Notes from the Field

Young Scientist Newsletter

Marsh Erosion

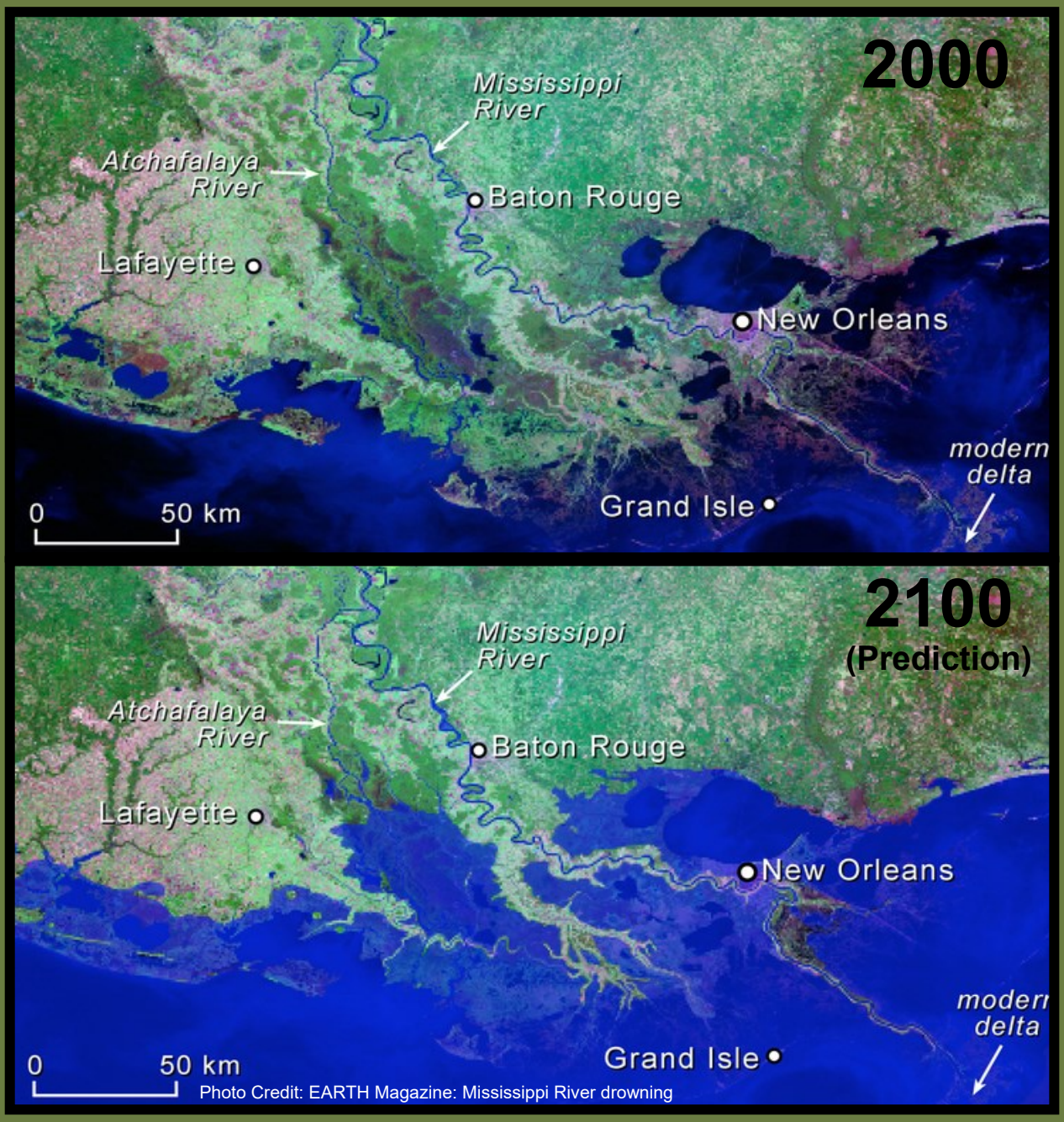


Photo Credit: EARTH Magazine: Mississippi River drowning

March 2017

What is erosion?

Growing up in southern Louisiana, you have probably heard the terms “marsh erosion” or “land loss” used before. **Erosion** is the gradual wearing of soil, rock, or land due to water, wind, or other natural agents. A commonly discussed example is a river washing away, or eroding, topsoil or rock from along its riverbank. The Grand Canyon formed over millions of years as the fast moving waters of the Colorado River eroded away layers and layers of rock. And now it is erosion by wind that continues to change the Grand Canyon far above the reach of the river. Another example is how islands “move” and change shape over time as waves crash along the shores shifting and removing sand and rock. Erosion in salt marshes happens naturally due to tides, waves, storms, and even plant and animal life. However, scientists have also shown that humans and human-caused disturbances are having a major effect on natural landforms and often cause erosion to happen faster than it might naturally.

Flip to the next page to explore land loss in Louisiana.

Aerial photographs of East Timbalier Island, LA, from July 18, 2001 (top); September 30, 2005, six days after the landfall of Hurricane Rita (middle); and September 4, 2008, three days after the landfall of Hurricane Gustav (bottom). Yellow cross-hairs indicate a common reference location for comparison.
Photo Credit: USGS

The Grand Canyon (Arizona) is an example of the power of water and wind erosion over millions of years
Photo Credit: Encyclopedia Britannica

The position of Fenwick Island and Ocean City, Maryland (top) illustrate the westward migration of Assateague Island (bottom). The two barrier islands used to be parallel (along the dashed line).
Photo Credit: Teach Ocean Science

A glossary of **key words** located on page 5

Over the last 7,000 years, the course of the lower Mississippi River has shifted six times. You didn't realize that a river that size could change its route? It actually happens with rivers of all sizes all the time (geologically speaking). Fast moving waters, like in a river, want to follow the straightest path, with the fewest roadblocks, possible. Therefore, over time it might erode through a narrow strip of land or maneuver around a physical barrier and change the course of the riv-

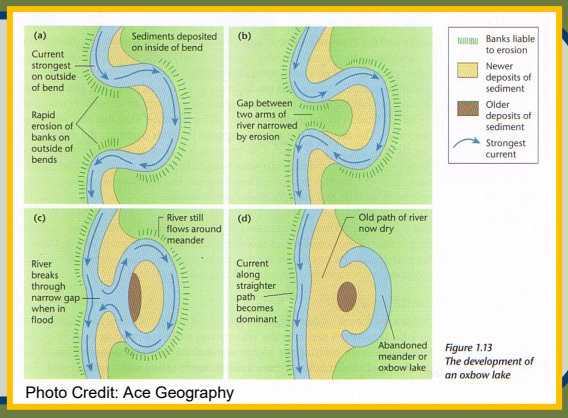


Photo Credit: Ace Geography

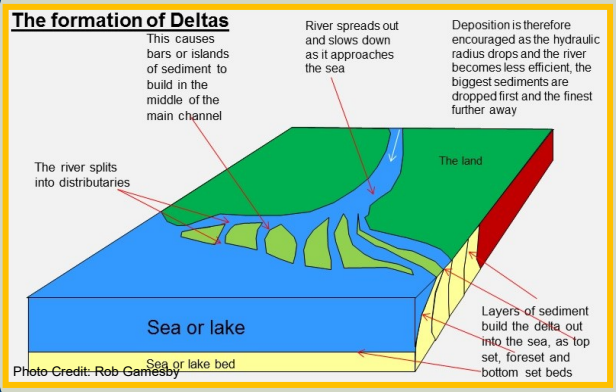


Photo Credit: Rob Gamesby

The route of the Mississippi River that we see on maps today is actually quite different from what it looked like a couple thousand years ago. As it flows south, the Mississippi River picks up tons of sediment (436,000 tons per day![1]) and then deposits it offshore when it reaches the "quiet" waters of the Gulf of Mexico. This process of **deposition** creates a **delta** that can eventually support plant and animal life. But as the delta grows the path of the river becomes longer and more difficult. So what does the river do? It finds a shorter, easier path to the coast[2]. Based on studies of the sediment in southern Louisiana, scientists have been able to track the shifts of the Mississippi River Basin since its formation approximately 7,000 years ago[3].

★ **Bold words** can be found in the glossary on page 5

Now you might be asking, "Why is this important?" when we are talking about marsh erosion. This process of depositing sediment to form a delta is actually the first step in creating a marsh. Land is built up over time and plants and animals (maybe even humans) begin to colonize. But if the delta is not continuously replenished with sediment from the river, the land will sink and water will move in. Over time (usually this takes hundreds of years), the dry land becomes flooded and a marsh ecosystem emerges[4]. Fast forward 1,000 years and the river will shift, forming a new delta and restarting the whole cycle.

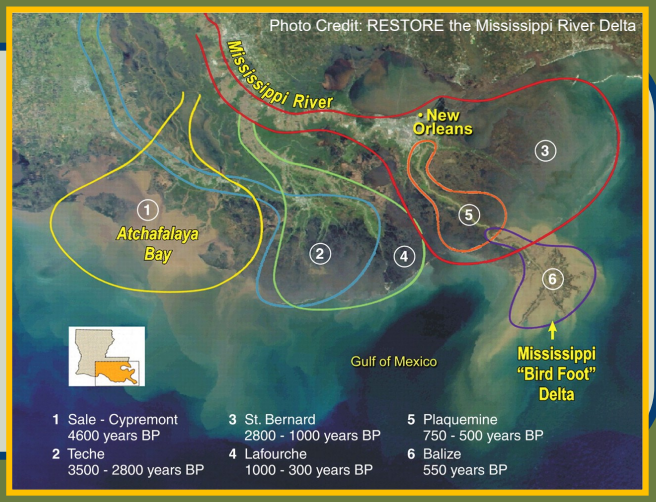


Photo Credit: jgwchpc.com

In theory, this process should continue until the river dries up but as human civilizations settled along the banks of the Mississippi we started to change the natural rhythm. The meandering path of the river was inconvenient for ships and flooding was devastating for towns along the bank. The first **levees** in Louisiana were built as early as the mid-1700s but they became more widespread when the Army Corps of Engineers took charge in the 1920s. The levee system we see now was designed to stop the shifting of the river and prevent flooding during storms[5]. Unfortunately, sediment from the Mississippi is no longer replenishing the rest of the Louisiana coastline. It is contained at the existing delta while historical deltas continue to sink and erode away. In other words, marshes that were established on historical deltas are eroding away and have no natural source of replenishment.

The "root" of the problem...

Coastal erosion is typically the result of natural processes like hurricanes, rivers and waves. However, research is showing that actions taken by humans to "control" their environment are making our coastlines more vulnerable to erosion. Urban development (the building of houses and roads), **dredging** for oil and gas lines and navigation channels, and the use of levee systems all contribute to land loss. These activities change the shape of the land and remove the planet's natural stabilizer – plants. Plant roots spread throughout soil and serve as a framework that keeps the sediment in place. The loss of these roots through physical removal or death can leave a patch of land without any anchors.


Photo Credit: Scientific Earth Conscientious

Research started after the Deepwater Horizon oil spill in 2010 demonstrates just how important those root systems are to the future of Gulf Coast marshes. Referring to a study published in 2012, Dr. Brian Silliman of Duke University states that "when grasses die from heavy oiling, their roots, that hold the marsh sediment together, also often die. By killing grasses on the marsh shoreline, the spill pushed erosion rates on the marsh edge to more than double what they were before. Because Louisiana was already experiencing significant erosive marsh loss due to the channelization [the building of channels] of the Mississippi, this is a big example of how multiple human stressors can have additive effects"[6].

CWC scientist Dr. Brian Roberts and his lab have been studying how the oil has affected the marsh sediment itself and how **greenhouse gas** production has changed. They are also finding that the **microbe** community and chemical properties of the sediment have changed due to oil exposure and are wondering if this might be affecting the physical structure of the grass as it grows back. Regrowth is a good sign that a marsh is recovery but if the grasses and their roots are unable to stabilize the sediment than they are not successfully preventing erosion. Roberts' lab is in the process of building **mesocosms** that will allowing them to test their hypotheses about the oil spill without damaging the environment.

★ **Bold words** can be found in the glossary on page 5

Land loss through a lens

CWC scientists Giovanna McClenachan and R. Eugene Turner, both of Louisiana State University's Department of Oceanography and Coastal Science, had evidence that marsh erosion was happening at an increased rate but needed to find a way to accurately document it. They tackled this challenge with every surfer, paddler and adventurer's best friend – the GoPro®!

McClenachan and Turner attached two GoPro cameras to a pole that was 1.5m from the marsh edge and aimed at a target pole. Additional poles were placed to the left and right of the study site to serve as reference markers in the pictures. The cameras, designed to function in any number of conditions, took photos throughout each day of the study period capturing the changing tides, passing storms and the gradual decrease in soil around the marsh grass roots. The collected photos show a dramatic loss of sediment. So much so, that the scientists had to put in more poles during the study period to mark the changing marsh edge. Not all of their data is available as they are still doing analysis but they did share that 5.2m^2 of the 10.5m^2 study site was lost over the course of the year. That's nearly 50%!

A time lapse video was created and you can find it by searching "Time lapse of land loss in coastal Louisiana" on YouTube.

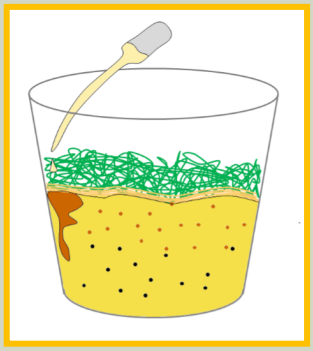
D.I.Y. Science

Activities and experiments you can do at home with your family and friends

Losing It: Oiled Erosion

(Author: Brandon Coleman, CWC)

Background:
Some coastal states have experienced erosion due to freshwater flow, turbulent coastal conditions, and soft substrate. Oil pollution has been known to intensify coastal erosion in some areas. The oil decays plant root systems, and as a consequence, loosens the sediment held together by the plant's roots. When turbulent coastal conditions or increased freshwater flow comes in contact with areas subjected to coastal erosion, increased land loss may occur.



Here is what you need:

Clear plastic cups
Vegetable oil
Sand (craft stores)
Easter grass (craft store)
Small plastic pipettes
Plastic spoons

Creating your oiled marsh sediment:

1. Add sand into the plastic cups, until it reaches a little above the halfway point.
2. Add the Easter grass on top of that. Pack it down until it has the same volume as ¼ of the plastic cup.
3. Use the pipettes to slowly squirt oil onto the sides of the cups. Focusing on the sides of the cups so you can easily see the interaction of oil and sand.
4. Use as many squirts as it takes for the oil to finally reach the bottom of the plastic cup.
5. Use the spoon to scoop some unoiled sand. Compare the difficulty with scooping the oiled sand.

Objectives:
With this activity you are simulating oil contamination on a sandy substrate. The objective is to examine what happens to sand once oil mixes with it and how it is easier for clumps of sand to be removed from the cup once mixed with oil. Think about how this is related to oil contamination intensifying coastal land loss.

Consider these questions:

1. Does the oil immediately begin to appear in the sand? Why or why not?
2. If you study a typical salt marsh profile (below), where would protection from oil contamination be the highest (exclude water level mark)?
3. What was the difference between scooping unoiled sand versus oiled sand? Do you know why? Do you think a muddy substrate would react the same way?
4. Mussels, clams, worms, birds, crabs, snails, and turtles live in or on these coastal marshes. How may oil contamination affect these organisms?

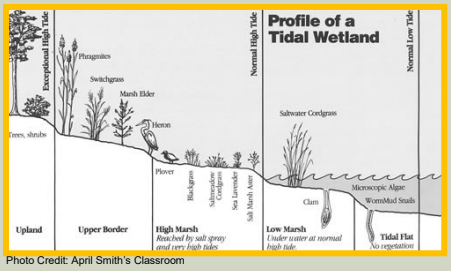
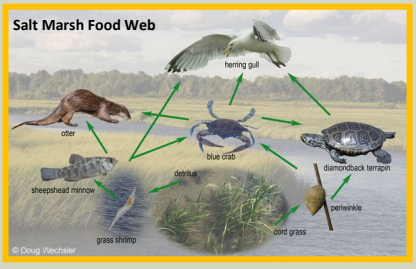


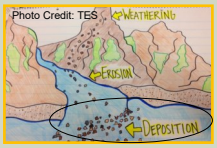
Photo Credit: April Smith's Classroom



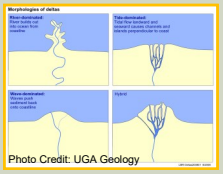
Glossary of Terms

Erosion—the gradual wearing away of soil, rock and land by water, wind or other natural processes.

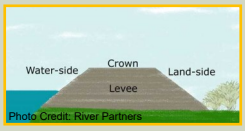
Deposition—the process by which sediment settles out of the water or wind that is carrying it, and is deposited in a new location.



Delta—a landform made of sediment that is deposited where a river flows into an ocean or lake.

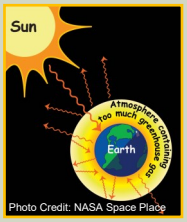


Levee—an embankment built to prevent the overflow of a river or other body of water.



Dredging—the removal of sediments and debris from the bottom of lakes, rivers, harbors, and other water bodies. Most often done to create and maintain navigational channels.

Greenhouse Gases—gases, such as carbon dioxide and methane, that trap heat inside the Earth's atmosphere and contribute to climate change.



Mesocosm—an experimental tool that brings a small part of the natural environment under controlled circumstances.

Microbes—microscopic living organisms that many be single-celled or multicellular, have adapted to nearly all habitats on Earth and include bacteria, archea and protozoas.


Photo Credit: Geology.com

For More Information:

Check out these short YouTube videos:

-"Why Do Rivers Curve?" — Minute Earth
-"Meanders" — Jeeto Bharat
-"Why Do Rivers Have Deltas" — Minute Earth
-"How a Delta is Formed?" — Louisiana Sea Grant

Other Resources:

- [1] The Mississippi River Delta Basin—Coastal Wetlands Planning, Protection and Restoration Act https://lacoast.gov/new/About/Basin_data/mr/
- [2,4] How The Delta Formed—Restore the Mississippi River Delta http://www.mississippiriverdelta.org/discover-the-delta/how-the-delta-formed/
- [3] Mississippi Delta Drowning—Earth Magazine https://www.earthmagazine.org/article/mississippi-delta-drowning
- [5] What We've Done to the Mississippi River: An Explainer—The Atlantic https://www.theatlantic.com/technology/archive/2011/05/what-weve-done-to-the-mississippi-river-an-explainer/239058/
- [6] BP Deepwater Horizon oil spill exacerbated existing environmental problems in Louisiana marshes —Scientific Earth Conscientious https://scientificearthconscientious6.wordpress.com/2012/06/25/557bp-deepwater-horizon-oil-spill-exacerbated-existing-environmental-problems-in-louisiana-marshes/#more-557
- Is Gulf Oil Spill's Damage Over or Still Unfolding—National Geographic http://news.nationalgeographic.com/2015/04/150414-deepwater-oil-spill-birds-gulf-macondo-louisiana/

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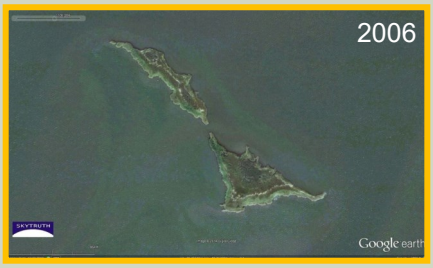

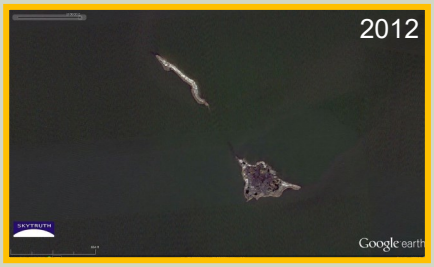

Cat Island, Louisiana in 2006 (with vegetation covering most of the island), 2010 (surrounded by absorbent booms to protect it from oil slicks), and 2012 (visibly smaller and virtually no vegetation).

Photo Credit: Google Earth