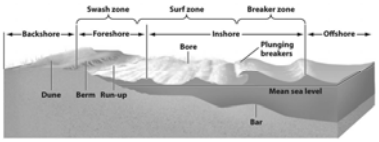
Fifty percent of the population of the industrialized world lives within 100 km of a coast.

Coastal management has lagged behind the growth in population leading to problems with pollution…

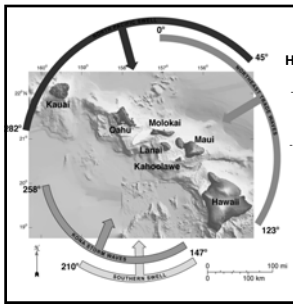
Winds, waves, tides, sea-level change, and currents are collectively called Coastal Processes.



Change Is Constantly Occurring on the Shoreline.

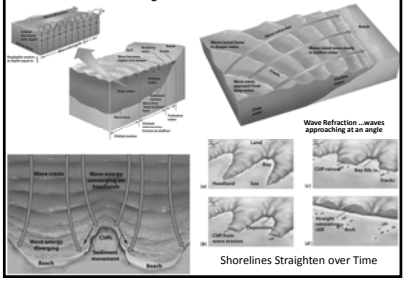
Wind Waves
are generated by the friction of air blowing across the water in the chaotic environment of a Sea.

Wave Energy Is the Dominant Force Driving Natural Coastal Change.



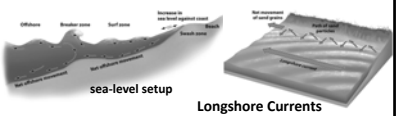
Hawaiian Waves
-Winter north swell
-Summer south swell
-Trade wind waves and swell
-Kona storm waves
-Hurricane waves and swell

The form of a wave changes when it enters shallow water.



Shorelines Straighten over Time

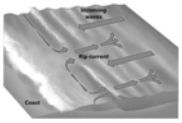
... Wave-Generated Currents occur in Shallow Water.



sea-level setup

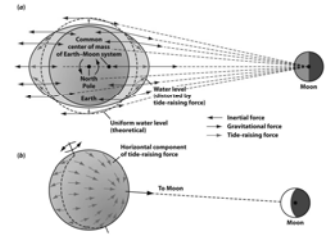
Longshore Currents

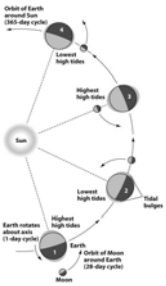
and Rip Currents Transport Sediment in the Surf Zone.



Gravity and Inertia Create Two Tides Every Day.

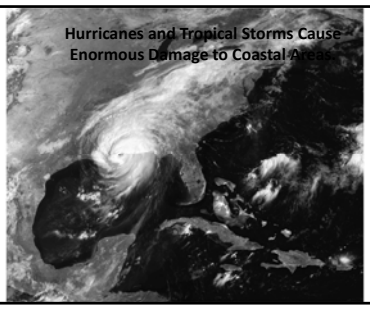
Lunar Tide





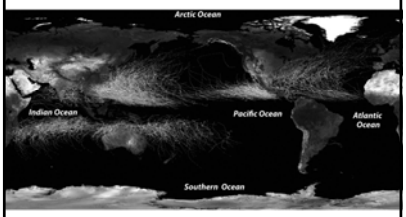
Solar Tide

Hurricanes and Tropical Storms Cause Enormous Damage to Coastal Areas



STORM SURGE

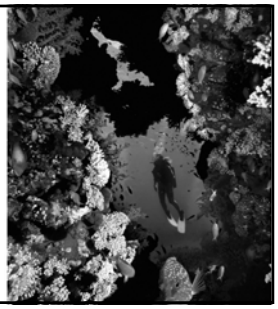
Five Major Areas where Hurricanes Form

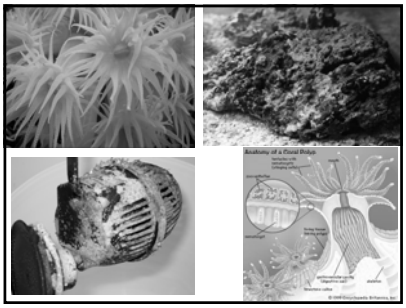


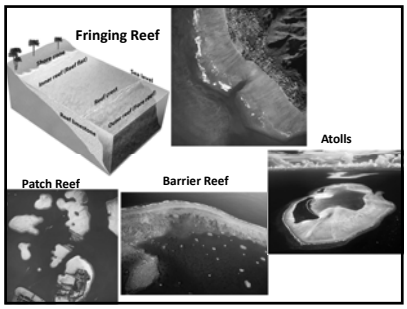
Coastal Problems Are Growing as Populations Increase.

Coastal Armoring

Coral Reefs Are Home to 25% of All Marine Species.

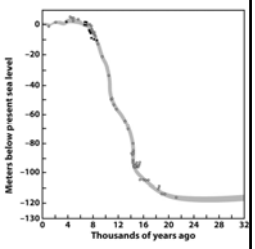




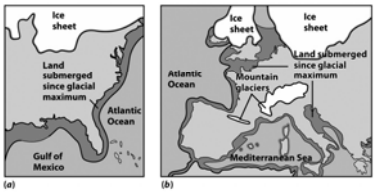


As populations grow in the coastal zone, buildings, roads, homes, and hospitals are built in locations that are vulnerable to natural coastal hazards. Sea-level rise associated with global warming will make these locations even more vulnerable.

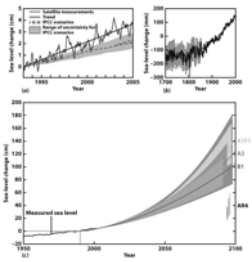
Sea-Level Rise since the Last Ice Age Has Shaped Most Coastlines and Continues to Do So.

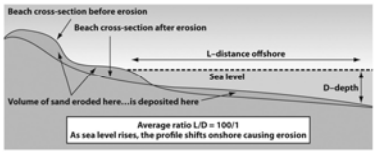


Land Submerged since the Last Ice Age



Sea level rise is a characteristic of global warming



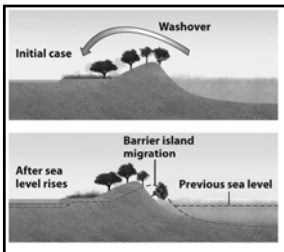


Beach Profile

Low-elevation coastlines with an abundance of sand ...

- **Sandy Beaches**
- **Tidal Inlets**
- **Lagoons**
- **Tidal Marshes**

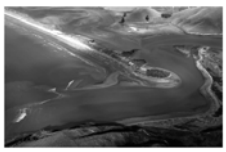
... tend to form long, narrow Barrier Islands.

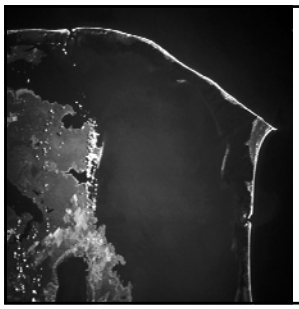


Washover causes Barrier Rollover

Barrier Islands Migrate with Rising Sea Level.

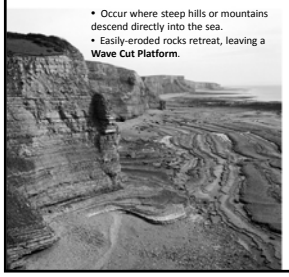
Barrier Islands are fragile, constantly changing environments.





The Outer Banks of North Carolina

Retreating Rocky Shorelines



- Occur where steep hills or mountains descend directly into the sea.
- Easily-eroded rocks retreat, leaving a **Wave Cut Platform**.

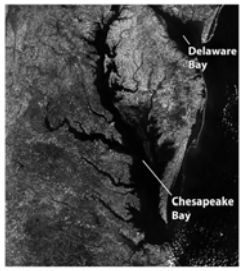
Rocky Shorelines, Estuaries, and Tidal Wetlands Are Important Coastal Environments.

- **Erosion-resistant rocks protrude into the surf.**
- **Sea Stacks mark the former position of the shoreline.**

Protruding Rocky Shorelines

Estuaries

- **Marine Transgression flooded coastal uplands after the last ice age, moving the shoreline inland.**
- **Seawater flooded the mouths of stream valleys.**



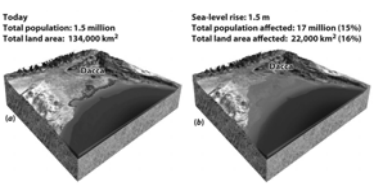
Tidal Wetlands

- **Develop along the fringes of estuaries.**
- **Upland drainage deposits sediments, nutrients, and pollutants in mud rich wetlands.**
- **Wetland plants and soils act as a buffer between the land and ocean.**
- **Salt Marsh grasses and other plants help stabilize the shoreline.**

Coasts May Be Submergent or Emergent, Depositional or Erosional, or Exhibit Aspects of All Four of These Characteristics.

Emergent Coasts
(wave cut platforms and beach ridges)

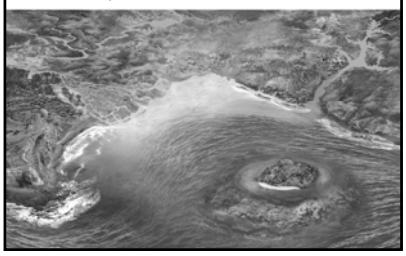
Submergent Coasts
(flooding, lithosphere subsidence)



Erosional Coasts

Depositional Coasts

Label the coastal environments and identify the processes that occur there

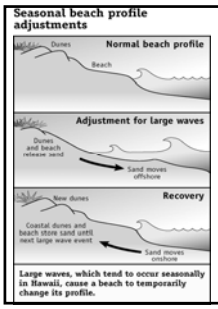


Polluted Runoff

Eutrophication

Many Hawaiian beaches suffer erosion because their dunes have been destroyed (even before seawalls have been built)

Coastal dunes are a storehouse of sand for the beach

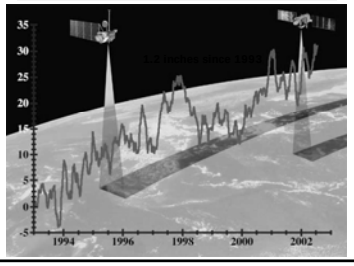


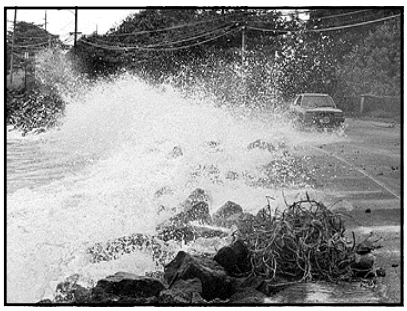
Dunes store sand until high waves move it to the beach

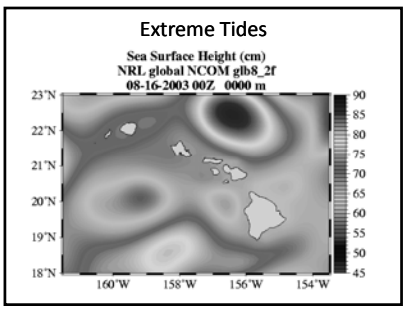
Beach=checking account

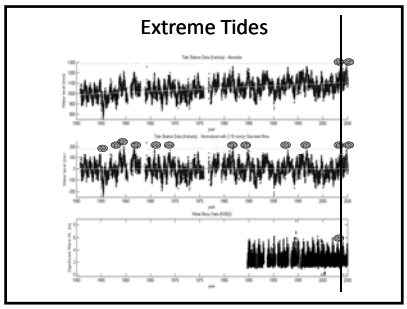
Dunes= savings account

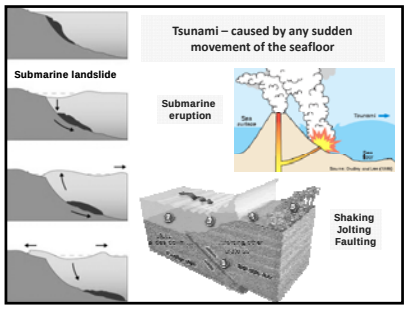
Sea level has been rising for several centuries and will continue to rise for several centuries into the future

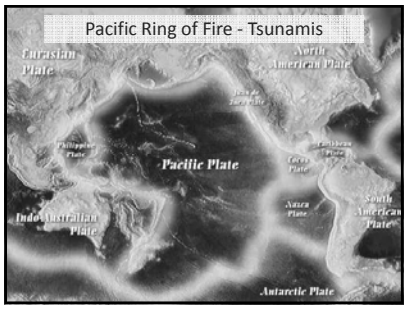


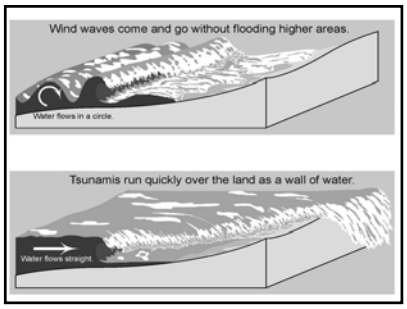


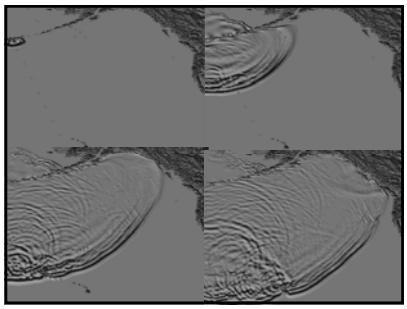



Extreme Tides

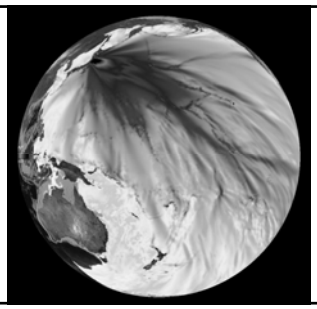

Tsunami – caused by any sudden movement of the seafloor
Submarine landslide
Submarine eruption
Shaking
Jolting
Faulting

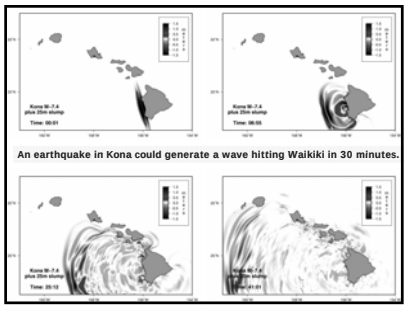

Pacific Ring of Fire - Tsunamis
Eurasian Plate
North American Plate
Pacific Plate
Indo-Australian Plate
South American Plate
Nazca Plate
Antarctic Plate

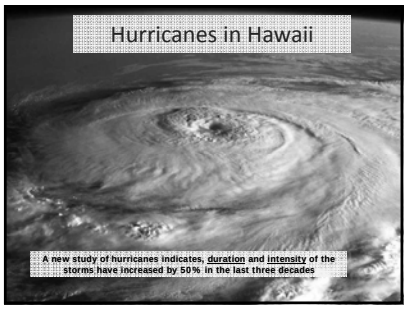

Wind waves come and go without flooding higher areas.
Water flows in a circle.
Tsunamis run quickly over the land as a wall of water.
Water flows straight

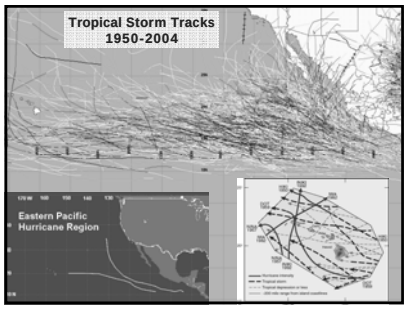


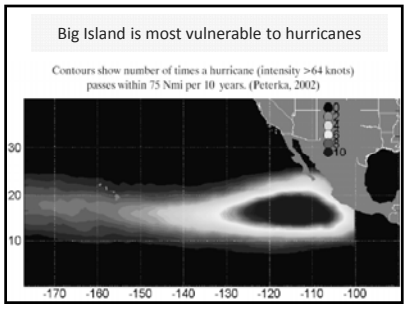
Japan 2011



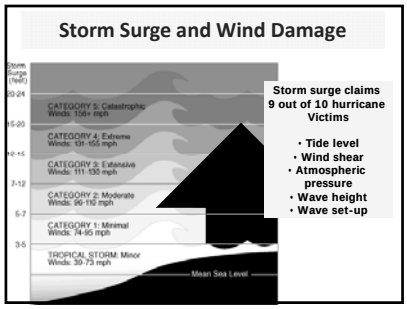

An earthquake in Kona could generate a wave hitting Waikiki in 30 minutes.

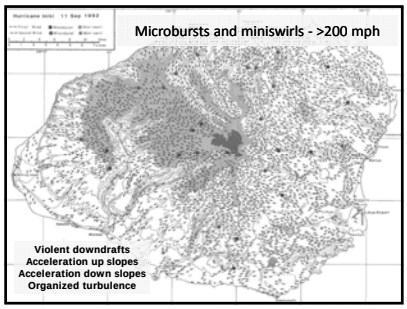

Hurricanes in Hawaii
A new study of hurricanes indicates, duration and intensity of the storms have increased by 50% in the last three decades

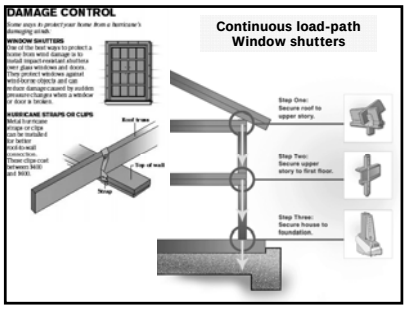

Tropical Storm Tracks
1950-2004
Eastern Pacific
Hurricane Region

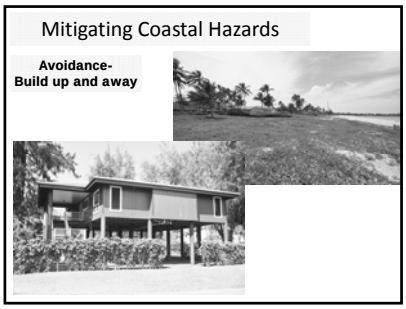

Big Island is most vulnerable to hurricanes
Contours show number of times a hurricane (intensity >64 knots) passes within 75 Nmi per 10 years. (Peterka, 2002)
30
20
10
-170
-160
-150
-140
-130
-120
-110
-100

Iniki storm surge debris line


Storm Surge and Wind Damage
CATEGORY 5: Catastrophic
Winds: 156+ mph
CATEGORY 4: Extreme
Winds: 131-155 mph
CATEGORY 3: Extensive
Winds: 111-130 mph
CATEGORY 2: Moderate
Winds: 96-110 mph
CATEGORY 1: Minimal
Winds: 74-95 mph
TROPICAL STORM: Minor
Winds: 39-73 mph
Mean Sea Level
Storm surge claims 9 out of 10 hurricane Victims
• Tide level
• Wind shear
• Atmospheric pressure
• Wave height
• Wave set-up


Microbursts and miniswirls - >200 mph
Violent downdrafts
Acceleration up slopes
Acceleration down slopes
Organized turbulence


DAMAGE CONTROL
Continuous load-path
Window shutters
WINDOW SHUTTERS
HURRICANE STRAPS OR CLIPS
Roof trusses
Top of wall
Strap
Step One:
Secure roof to upper story.
Step Two:
Secure upper story to first floor.
Step Three:
Secure house to foundation.


Mitigating Coastal Hazards
Avoidance-
Build up and away