

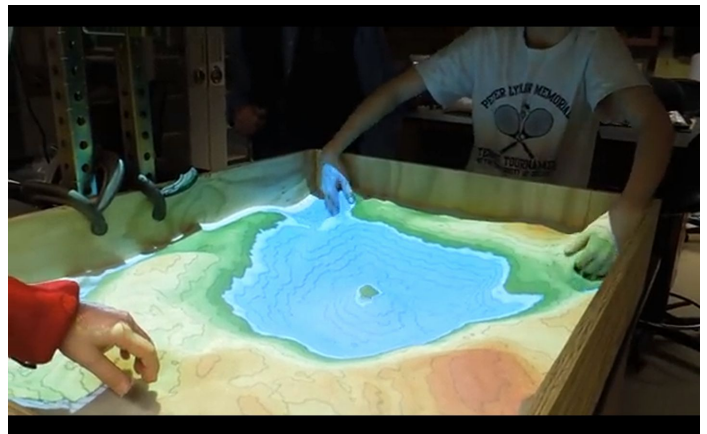
Rising Sea Simulation in Buzzards Bay!

Via the Augmented Reality Sandbox

Teacher Copy

Concepts:

- Contour Maps
- Buzzards Bay Estuary
- Sea Level change
- Hurricanes
- Storm surge/Coastal Flooding
- Human development



The Learning Objective is twofold:

- To understand how elevation of land (3D) is represented by contour lines (a line of equal elevation) in a 2 dimensional map format (topographic map).
- To see how sea level rise floods lower elevations of land where lots people live and work.

Materials – Augmented Reality Sandbox provided at Zephyr Education Foundation, your hands, ruler, worksheet, marker

Procedures:

1. Students take turns investigating change in topography and contour lines based on sediment movement (in other words, get your hands in the sand box and **free play!!!**)
2. Make a mound feature in the sandbox. Sketch the 2-D contour map representation (must be looking down from above – birds eye view!)



C.I. = _____

3. Make a depression (or pond) irregularly shaped. Sketch the 2-D contour map representation.



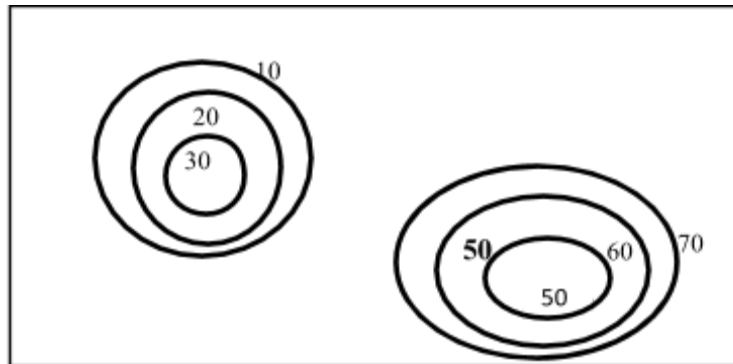
Vertical Scale 1cm = 1 m
Horizontal Scale 1 cm = 10 m?
0 (Zero) cm = Sea Level

C.I. = _____

4. Label each contour line on your 2D map (elevation in cm), add a CI (Counter Interval) legend (**C.I. = 10cm**)

Teachers: It may help to project the sandbox onto a dryboard on the wall and

- **trace the countour lines,**
- **then cover the side projector**
- **ask students which set of countour lines is the mound, and which is the depression? (there is no way to tell). Ask the students what they should do so it becomes obvious which is which? Answer: label each contour line with a number which represents elevation about sea level**



5. Create a landform in the shape of Buzzards Bay Estuary (**would be awesome to have a 3D BB map and a 2D BB contour map**)

- **Teacher: While the students create Buzzards Bay formation in the sandbox (make sure you create the ocean (sea level) at the edge of the sandbox, that is your datum (zero elevation = sea level), explain glacial retreat 16,000 years ago and sediment deposition of loose glacial till which formed Cape Cod + Islands. Explain how gravity and water (agents of erosion) have reworked the sediment, and sea level rise moved coastline landward and created the estuary we call BB (Buzzards Bay).**
 - **Show Contour Map of Buzzards Bay on wall (with sandbox projection next to it) – point out map features...contour lines, CI, moraines, how ridges and ponds appear, roads, buildings etc. Find your school.**

6. Add 3D landforms to proper locations along BB (we want to make 3D prints of well known landmarks such as: NB ferry terminal, a school, a lighthouse, fire station, police station, Mass Maritime Academy, Falmouth Hospital, Onset beach? Or use legos + toys to place around edge of BB.

7. Sketch Topographic Map (a 2D contour map representation) of Buzzards Bay...birds eye view!
 - Add Landforms (Mark with an X) - be sure they are on or near the right contour lines.



C.I. = _____

8. Generate Sea Level Rise (explain for 20th century, SL rose 1 ft (~30cm) in New England).
 - Why is Sea Level rising? Discuss
 - Hypothesize what will happen to landforms, what impacts on humans and development – have a discussion while your hand is making the water level rise.
 - Watch the water rise and cover first counter line then second etc.
9. Sketch, using blue marker, the resulting water level in the box above.

Discussion

- Which structures are flooded?
- Which are safe? Did “safe” structures become islands and lose access to flooded roads?
- What is the monetary damage? How do you calculate that?
- How can we protect things we value?
- Should we look at this map before building anything new?

Going Further: Storm Surge!

1. Imagine a Hurricane striking Buzzards Bay. Generate a Hurricane (Teacher describe how storm surge is generated by massive size of low pressure Hurricane, spinning counter clockwise for many hours over the same location, increased winds and piling up of water and waves).
 - Hypothesize what will happen to your buildings and humans
 - Imagine what water levels will be when a hurricane passes the area and pushes piles of water (called Storm Surge) up the funnel-shaped Buzzards Bay.
 - Create a dam (just so water level builds up)...Then Break the dam and watch water rise and slosh throughout BB (this will be amplified because BB is funnel shaped)
 - What if sea level at the time is 2 feet higher than present levels?
 - What if it's high tide?

Definitions:

Topographic map
Countour line
Countour interval
Storm surge
Sea level rise

Estuary/Basin/Watershed
How many cm in an inch?
Explain vertical + horizontal scale

Wall Projection:



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Science Standards covered during lesson (Massachusetts): *Published 2006*

- Recognize, interpret and be able to create models of the Earth's common physical features in various mapping representations, including **contour maps**. (#1 *Earth and Space Science, Grades 6-8*)
- Describe and give examples of ways in which the Earth's surface is built up and torn down by natural processes, including deposition of **sediments**, rock formation, erosion and weathering. (#6 *Earth and Space Science, Grades 6-8*)
- Explain and give examples of how physical evidence, such as fossils and **surface features of glaciation**, supports theories that the Earth has evolved over geologic time. (#7 *Earth and Space Science, Grades 6-8*)
- Describe the various conditions associated with frontal boundaries and **cyclonic storms** (e.g. thunderstorms, winter storms (nor'easters), **hurricanes**, tornadoes) **and their impact on human affairs, including storm preparations**. (1.6 *Earth and Space Science, High School*)
- Explain how physical and chemical weathering leads to erosion and **the formation of soils and sediments, and creates various types of landscapes**. Give examples that show the effects of physical and chemical weathering on the environment. (3.1 *Earth and Space Science, High School*)
- Explain how **water flows into and through a watershed**. Explain the roles of aquifers, wells, porosity, permeability, water table and runoff. (3.4 *Earth and Space Science, High School*)
- Describe the influence of gravity and inertia on the rotation and revolution of orbiting bodies. Explain the Sun-Earth-Moon relationships (e.g. day, year, solar/lunar eclipses, **tides**). (4.2 *Earth and Space Science, High School*)

Scientific Inquiry Skills Standards

- SIS1: Make observations, raise questions, and formulate hypotheses
- SIS2: Design and conduct scientific investigations
- SIS3: Analyze and interpret results of scientific investigations
- SIS4: Communicate and apply the results of scientific investigations

Mathematical Skills Standards

- Use common prefixes such as milli-, centi-, and kilo-
- Use ratio and proportion to solve problems

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