NCSE
National Center for Science Education

Activity Training Guide

Rising Tides

Protect Your Home from the Waves

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Rising Tides

Overview

Warming oceans and melting landlocked ice caused by global climate change may result in rising sea levels. This rise in sea level combined with increased intensity and frequency of storms will produce storm surges that flood subways, highways and homes. In this activity, visitors design and test adaptations to prepare for flooding caused by sea level rise.

Learning Goals

1. Sea-level rise is related to increases in global temperature.
2. I am capable of being part of the solution to climate change.
3. Scientists don't always succeed on the first try, but learn from their failures.

Materials

- Aluminum tray (at least 10 inch square)
- Water
- 500 ml water bottle (or other vessel)
- Straight Pins
- Sand
- Tools (for rent)
    - Mini tools
    - Pick Set
- Design material
    - Beads
    - Toothpicks
    - Popsicle Sticks
    - Pipe Cleaners
    - Sponges
    - Other materials are fine, but **please make sure these materials are reusable**. Design challenges are very materials intensive and we want to avoid creating a lot of waste.
- Posters
    - Ocean Level Rise
    - Price List/ Challenges
    - Engineering Design Process
- Bucket or location for water drainage (be sure to call ahead and make a plan with the event's organizers)

Set-up

1. Make sure you have holes in roughly half of the trays. Set the trays with holes above trays without holes for drainage purposes. We strongly suggest having (n-1) trays, where n is the number of volunteers. There can be multiple houses on the same tray or visitors can work together to provide a solution for a house. The volunteer not monitoring the building and testing process can drain water, fill sand, and supervise distribution of supplies.
2. Fill about half the tray with sand, ideally sloping up from the middle of the tray to rise to a quarter inch below the tray top.
3. Fill the rest of the tray with water, so that after absorption the water barely covers the sand-free half of the tray.
4. Put two pins in the sand, one about half an inch from the water level and one about an inch further back. This will be the design "area".
5. Place 2-3 houses within the boundary of the pins. Use pins on the ocean side level to divide the sand into the "zones" of different teams.
6. Set up posters. Keep the price list and follow-up challenges hidden for now.

Procedure (for drop-in activities, see modifications below for other set-ups)

1. Give an outline of the problem and ask if visitors would like to help find a solution. (You don't have to give a full description of why sea level rise is happening at this stage, let visitors get their hands dirty first). Briefly explain how the design challenge will work.
2. Allow visitor to select from a list of supplies. Assist the visitors by validating and giving real world context to their designs (e.g., digging trenches or using sandbags). Try to resist the urge to give hints. Rather, encourage them to test their designs early and often.
3. As visitors are building their designs, talk to them about their experience with flooding (or hurricanes). If applicable, involve adults in the discussion by asking whether they experienced this rate of flooding when they were kids. Talk about the effects climate change has on sea level rise and how this problem is likely to get worse.
4. Test the designs by vigorously pouring 500 ml of water into the tray. Success is defined when the house stays dry and doesn't move (unless they have designed a floating house). Instead of focusing on whether the design succeeded or failed, help the visitors make observations about what worked and what could be improved. Help rephrase the design ideas using engineering principles and climate change theory.
5. Regardless of the outcome, congratulate the visitor for working hard to come up with a solution for climate-change induced flooding. Encourage visitors to rework their design. If they have achieved success, introduce the second challenge.
6. Reset the activity by lifting the top tray, draining the water, and refilling the tray with sand and water. Make sure you save building supplies and dispose of water waste safely.
7. Have videos on hand such as: https://coast.noaa.gov/slr/ - This is a great way to model sea level rise in your area. Use this to broaden the discussion to talk about global sea level issues.

Further Challenges

Second Challenge: Many of the initial designs will involve building walls or allowing the houses to float and create islands. However, we have to think about the practical solutions. For the 2nd challenge, you should be able to see the ocean from the windows and be able to drive to the house.

Third Challenge: Design challenges are rooted in the real world. Therefore, we have to work under a budget. Introduce the budget and challenge them to modify their design to work within a $100 budget. If you are doing a longer program, have a higher budget constraint ($250 worked for me) and give a prize for the successful design that comes in under budget.

Modifications

For longer programs (1 hour – 90 minutes)

Break visitors into teams and go through the entire engineering design process. Provide pencils and papers for them to diagram potential solutions. Include a price list so that teams must keep their design within a maximum price. Have a set time limit that all teams will have to test their designs. After a set time, have a final test of each team's design. Provide prizes to the most efficient team and the team whose design can sustain the highest storm surge.

For mixed-age audiences

With not too much effort, you can shape the sand and place the houses in ways that are more or less forgiving. You can also encourage visitors to work together to come up with a solution.

Further Resources

- NASA - Climate Change: Vital Signs of the Planet
- Climate Central
- Housing investment, sea level rise, and climate change beliefs

NGSS Standards

K-ESS3-3 Earth and Human Activity

Communicate solutions that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment.

2-ESS2-1 Earth's Systems

Compare multiple solutions designed to slow or prevent wind or water from changing the shape of the land.

4-ESS3-2 Earth and Human Activity

Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.

3-5-ETS1-1 Engineering Design

Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

MS-ESS3-3 Earth and Human Activity

Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

MS-ESS3-5 Earth and Human Activity

Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.

MS-ETS1-1 Engineering Design

Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

MS-ETS1-2 Engineering Design

Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

HS-LS2-7 Ecosystems: Interactions, Energy, and Dynamics

Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.

HS-ESS3-4 Earth and Human Activity

Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

HS-ETS1-3 Engineering Design

Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.