



Weathering & Erosion
2025 NHERI Summer Institute Lesson Plan
Anne Eggers, NISD

Subject: Science

Associated Unit: Weathering and Erosion

Lesson Title: Harbor Havoc – Engineering a Hurricane & Tsunami Defense

Grade level: 7

Time required: 5 days

Summary: In this hands-on STEM challenge, student engineering teams will tackle a real-world problem: protecting a coastal community's harbor from the destructive force of a hurricane's storm surge or a tsunami. Using the engineering design process, teams will design, build, and test a model of a protective structure. Special consideration will be given to designs that incorporate natural, living elements (like oyster beds or mangrove-like structures) to create a more resilient and ecologically friendly solution.

Engineering Connection

7.1A & 7.2A-E (Scientific & Engineering Practices): The student uses scientific practices to ask questions, plan and conduct investigations, analyze data, and communicate results.

Engineering Category: Civil Engineering, Environmental Engineering

Keywords:

Coastal Engineering

Wave Energy / Wave Dynamics

Force & Motion

Erosion Control

Habitat Restoration

Natural Disaster Preparedness

Human-Environment Interaction

Resilient Design

Engineering Design Process

Educational Standards:

TEKS (2021):

- 7.10B: Analyze the effects of weathering, erosion, and deposition on the environment in ecoregions of Texas.
- 7.12A: Investigate and explain how catastrophic events, including floods, hurricanes, and tornadoes, have changed ecosystems.
- 7.13A: Model and illustrate the flow of energy in a food web and predict how changes in a food web affect the ecosystem. (Applies to "natural elements" extension).
- 7.1A & 7.2A-E (Scientific & Engineering Practices): The student uses scientific practices to ask questions, plan and conduct investigations, analyze data, and communicate results. This entire lesson is built on these practices.

Learning Objectives:

I Can...

- I can use the engineering design process to solve a problem.
- I can explain how catastrophic events like hurricanes impact coastlines and ecosystems.
- I can design a structure that reduces the effects of erosion from a large wave.

We Can...

- We can work as a team to design, build, and test a solution.
- We can analyze data to improve our designs.
- We can explain how human-made structures can work with nature to protect the environment.

Essential Questions:

- How can we use engineering to protect human lives and property from natural disasters?
- Why is simply building a solid wall not always the best solution?
- How can we design solutions that not only solve a problem but also help the environment?

Lesson Background:

Students should have a basic definition of a hurricane and a tsunami. They don't need to be experts, but they should understand that hurricanes are powerful storms with high winds and water, and tsunamis are giant waves caused by events like underwater earthquakes.

Students should also have a basic understanding of erosion by water. That water can pick up sand and soil and deposit it miles away from its origin dramatically changing the landscape and the ecosystems that surround it.

Introduction:

Complete the Engage activities in the 5 lesson plan below.

Vocabulary/Definitions:

Storm Surge: An abnormal rise of water generated by a storm, over and above the predicted tides.

Tsunami: A series of extremely long waves caused by a large and sudden displacement of the ocean, usually the result of an earthquake below or near the ocean floor.

Erosion: The process by which soil and rock are removed from the Earth's surface by natural processes such as wind or water flow.

Ecosystem: A community of living organisms in conjunction with the nonliving components of their environment, interacting as a system.

Biomimicry: The design of materials or structures that are modeled on biological entities and processes.

Prototype: A first or preliminary model of something from which other forms are developed or copied.

Criteria: The requirements that a successful design must meet.

Constraint: A limitation or restriction (e.g., materials, time, budget).

Associated Activities: 5E Lesson Plan

1. Engage (1 session of 35 minutes)- Day 1

- Show a short, dramatic video clip of a hurricane storm surge or tsunami wave hitting a coastline.
 - Video for Tsunami- [How tsunamis work - Alex Gendler](#)
 - Video for hurricane storm surge [Hurricane Storm Surge](#)
- **Think-Pair-Share:** "What did you observe? What kind of damage can a wave like that do to a town on the coast?"
- **Introduce the challenge:** You are a team of engineers. The city of Port Gemini, Texas (hurricane storm surge) or Hilo Harbor on Hawai'i Island (tsunami wave) needs your help! They need a new structure to protect their harbor from the next big hurricane or tsunami. Your job is to design, build, and test a solution.

- **Explore and choose materials:** Teams have time to look at the materials. Test a small portion of each material and set up their budgets. (Total cost and what each material is worth is up to the instructor and what is available at the time of this challenge.)

2. Explore (2 sessions of 35 minutes)- Day 2 and Day 3

- **Introduce Criteria & Constraints:**
 - **Criteria:** Must significantly reduce the wave height inside the harbor, prevent major erosion of the "beach," and keep the "boats" safe. Extra points for incorporating "living" elements (sponges for coral, mesh for oyster beds, etc.).
 - **Constraints:** Use only the materials provided. You have two days to plan, sketch and build your prototype.
- **Team Huddle & Design:** Hand out the Engineering Design Process graphic organizer. Groups brainstorm and sketch their design. The teacher circulates, asks guiding questions, and checks for understanding.
- **Build:** Students construct their prototypes in their "harbor" (the plastic tub with sand).

3. Explain (15 minutes) Day 4-Testing Day!

- Each group brings their harbor to the central testing station.
- Before testing, the group's "Spokesperson" gives a 1-minute explanation of their design, highlighting their strategy and the purpose of their chosen materials.
- The teacher uses the "Wave Maker" to send a consistent wave toward their harbor. The group observes the results.
- **Data Collection:** A student measures how high the water got inside the harbor and the class notes the effectiveness of the design.

4. Elaborate (15 minutes)- After each test students have time to go back and reiterate. Redesign & Retest: Based on their observations, groups get 10 minutes to modify their design. Did their wall collapse? Did water go over the top? How can they make it better?

- **Ecosystem Focus:** "Think about the 'extra points' challenge. How could your structure also serve as a habitat for marine life? How would adding a 'living shoreline' change your design?"
- Groups re-test their improved designs and compare the results.

5. Evaluate (35 minutes)

- **Final Presentations & Closing Questions:** Groups briefly share what they changed and why it was (or wasn't) more effective. This is followed by the closing questions below.

- **Quiz:** Administer the short quiz to assess individual understanding of the core concepts.

Rubric: see at the bottom of the lesson plan

Quiz: see at the bottom of the lesson plan

Materials needed per group:

For each group: Large plastic tub or paint tray, sand/gravel mixture, water, small toy boats or houses for the "harbor."

Wave Maker: A piece of wood or a plastic jug that can be pushed into the water to create a consistent "storm surge" or "tsunami" wave.

Building Materials: Craft sticks, clay, sponges, small rocks, cotton balls, pipe cleaners, straws, LEGOs, recycled materials (plastic bottles, cardboard), mesh/screen material.

Measurement Tools: Rulers, measuring cups, stopwatches.

Handouts: Engineering Design Process graphic organizer, vocabulary sheet with images, design rubric

Assessment:

Rubric:

Harbor Havoc – Engineering a Hurricane & Tsunami Defense

Criteria	5 - Excellent	4 - Proficient	3 - Satisfactory	2 - Developing	1 - Beginning
Understanding of Weathering, Erosion, and Deposition (TEKS 7.10B)	Thoroughly analyzes and explains how weathering, erosion, and deposition affect Texas ecoregions with clear examples in design	Clearly explains effects of weathering, erosion, and deposition in Texas ecoregions and relates to model	Provides basic explanation of weathering, erosion, and deposition with limited connection to the design	Provides incomplete or unclear explanation of weathering, erosion, and deposition	Does not demonstrate understanding of weathering, erosion, and deposition

Investigation of Catastrophic Events (TEKS 7.12A)	Insightfully investigates and explains how hurricanes, floods, and tsunamis change ecosystems with strong connections	Explains how catastrophic events impact ecosystems and relates this to the structural design	Provides a general explanation of catastrophic events with some connection to the project	Shows limited understanding of catastrophic events and weak or no connection to the project	Does not demonstrate understanding of catastrophic events
Modeling Energy Flow in Food Web with Natural Elements (TEKS 7.13A)	Creatively models and illustrates energy flow in a food web including natural elements and predicts ecosystem effects	Models energy flow in a food web including some natural elements and predicts basic ecosystem effects	Attempts to model energy flow and natural elements with limited prediction of ecosystem effects	Minimal modeling of energy flow or natural elements, predictions unclear or incomplete	Does not model energy flow or include natural elements
Use of Scientific & Engineering Practices (TEKS 7.1A & 7.2A-E)	Effectively asks questions, plans, conducts investigations, analyzes data, and clearly communicates results	Adequately uses scientific practices with minor gaps in planning or communication	Uses some scientific practices but investigations or communications are incomplete	Limited use of scientific practices, investigations lack clarity or depth	Does not use scientific or engineering practices appropriately

Engineering Design and Creativity	Designs an innovative, ecologically friendly protective structure incorporating natural elements with strong justification	Designs a functional protective structure with some natural elements and a clear rationale	Designs a basic protective structure with limited inclusion of natural elements	Design is incomplete or lacks ecological consideration	Design does not meet project requirements or ecological considerations
Teamwork and Collaboration	Demonstrates excellent teamwork with clear roles, cooperation, and shared problem solving	Works well with team members, shares tasks, and cooperates effectively	Participates in team but with inconsistent cooperation or role fulfillment	Limited participation or cooperation in the team	Does not participate effectively in the team

This rubric aligns with the TEKS 2021 standards 7.10B, 7.12A, 7.13A, and 7.1A & 7.2A-E for scientific and engineering practices, assessing both content knowledge and application through the STEM challenge.