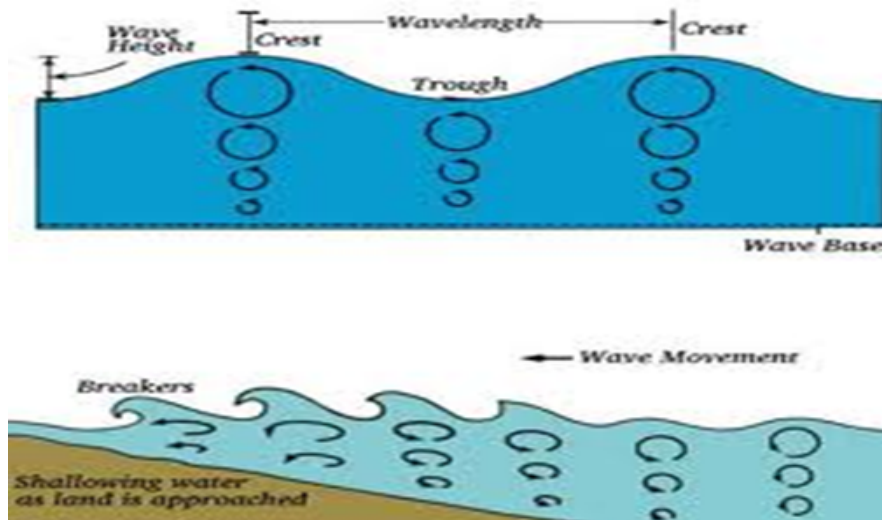


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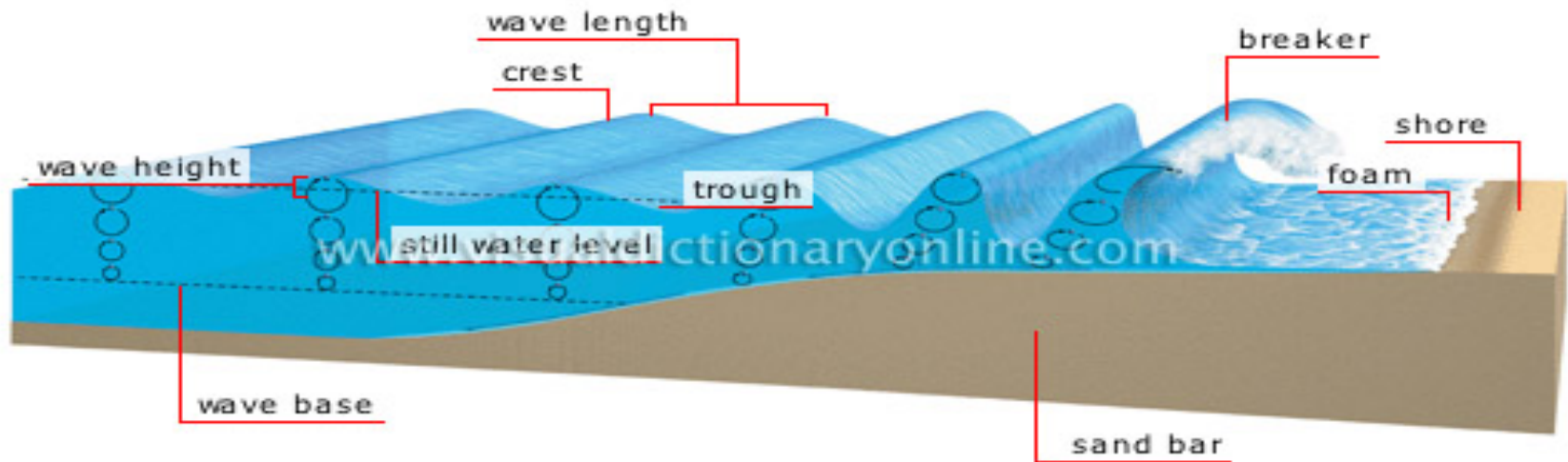
Physics of Wave movement

Waves normally break in the near-shore zone when forward velocity begins to be affected by bottom friction and depth of water equal to about $1.28H$. Or $H/D = .78$





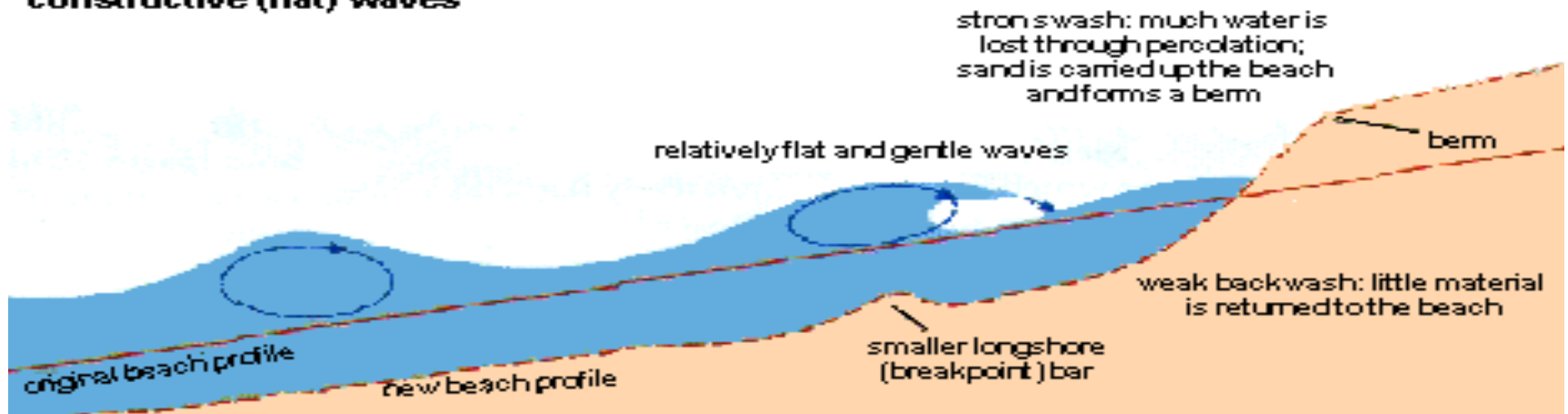
Wave Energy in Near-shore Environment



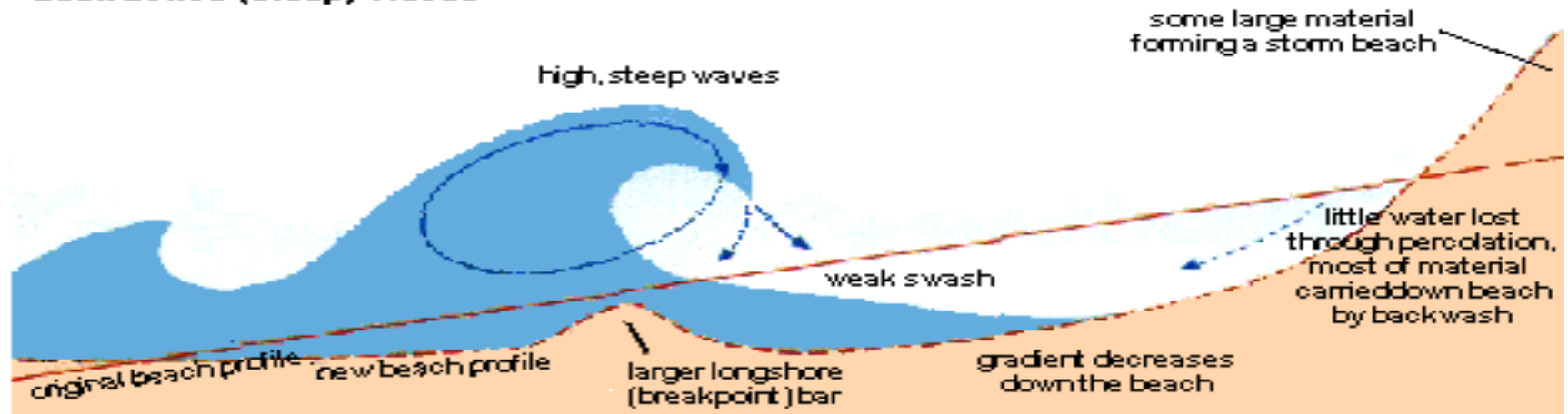


Waves During Different Seasons

constructive (flat) waves

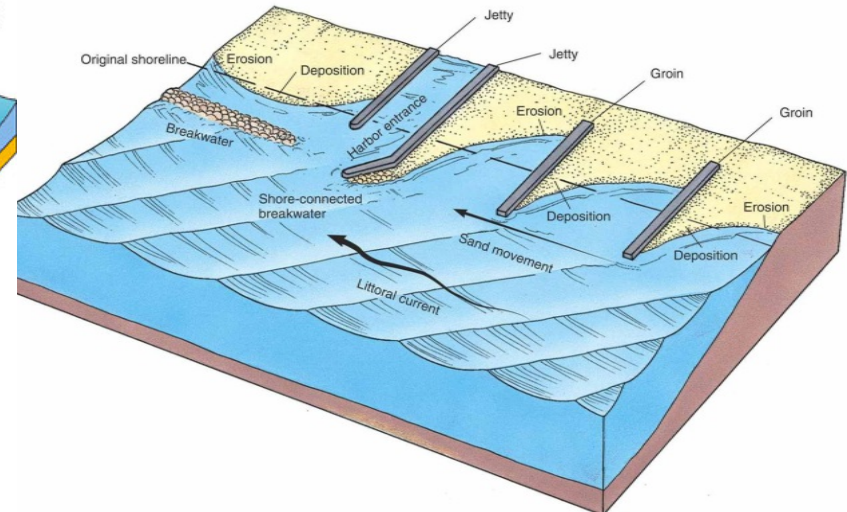
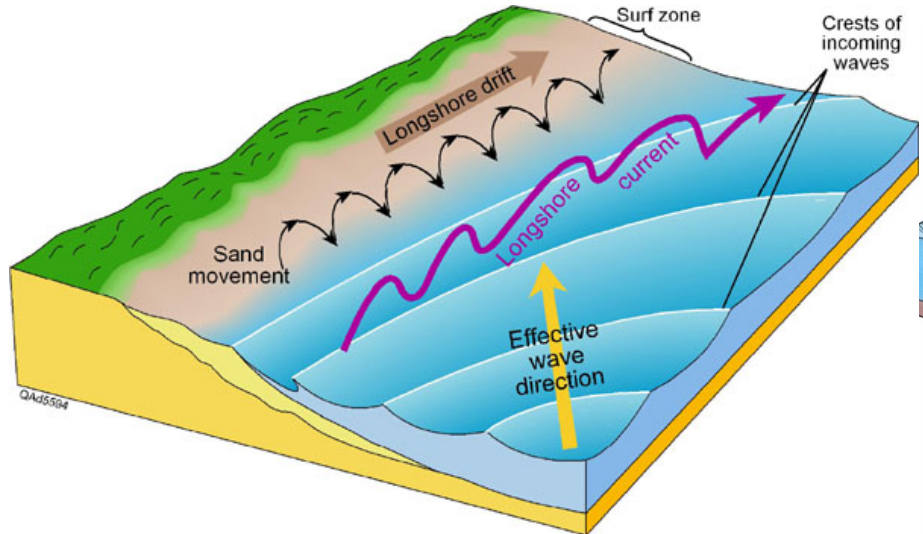
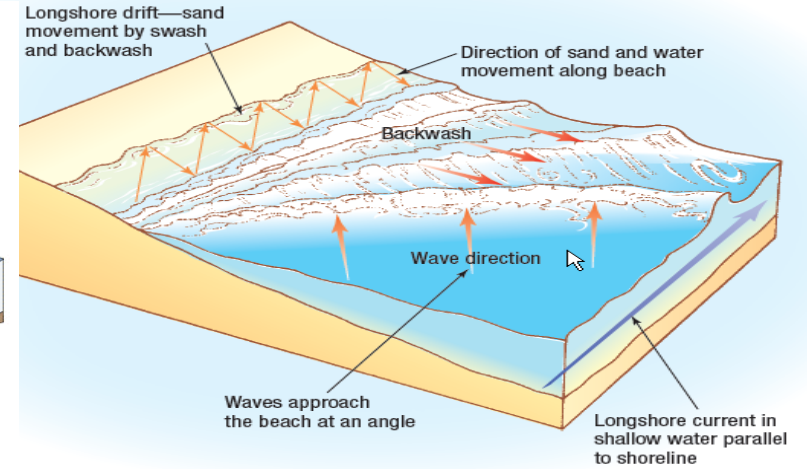
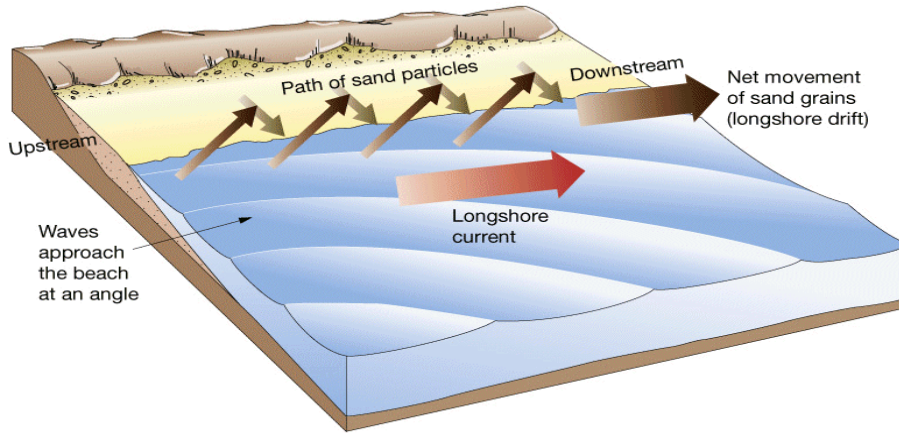


destructive (steep) waves





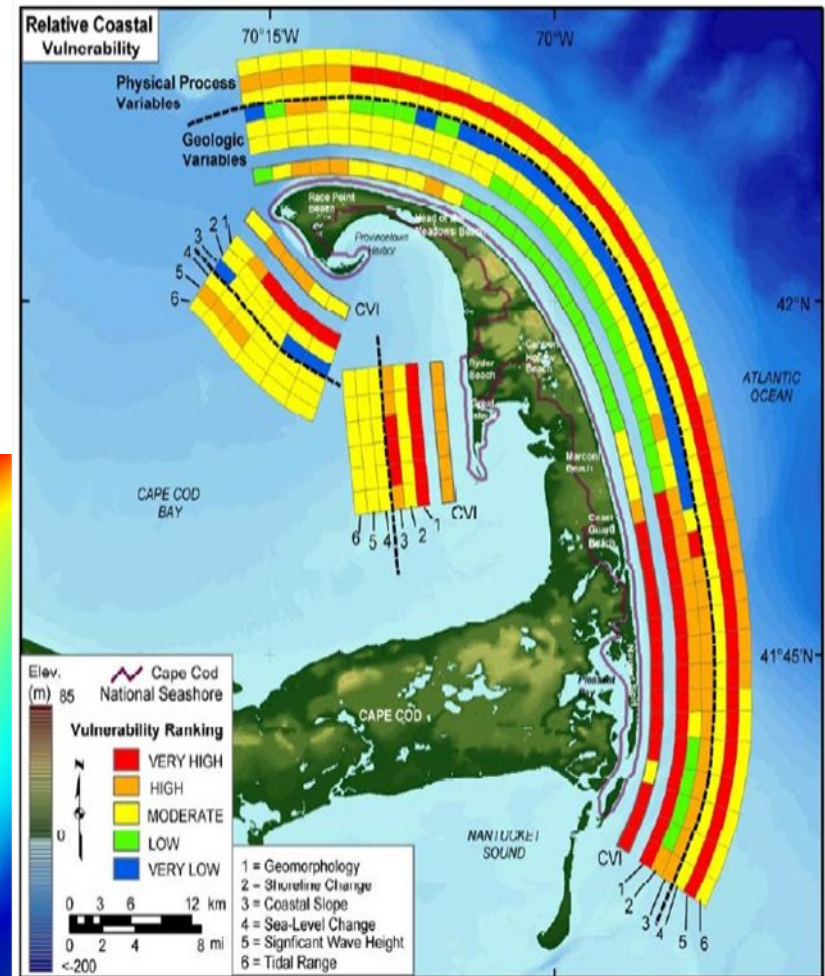
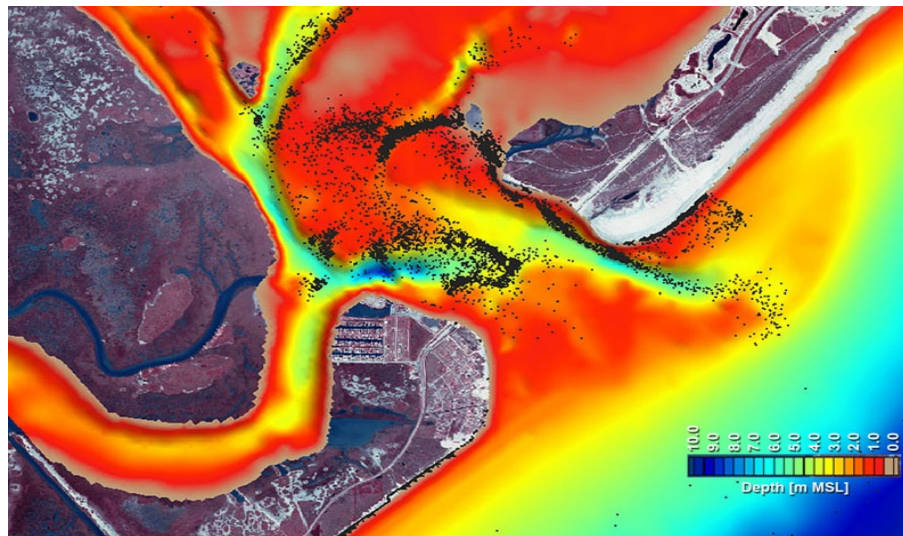
Coastal Sediments; Littoral Process in The Coastal Zone





Various Modeling Tools To Assess Wave Energy Along Shorelines

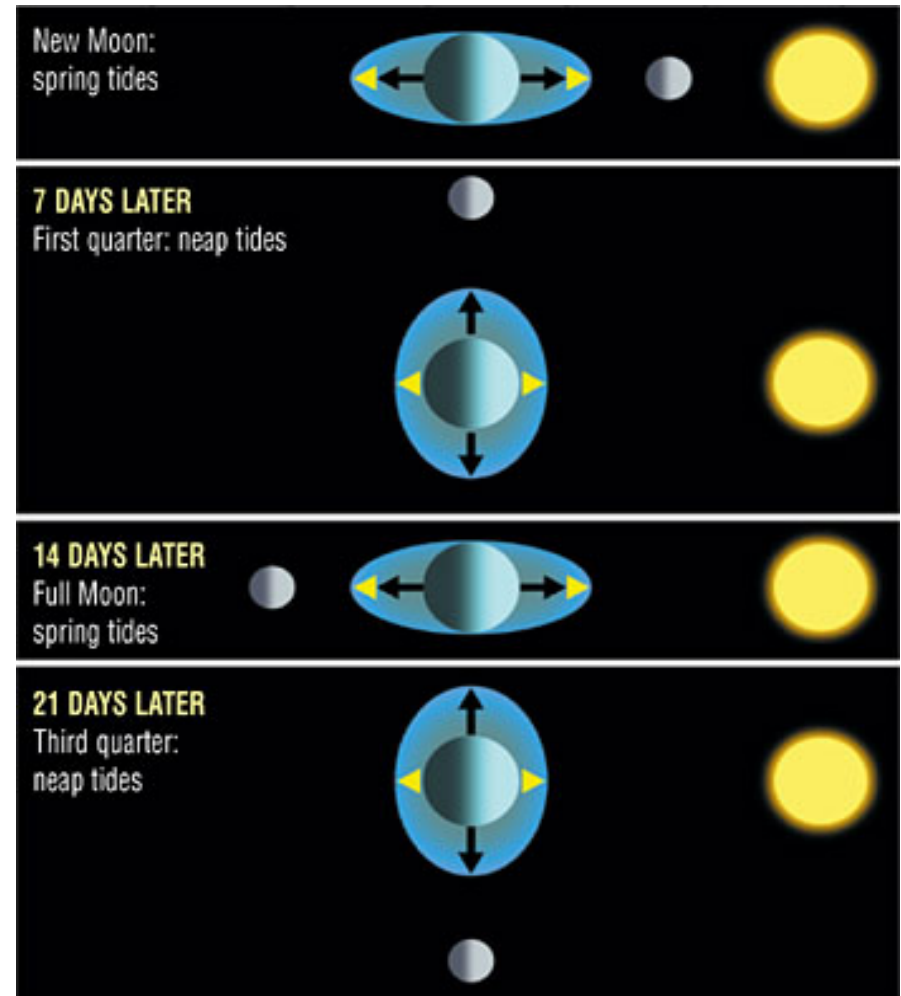
- ADCIRC- Advanced Model
- STWAVE – Near-shore Wave Modeling BY US-ACOE
- Coastal Hazard Analysis & Modeling By FEMA





Tides and Their Various Phases & Cycles

- Tides are generated by differing gravitational pull on the surface of the water from the sun and the moon.
- When the sun and the moon are aligned, they create the highest tides every lunar cycle.
- New moon and full moon generate the monthly spring tides
- Tides can be diurnal (once/day) Gulf of Mexico
- Or semi-diurnal (twice/day) eastern coast of north America
- Mixed diurnal, western coast of north America



Coastal Erosion in High Energy Areas

- Loss of Infrastructure
- Damage to property
- Impact on maritime business



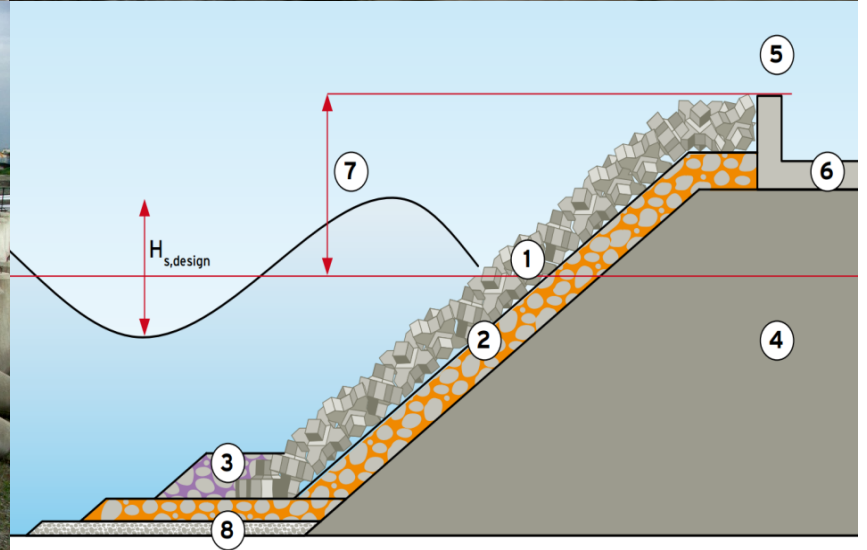


Devastation to Infrastructure & Shorelines from Hurricanes & Typical Nor'easters





Coastal Structures; Traditional Methods of Protection to Coastal Property in High Energy Zones





Proven Coastal Protection Structures

- Groins
- Offshore breakwaters
- Wide beaches





Coastal Ecology; Softer Shoreline Protection in Low/Medium Energy Environments



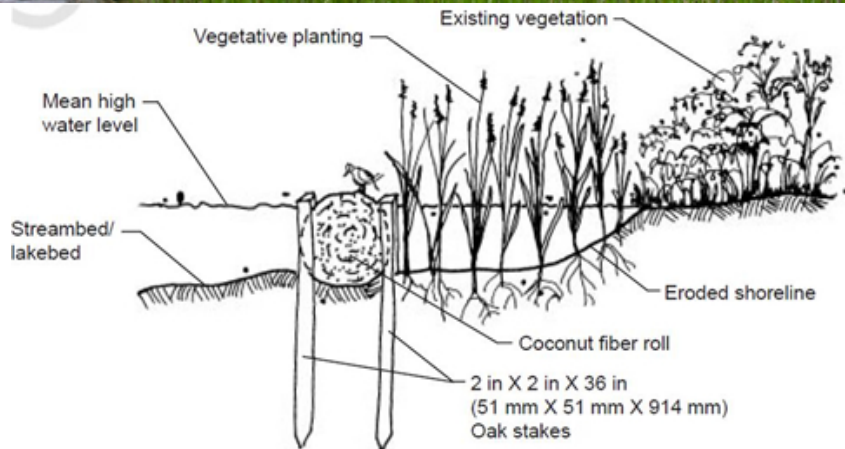
From - *Shoreline Management in Chesapeake Bay*,
by Hardaway and Byrnes.



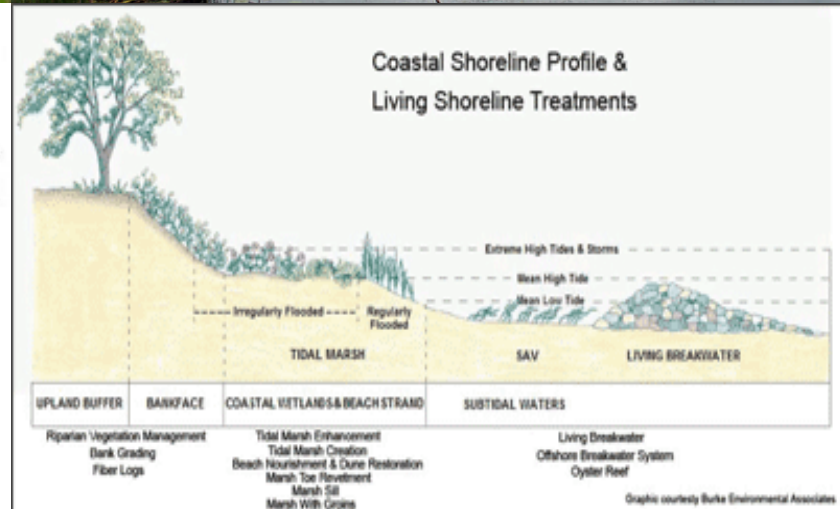
Living Shoreline Options



A Hybrid system

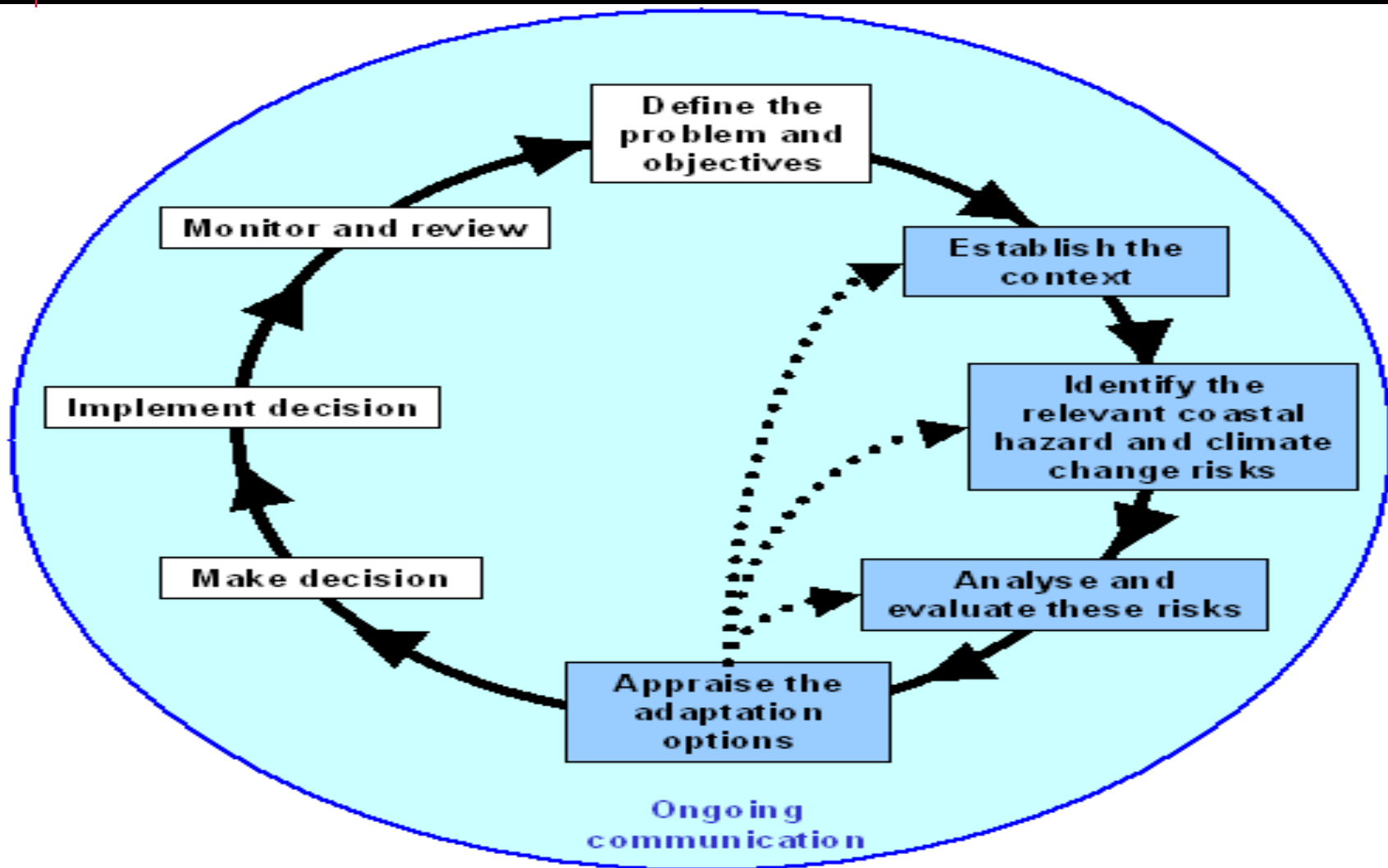


Coconut Fiber Roll with Emergent Vegetation
Section View





Managing Complex Coastal Processes





Sunset View From Gay Head at Martha's Vineyard





Questions?

