# Lab - Beach in a Pan

**(MAKEUP VERSION)**

(modified from Monterey Bay Aquarium)

**Background:** A beach is a dynamic system. It is a river of moving sand and a place where sediment is constantly being transported and deposited. Sediment is transported and deposited by wind, waves and currents. Beaches are found in places suited to sediment deposition, like calm areas between rock outcroppings, shores sheltered by offshore islands and regions with moderate surf. A variety of sand grain sizes are usually found on a beach. The finest grains are often found furthest from the water. That's due to wind blowing and transporting fine grains up the beach. When a wave hits the beach, much of the wave energy is lost. The largest sediments drop out first and are deposited higher on the beach. The lighter sediments remain in suspension a bit longer and fall out as the wave recedes. The lightest sediments are carried back out to sea and may eventually settle out beyond the surf line. Therefore the largest particles are often found between the low tide mark and the berm (the berm is the furthest place sand is deposited by waves on a beach), with smaller particles found either offshore or higher up on the beach.

Beach slope is influenced by the size of sand grains and the waves. Coarser sediments tend to produce a beach with a steeper slope. Conversely, a beach with finer sediments tends to be flatter. The force and size of waves influences the beach composition, too. Stronger waves deposit more sediments on the beach and produce a steeper slope. This means that areas with weaker waves tend to be flatter and areas with calm waves tend to be steeper. Since the strength of waves can vary seasonally, the slope of a beach may also vary seasonally. Many beaches share a typical profile, though it will vary seasonally. Dunes, cliffs or seawalls are often the area farthest away from the water. Berms are found closer to the water. The area between the berm and the low tide mark is the intertidal. This is the active zone of the beach where waves crash during the daily rise and fall of the tides.

The dynamic nature of sand can result in challenges to coastal development. With most of the world's population living on the coast, new homes and businesses are built every year in coastal areas. Millions of dollars each year are invested in protecting structures from the natural process of coastal erosion. Breakwaters, groins, jetties and sea walls are all physical structures used to protect structures from strong waves and prevent the erosion of sand. Breakwaters, structures in the water parallel to the shore, prevent the longshore current from moving sand so sand may accumulate and need to be dredged to keep harbors functional. Groins, structures extending from the beach perpendicular to the coast, often result in the erosion of sand on the downdrift side. Jetties are similar to groins but are used to stabilize large inlets. Seawalls are on shore and built parallel to the beach but deflect wave energy into the sand in front of and next to them which cause erosion. Beach sand is sometimes imported to fight erosion. But that sand is often from deeper waters so is fine grained and often erodes faster. Building on solid substrate, like a rocky shore, and a reasonable distance away from the water, is a more sustainable method of coastal construction.

**Prelab Questions:**

1. In what ways is sand transported on a beach?

2. Why is smaller grained sand found further from the water?

3. Describe the differences between beaches with steep slopes and beaches that are flatter.

4. Describe the difference between a breakwater and a groin.

5. How does coastal development influence beach structure?

6. North Carolina does not allow large scale use of breakwaters and groins in order to preserve the natural feel and flow of barrier islands. Do you agree with this decision?

**What We Did in Class:**
Bring your beach towel and sunscreen! Students created a beach in a paint pan by putting sand in the shallow end and water into the deep end. They then used different size and frequency waves to determine the effect on the movement of sand and the integrity of buildings on the beach. They may have gotten a little wet, all in the name of science!

**Class Results:**
As waves increased in intensity and frequency, sand erosion increased and ultimately caused property damage. The result of waves hitting the beach at a 45$^{o}$ angle also creates a longshore current. While breakwaters and groins can be implemented to decrease beach erosion, these structures only lead to increased erosion downbeach.

**Watch the video** at https://youtu.be/Xf0kR79U6KU?t=123 to **answer the following questions.** (feel free to watch at higher speed)
(section 1: 1:23 – 11:30)

7. What are the major threats to the NC Outer Banks?

8. How much do tourists spend each year visiting the Outer Banks?

9. Describe the vulnerabilities of Highway 12.

10. Describe the natural movements of barrier islands.

11. How have human activities combatted the natural movement of barrier islands?

(section 2: 11:30-21:30)

12. Describe the threats and consequences to the Bonner Bridge.

13. Describe the possible solutions in addressing issues with the Bonner Bridge.
(FYI: they went with the short bridge and it was completed in 2019)

14. Describe the financial pressures to keep rebuilding current infrastructure despite environmental pressures.

15. What did you learn from this makeup lab?