Community Balance: A Sea-Level Rise Tumbling Tower

AGE RANGE
All audiences

TIME REQUIRED
20 minutes

MATERIALS
Tumbling tower game with coloring ends: three (3) blocks in purple, six (6) blocks in red, nine (9) blocks in pink, six (6) blocks in yellow, nine (9) blocks in green, and nine (9) blocks in blue OR a set of Lewo Wooden Stacking Board Games Building Blocks.

Avery® Name Badge Insert Refills, 2-1/4" x 3-1/2" (5390) *optional for ease of card preparation*

Laminating pages *optional*

LESSON TOPIC: Sea-level rise and community solutions

ACTIVITY SUMMARY: A tumbling tower game, where each removed block represents an impact to the community caused by sea-level rise and each block added represents a community solution.

OBJECTIVES:

Participants will be able to:

- Explain the two main causes of sea-level rise.
- Describe community impacts resulting from sea-level rise.
- Determine potential solutions they can lead or take part in.

LESSON BACKGROUND:

Along the northern Gulf of Mexico, we live near coastal wetland habitats offering resources and experiences like seafood, hiking, and birding. However, with increasing sea-level rise our communities, economies, and ecosystems will be impacted. Sea-level rise is a result of two combined factors caused by climate change: thermal expansion of water and melting land ice. When we burn fossil fuels such as coal or gas, we add excess carbon dioxide (CO_2) into the atmosphere. This CO_2 acts like a blanket, trapping heat and warming our atmosphere and air, changing our climate. As the temperature of the air rises, oceans absorb some of this heat and become warmer. As water gets warmer, each drop expands a little bit – thermal expansion. When you multiply this expansion over the entire ocean, the average sea level rises. Melting land ice also contributes to sea-level rise by adding water to the ocean that was previously stored as ice on land. Sea-level rise presents new problems as well as worsens existing problems such as erosion, storm surge inundation, nuisance flooding, and salt-water intrusion.

By preparing strategic resilience plans, communities can minimize the impacts of sea-level rise and support a healthy community. A prepared community is better able to face future impacts, allowing them to thrive and grow. This tumbling tower game showcases the critical impacts and solutions of sea-level rise together to create a fun interactive game. During play, participants will learn about different ways, both big and small, that sea-level rise impacts coastal communities, as well as about actionable solutions for all ages. The tower represents different components in your community that support your family and neighbors. As sea-level rise continues to impact the Gulf Coast, these different support layers are also impacted, sometimes resulting in difficulties for your community. Your tower, and community, can be stable with a few impacts. But too many impacts become a problem and may lead to imbalance. By playing, students - our future coastal resilience planners - will become familiar with sea-level rise and learn how they can work towards community solutions.

BLOCK REPRESENTATION:

PURPLE	your home in your community
PINK	animals living in the wetlands and the fishing industry they support
GREEN	wetlands & beaches that protect our communities from flooding and storm surge
YELLOW	connection within your community and to others through roads, bridges, and communication networks
RED	critical facilities that provide necessary care such as schools and hospitals
BLUE	access to fresh water

VOCABULARY

Atmosphere	The layer of gases surrounding the rocks and seas of the earth.
Barrier Island	A long, narrow coastal sandy island that is above high tide and parallel to the shore, and that commonly has dunes, vegetated zones, and swampy terraces extending landward from the beach.

Beach	The unconsolidated material that covers a gently sloping zone extending landward from the low water line to the place where there is a definite change in material or physiographic form (such as a cliff).
Climate	The average long-term atmospheric conditions, including temperature, wind, and precipitation, that prevail in a particular place.
Economy	The wealth and resources of a country or region, especially in terms of the production and consumption of goods and services.
Erosion	The mechanical removal of sedimentary material by gravity, running water, moving ice, or wind.
Estuary	A semi-enclosed coastal body of water which has a free connection with the open sea and within which sea water is measurably diluted with freshwater from land drainage.
Flooding	The temporary submergence of land that is normally dry, often due to periodic events such as storms.
Levee	A wall, generally of earthen materials, designed to prevent the flooding of a river after periods of exceptional rainfall.
Living Shoreline	A shore protection where some or all of the environmental characteristics of a natural shoreline are retained as the position of the shore changes.
Resilient	Able to prepare and plan for, absorb, recover from, or more successfully adapt to actual or potential adverse events.
Restoration	the practice of renewing and restoring degraded, damaged, or destroyed ecosystems and habitats in the environment by active human intervention and action.
Saltwater Intrusion	Displacement of fresh or ground water by the advance of salt water due to its greater density, usually in coastal and estuarine areas.
Satellite	A body that orbits around another body in space.
Sea Level	Base level for measuring elevation and water depth on Earth. Because the ocean is one continuous body of water, its surface tends to seek the same level throughout the world. However, winds, ocean currents, river discharges, and variations in gravity and temperature prevent "sea level" from being truly level.

Seawall	A structure, often concrete or stone, built along a portion of a coast to prevent erosion and other damage by wave action.
Shoreline	The intersection of a specified plane of water with the shore or beach.
Storm Surge	An abnormal rise in sea level accompanying a hurricane or other intense storm.
Thermal Expansion	The increase in volume of water due to increasing temperatures.
Tide	The alternating rise and fall of the surface of the ocean and connected waters, such as estuaries and gulfs, that results from the gravitational forces of the Moon and Sun.
Watershed	A land area that channels rainfall and snowmelt to creeks, streams, and rivers, and eventually to outflow points such as reservoirs, bays, and the ocean.
Weather	The state of the atmosphere at a particular location over the short-term
Wetland	An area that is inundated or saturated by surface or ground water with a prevalence of vegetation typically adapted for life in saturated soils; wetlands generally include swamps, marshes, bogs, and similar areas.

DIRECTIONS

GAME PREPARATION

1. Paint and label the game pieces OR use pre-colored set.
2. Print playing cards on Name Badge Insert Refills (pages 7-16), lamination optional.
3. Write in your own sea-level rise impacts on the blank cards. Specific local examples of sea-level rise impacts and solutions will help participants make connections to their own community.

GAME SET-UP

1. The tower is set up by alternatively (and perpendicularly) stacking 3 blocks per row.
2. Stack all the blue blocks on the bottom to create the first layer.
3. Stack blocks on top of the blue layer in the following order: red → yellow → green → pink.
4. At the top of the tower place 1 layer of purple blocks.
5. Shuffle playing cards and place them face down next to the tumbling tower.
    a. Advanced Play Cards explain broad range of climate change and sea-level rise impacts.
    b. Beginner Play Cards focus the concepts on personal impact with shorter phrases.

GAME PLAY

1. Explain to students that this game represents how changes in sea-level rise can impact our coastal communities. Introduce the two main causes of sea-level rise.
2. The first player picks a card, reads it aloud, and follows the instructions on the card. Only the block being removed or returned may be touched. Players are not allowed to hold the tower while moving a block.
3. If adding a block, the player may return any block of their choice however they must return it to the same color layer it corresponds to. They may gently hold onto the tower while adding the block, but if other blocks fall while returning they may not put them back. This represents the hardships that sometimes occur when trying to resolve a problem.
4. Once played, used cards should be put into a discard pile.
5. Removed blocks should be place in a discard pile off to the side.
6. Players take turns until the tower falls.
7. Use the provided discussion questions to guide a conversation of sea-level rise impacts and solutions that can be taken by coastal citizens of all ages.

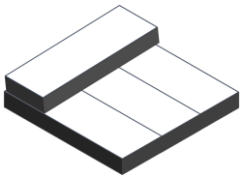
   EXTENSION: randomize the color blocks throughout the tower; start game with blocks already removed; use colored dice to determine which block to remove; create a giant tumbling tower by covering cardboard soda boxes in colored contact paper.

DISCUSSION QUESTIONS

1. What activities do you enjoy that rely on wetlands?
2. What happens to different aspects of the community when one block is removed?
3. Give an example of how one problem caused by sea-level rise intensifies another problem.
4. Are these community components (layers) the same in every community?
5. Suggest alternative community components (layers) based on your personal experiences.
6. What does a collapse of the tower mean for our real-life communities?
7. How do changes in the community affect the overall health and resilience to future impacts?
8. What do you think you could personally do to help keep our communities safe and resilient?
9. How does sea-level rise affect communities around the world?
10. Where can you find more resources about sea-level rise and flood resiliency?

Community Balance: A Sea-Level Rise Tumbling Tower STUDENT

GAME SET-UP



1. Set up the tower by alternatively (and perpendicularly) stacking 3 blocks per row.
2. Stack the blocks in order of color: blue → red → yellow → green → pink.
3. At the top of the tower place only 1 layer of purple blocks.
4. Shuffle playing cards and place them face down next to the tumbling tower.

BLOCK REPRESENTATION:

Your Home	PURPLE	your home in your community
Fisheries	PINK	animals living in the wetlands and the seafood industry they support
Coastal Land	GREEN	wetlands & beaches that protect our communities from flooding and storm surge
Connection	YELLOW	connection within your community and to others through roads, bridges, and communication networks
Critical Facilities	RED	critical facilities that provide necessary care such as schools and hospitals
Water Quality	BLUE	access to fresh water

GAME PLAY

1. The first player picks a card, reads it aloud, and follows the instructions on the card.
2. If adding a block, the player may return any block of their choice however they must return it to the same color layer it corresponds to.
3. Once played, used cards should be put into a discard pile.
4. Removed blocks should be place in a discard pile off to the side.
5. Players take turns until the tower falls.

- Only the block being **removed** may be touched.
- You may gently hold onto the tower while **adding the block**, but if other blocks fall while returning, they may not put them back. This represents the hardships that sometimes occur when trying to resolve a problem.

Advanced Play Cards

A group of students perform a play for the entire community about how climate change affects sea level and how, by reducing the use of fossil fuels (oil, coal, and gas) people can slow the impacts of climate change. **Add** 1 block of any color	A group of citizens in the estuary's watershed decide to encourage people to plant native plants, trees, and shrubs that soak up excess rainwater and nutrients therefore preventing run off. **Add** 1 block of any color
Salt marshes provide essential habitat for wildlife in an estuary. They remove large quantities of carbon dioxide from the atmosphere, and can absorb excess storm water, protecting areas from flooding, and sea-level rise. The community decides to restore 20 acres of a salt marsh. **Add** 1 block of any color	A garden club turns an abandoned paved area along the watershed into a native plant garden to educate residents. The native plants can capture carbon and are more tolerant of pests and drought. **Add** 1 block of any color
A collection of scientists and citizens work together to restore rush grass in the marsh. This helps the animals that hide and lay eggs in the marsh and also protects the shore from erosion. **Add** 1 block of any color	Local businesses and schools in the estuary's watershed agree to use more renewable energy resources, such as solar and wind energy, to cut down their greenhouse gas emissions that are contributing to climate change and affecting nearby estuary. **Add** 1 block of any color
A community encourages local officials to protect the nearby maritime forest in the estuary's watershed. The forest is now labeled as "Green Acres" and no one will be able to develop the area. **Add** 1 block of any color	The community decides it wants the storm protections against waves, currents, and erosion that oyster reefs provide. Oysters also filter and clean water. An oyster reef along part of shoreline is restored in the estuary. **Add** 1 block of any color

Advanced Play Cards

A tax is put on the emission of carbon dioxide when generating electricity. To avoid the tax, people start to use more renewable resources such as solar and wind energy. Reducing the emissions of carbon dioxide helps slow the rate of climate change and its impact on coastal communities. **Add** 1 block of any color	Your community passed a strategic plan for sea-level rise resilience. This comprehensive plan includes objectives for future sea-level rise and flooding planning and mitigation, to be ready to respond rapidly to sea-level rise impacts. **Add** 1 block of any color
To help reduce carbon dioxide emission from cars, students decide they will create a "Walking School Bus." Instead of being driven separately, a large group of students decide to walk to school together with the supervision of a few adults. **Add** 1 block of any color	Schools along the Gulf coast decide to educate their students about the effects humans can have on an estuary, and encourages students to take the message home to their family and friends. **Add** 1 block of any color
Scientists work with students and teachers to grow native beach dune plants in their classroom. The students travel to a nearby beach to plant the fully grown plants, helping to stabilize the beach and coastline. **Add** 1 block of any color	Your family has lived in your house for many years and never had an issue with flooding. However, during the recent storm there was more water in the area and you experienced flooding. Remove 1 purple block
With a changing climate, water temperatures are reaching higher highs that are killing off sea grasses, which are a primary breeding ground for crabs. This causes the crab population to decline. Remove 1 pink block	Sea-level rise is creating continuous floods in the estuary that kill off plants in parts of the salt marsh where many small fish and shrimp sought refuge and a place to reproduce. Remove 1 pink block

Advanced Play Cards

Sea-level rise floods the beaches sea turtles use as nesting grounds. Sea turtles have less nesting space available and many return to the Gulf without laying their eggs. Remove 1 pink block	As sea levels rise, saltier water intrudes into previously fresh water areas of the estuary. The rise in salt levels causes some species of phytoplankton to decline in abundance. Remove 1 pink block
With warming water temperatures gulf shrimp are not found as frequently by shrimpers. Shrimpers travel farther to bring in the same catch. Since they must pay more money for gas, their profits are declining. Remove 1 pink block	As sea levels rise, some marsh plants do not grow fast enough to stay above water. Marsh areas shrink. Red Drum have a harder time finding nurseries for their young. Red Drum catch rates decline. Remove 1 pink block
Rising sea levels push salt water farther into freshwater marshes. The marsh plants cannot survive in salt water and die. Remove 1 green block	Warmer ocean temperatures led to increased storm frequency. A storm uproots a large area of salt marsh plants. Future storms travel farther inland because there is less marsh to slow them down. Remove 1 green block
Climate change is causing the surface temperature of the ocean to rise. Warmer water temperatures increase storm intensity. As a fierce storm blows through the estuary, it rips apart an oyster reef. Remove 1 green block	Waves from a recent storm eroded the sand on the local beach creating a sharp drop off from the road beyond. Remove 1 green block

Advanced Play Cards

Wetlands along the coast act as “speed bumps” for incoming Gulf storms, like hurricanes. Sea-level rise is reducing area of wetlands. A hurricane makes landfall and travels farther inland than previously recorded. More homes and business experience wind and water damage. Remove 1 green block	Waves from a recent storm eroded the sand on the local beach. Next summer tourists travel to different areas that have bigger beaches. Nearby restaurants notice a decline in profits. Remove 1 green block
A strong hurricane makes landfall destroying a bridge connecting the barrier island to the mainland. People are not able to return to their homes for many months while the bridge is repaired. Remove 1 yellow block	A thunderstorm happens during high tide. The storm drains do not drain the water quick enough and the town’s main street floods, making it impassable by car. Remove 1 yellow block
The road next to the beach covers with water during high tide. Parked cars are flooded. Remove 1 yellow block	Town residents evacuate to the area school to prepare for a hurricane. Residents living on the other side of the bayou cannot access the building due to flooding ahead of the storm. Remove 1 yellow block
Flooding has destroyed the electronics at the base of cell-phone towers, and rooftop stations do not have back-up generator power. All phones with local area codes no longer connect. This affects residents across the country with the area code. Remove 1 yellow block	The regional headquarters of the telecom company has flooded. The damaged telecom equipment has knocked out service and there is no cellular phone service for anyone, including first responders. Remove 1 yellow block

Advanced Play Cards

An old causeway bridge connecting a barrier island sits only 5 feet above sea-level. This bridge is now covered by water during high tides. Remove 1 yellow block	Due to increased storm-frequency the road's storm drains and catch basins become clogged with litter and plant debris. These drains backup and frequently flood the road. Remove 1 yellow block
The elementary school is an evacuation point for hurricane warnings. However, with increased population size the building is unable to accommodate the entire town. Remove 1 red block	Developers pause the planned hospital expansion due to frequent flooding from the nearby drainage ditch causing construction vehicles sink into the road when driving on the dirt service road. Remove 1 red block
The beach area school district must decide whether to raise the school's foundation or move to a new location to avoid increased flooding. Remove 1 red block	Wind force knocks down power lines connected to the city hospital. The hospital must rely on generator power until service crews can repair the damage. Remove 1 red block
During the recent storm, the force of winds blew out the windows on the school. Students are sent to other schools in the area while the district repairs the windows. Remove 1 red block	The city hospital is forced to evacuate all patients after storm flood waters damage the building. Remove 1 red block

Advanced Play Cards

As sea levels rise, more water is entering and mixing with the groundwater. This contaminates drinking water. Remove 1 blue block	Farmers' fields are being converted from agricultural crops to salt marsh due to salt water flooding. Remove 1 blue block
During a period of drought more water is removed from the aquifer. The resulting drop in pressure allows saltwater to enter. Remove 1 blue block	Sea water has intruded into the water table making soil and water too salty for plants to grow. Remove 1 blue block
Storm surge from the recent hurricane brought water farther inland. This saltwater seeps into the groundwater drinking supply. Remove 1 blue block	Sea-level rise causes a river delta to increase in salinity. The surrounding farmland can no longer rely on the fresh water irrigation. Remove 1 blue block
Sea level rise causes flooding in many parts of the salt marsh. Larger predators can enter the now open areas where small fish and crabs used to be able to find refuge and protection. Remove 1 green block and 1 pink block	A new roadway is constructed along the estuary. After rainstorms, oil and other toxic contaminants from cars and trucks run off into the estuary. The runoff from roadways affects the growth of many small plants and animals. Remove 1 yellow block and 1 pink block

Advanced Play Cards

A drop in pH and increase in temperatures leads to a decline in clam and oyster populations. This causes phytoplankton populations to increase which blocks sunlight, decreasing the growth of sea grasses that blue crabs use to hide from predators. Remove 1 pink and 1 green block	Saltwater intrusion has caused an ecological shift where marsh plants have moved into areas previously forested by cypress trees. Animals that lived in the freshwater habitat can no longer find the protection and resources they need. Remove 1 pink block **Add** 1 green block

Beginner Play Cards

You help your family care for a garden with native plants. Add 1 block of any color	You and your friends put on a play for neighbors about the impacts of sea-level rise. **Add** 1 block of any color
You choose to walk or ride your bike to a friend's house instead of driving. Add 1 block of any color	You often take walks with your family in the protected maritime forest. **Add** 1 block of any color
Your house floods with water. Remove 1 purple block	You don't get to eat your favorite gulf seafood anymore because there are fewer caught by fishermen. Remove 1 pink block
The marsh area near your house is smaller, and you don't see as many fish. Remove 1 pink block	The beaches in your town are much smaller and sea turtles no longer nest there. Remove 1 pink block

Beginner Play Cards

The beach near your house doesn't have as much room to play games anymore. Remove 1 green block	The marsh you like to explore has less space than it used to have. Remove 1 green block
Wetlands along the coast act as "speed bumps" for incoming Gulf storms. With shrinking wetlands, you will see stronger storms near your house. Remove 1 green block	During the high tide the ocean rises over the beach parking lot. You cannot go to the beach even on a sunny day. Remove 1 yellow block
Your street is covered by water after most thunderstorms. Remove 1 yellow block	Flooding has damaged cellphone towers. You cannot use your cell phone for calls or internet access. Remove 1 yellow block
Yours school's playground stays covered in water after it rains. You cannot play outside. Remove 1 red block	A storm damages a power facility and your electricity is out at home and school. Remove 1 red block

Beginner Play Cards

Water from a storm flooded your school, so you have to go to a different school while it is repaired. Remove 1 red block	Ocean water mixes with fresh water. You cannot drink it. Remove 1 blue block
The river near your backyard has mixed with saltwater and is no longer fresh water. Remove 1 blue block	Sea water has intruded into ground water making soil and water too salty for you to grow your plants at home. Remove 1 blue block

Additional sea-level rise and climate change educational materials:

NASA Jet Propulsion Laboratory. “Lessons in Sea-Level Rise.” https://www.jpl.nasa.gov/edu/teach/activity/the-science-of-earths-rising-seas/

NASA Jet Propulsion Laboratory. “Thermal Expansion Model.” https://www.jpl.nasa.gov/edu/teach/activity/thermal-expansion-model/

NASA Jet Propulsion Laboratory. “What’s Causing Sea-Level Rise? Land Ice Vs. Sea Ice.” https://www.jpl.nasa.gov/edu/teach/activity/thermal-expansion-model/

NOAA. “Sea Level Rise.” https://oceanservice.noaa.gov/education/sea-level-rise/welcome.html

Program for Local Adaptation to Climate Effects: Sea-Level Rise. www.placeslr.org

Resources and definitions from:

Office of Air and Radiation/Office of Atmospheric Programs/Climate Change Division. “Coastal Sensitivity to Sea-level Rise Glossary and Acronyms.” January 15, 2009.

National Research Council. “Disaster Resilience: A National Imperative.” Washington, DC: The National Academies Press. 2012. https://doi.org/10.17226/13457.

NOAA. “Is sea level rising?” 06/25/18. National Ocean Service website, https://oceanservice.noaa.gov/facts/sealevel.html.

Sea-level rise impacts on fisheries

Johnson, M.R., Boelke, C., Chiarella, L.A., and Greene, K. 2019. Guidance for Integrating Climate Change Information in Greater Atlantic Region Habitat Conservation Division Consultation Processes. Greater Atlantic Region Policy Series 19 -01. NOAA Fisheries Greater Atlantic Regional Fisheries Office. 235p.

Osgood, K. E. (editor). 2008. Climate Impacts on U.S. Living Marine Resources: National Marine Fisheries Service Concerns, Activities and Needs. U.S. Dep. Commerce, NOAA Tech. Memo. NMFSF/SPO-89, 118 p

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PLACE:SLR PROGRAM FOR LOCAL ADAPTATION TO CLIMATE EFFECTS SEA LEVEL RISE
MISSISSIPPI STATE UNIVERSITY COASTAL RESEARCH & EXTENSION CENTER
Sea Grant Mississippi-Alabama
MASGP-21-058