

## Lesson Planning Tool for Climate Change

**Title of Lesson:** Boston: Coastal City Design

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**Grade Level:** 6-8

**Subject:** Environmental Science; Engineering

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**Source(s) of the lesson:**

Next Generation Climate Science Curriculum: <http://curriculum.climategen.org/2015/Climate-Generation-NGC-WEB.pdf>

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**Essential Question(s):**

How will we deal with the anticipated effects of climate change on the City of Boston?

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**Massachusetts Curriculum Frameworks Science Standards:**

6 ETS 1-1: Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution. Include potential impacts on people and the natural environment that may limit possible solutions.

7 LS 2-5: Evaluate competing design solutions for protecting an ecosystem. Discuss benefits and limitations of each design.

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Content Objectives	Practice Objectives	Language Objectives
<p>Define the effects of rising sea level and flooding on the City of Boston.</p> <p>Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution. Include potential impacts on people and the natural environment that may limit possible solutions.</p> <p>Evaluate competing design solutions for protecting an ecosystem. Discuss benefits and limitations of each design.</p>	<p>1) Asking questions and defining problems</p> <p>4) Analyzing and interpreting data.</p> <p>5) Using mathematics and computational thinking.</p> <p>6) Constructing explanations and designing solutions.</p>	<p>I can identify anticipated effects of flooding and rising sea level on the City of Boston, and communicate ways to reduce impact of effects of climate change on existing structures in Boston.</p>

**Important Vocabulary:**

**Tier 1** Flooding **Tier 2** Sea level rise; long-term effect; short-term effect **Tier 3** Mitigation (technology changes that reduce emissions, reduces or prevents greenhouse gas emissions); adaptation (adjustment in natural or human systems to a new or changing environment that moderates negative effects, reduces harm to the environment); resilience (the capacity of a community, business, or natural environment to prevent, withstand, respond to, and recover from a disruption)

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**Materials Needed:** Projector, Computer/tablet access for small groups (of 3-5 students each) - to review design briefings in small groups, Lab notebooks or students' preferred medium for drafting design solutions

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**Other Resources: (websites, videos, books, etc.)**

Resources used during lesson:

**Boston underwater: How the rising sea levels will affect the city (Boston.com) -**  
[http://archive.boston.com/yourtown/specials/boston\\_under\\_water/](http://archive.boston.com/yourtown/specials/boston_under_water/)

**Underwater: How rising sea levels will effect various cities (Boston.com) -**  
[http://archive.boston.com/yourtown/specials/cities\\_underwater/](http://archive.boston.com/yourtown/specials/cities_underwater/)

**What Could Disappear (NYTimes) -**  
[http://www.nytimes.com/interactive/2012/11/24/opinion/sunday/what-could-disappear.html?\\_r=1&](http://www.nytimes.com/interactive/2012/11/24/opinion/sunday/what-could-disappear.html?_r=1&)

**Human-caused sea level rise (Climate Central) -**  
<http://www.climatecentral.org/news/the-human-fingerprints-on-coastal-floods-20050>

**Boston Living with Water design challenge (City of Boston) -**  
<http://www.bostonlivingwithwater.org/about>

**Climate Ready City design proposal (City of Boston) -**  
<http://imagine.boston.gov/emerging-ideas/>

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**Background Information for Teacher:** Provide the necessary information for effective instruction.

Global warming has raised global sea level about 8 inches since 1880, and the rate of rise is accelerating. Rising seas dramatically increase the odds of damaging floods from storm surges. A Climate Central [analysis](#) finds the odds of “century” or worse floods occurring by 2030 are on track to double or more, over widespread areas of the U.S. These increases threaten an enormous amount of damage. Across the country, nearly 5 million people live in 2.6 million homes at less than 4 feet above high tide — a level lower than the century flood line for most locations analyzed. And compounding this risk, scientists expect roughly 2 to 7 more feet of sea level rise this century — a lot depending upon how much more heat-trapping pollution humanity puts into the sky. (From <http://sealevel.climatecentral.org/>)

Having already learned about thermal expansion and glacier melt, students should be able to understand that we will have to develop solutions to mitigate the effects of chronic sea level rise and episodic flooding on our cities and communities. In Boston, a coastal city, we are presented with some specific challenges for mitigating and adapting to climate change in our buildings, neighborhoods and infrastructure.

*Explore the interactive links in the “Resources” section to understand the effect a rising sea level will have on the City of Boston, and review the City’s “Living with Water” design challenge to understand both the challenge climate change presents to Boston and some solutions designed to address it.*

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**Background Information the Student Needs to Access the Lesson:** What prerequisite knowledge should the students have?

Students should have learned that thermal expansion and glacier melt, as effects of climate change, are causes of chronic sea level rise.

**Lesson Structure**

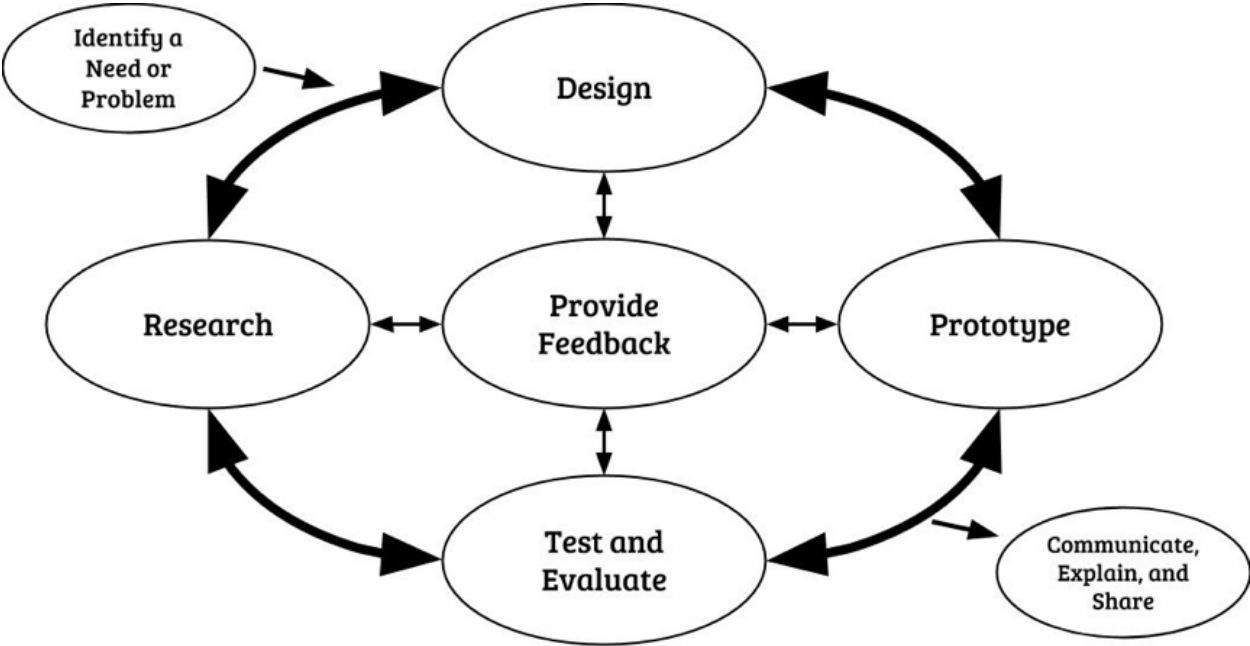
<p><b>Lesson Launch (Do Now)</b></p>	<p>Think-pair-share: We have learned that one effect of climate change will be rising sea levels. As a coastal city, how could sea level rise affect (building, parks, roads and infrastructure in) the City of Boston? What are some specific places you think a rising sea level will affect?</p>
<p><b>Background Instruction (pre-activity)</b></p>	<p>Discuss: what could be affected? Invite each pair to share one feature or aspect of Boston they brainstormed might be affected by sea level rise. Ask the larger group for thoughts about the factors that might affect each ideas' vulnerability to sea level rise. Elicit students' prior knowledge of and familiarity with the city in their answers and hypotheses.</p> <p>Review: long-term vs short-term effects Ask students to define long- and short-term effects. Remind students that sea level rise is a long-term effect of climate change. Provide students with the follow effects, and ask them to sort into long- vs short-term:</p> <ul style="list-style-type: none"> <li>● Melting glaciers (long-term)</li> <li>● Thermal expansion (long-term)</li> <li>● High winter rainfall (short-term)</li> <li>● Landslides (short-term)</li> <li>● Flooding (short-term)</li> <li>● Erosion of dunes - natural seawall (long-term)</li> </ul> <p>Teach: how will Boston be effected? Show students the image of Back Bay from "Boston Underwater." Ask students to identify features of Back Bay (Charles River, Mass Ave bridge, etc) as seen on the map. Then, show students what rising sea levels will look like in Back Bay, the Boston Harbor, and the Harvard Campus at 5, 12 and 25 feet.</p> <p><b>Boston underwater: How the rising sea levels will affect the city (Boston.com) -</b> <a href="http://archive.boston.com/yourtown/specials/boston_under_water/">http://archive.boston.com/yourtown/specials/boston_under_water/</a></p> <p>Remind students that 0 feet is today's sea level. Five feet will take between 100 and 300 years. Twelve feet of water is the potential level in the year 2300 and 25 feet will occur centuries from now.</p>

	<p>Next, show students the interactive “human-caused sea level rise link,” clicking on Boston. Point out that in addition to long-term effects, flooding is a short-term effect with potentially devastating effects to a city. Click around different cities and compare the ratios of human- and naturally-caused floods. Note that about 2/3 of floods in the last century have been attributed to human causes.</p> <p><b>Human-caused sea level rise (Climate Central) -</b>  <a href="http://www.climatecentral.org/news/the-human-fingerprints-on-coastal-floods-20050">http://www.climatecentral.org/news/the-human-fingerprints-on-coastal-floods-20050</a></p> <p>As students are interested, explore how rising sea levels will affect other US cities through the interactive graphics in the following links:</p> <p><b>Underwater: How rising sea levels will effect various cities (Boston.com) -</b>  <a href="http://archive.boston.com/yourtown/specials/cities_underwater/">http://archive.boston.com/yourtown/specials/cities_underwater/</a></p> <p><b>What Could Disappear (NYTimes) -</b>  <a href="http://www.nytimes.com/interactive/2012/11/24/opinion/sunday/what-could-disappear.html?_r=1&amp;">http://www.nytimes.com/interactive/2012/11/24/opinion/sunday/what-could-disappear.html?_r=1&amp;</a></p>
<p><b>Activity</b></p>	<p>Let students know that climate scientists and city officials have been taking the projected effects of climate change seriously, and have been developing plans to deal with the effects of climate change for decades.</p> <p>Introduce the Boston Living with Water design challenge - a global competition for architects and engineers to submit solutions to some of the toughest challenges climate change will pose for the city of Boston.</p> <p><b>Boston Living with Water design challenge (City of Boston) -</b>  <a href="http://www.bostonlivingwithwater.org/about">http://www.bostonlivingwithwater.org/about</a></p> <p>As you review the design challenges, ask students to think about how their ideas from the think-pair-share fit into the City’s challenges.</p> <p>Read from the website’s “About” page, defining unfamiliar vocabulary as you go along:</p> <p>“Boston is blessed with a highly protective harbor and a substantial tide cycle. Winthrop, Hull and 34 harbor islands substantially dampen and dissipate storm surges. As well, with a 10’ swing in height between low and high tide, unless storm surges peak at high tide, they typically don’t overtop our seawalls. The downside to this is that approximately 30 percent of Boston (our filled tidelands) lie within 8’ of today’s high tide and, without intervention, will be at risk of chronic saltwater flooding by 2100.”</p> <p>“Successful design proposals embrace Designing with Water</p>

	<p>design strategies, solving multiple challenges including minimizing damage from chronic and episodic coastal flooding. They mitigate adverse building impacts on the environment, enhance climate resiliency, are incremental, and implementable. They are economically and social sustainable, inclusive and equitable, and beautiful.”</p> <p>Let students know that they will have a chance to serve as designers and engineers for the 3 Challenges the City presented. On the “About” page, view the “Challenge” tab, and read the 3 challenges, soliciting students’ knowledge about where those sites are located, and what they are familiar with at those sites. If students need help locating these sites, find them on Google Maps as a classroom.</p> <p>Divide students into small groups to work on design challenges! As the teacher, decide if all students will all work on one challenge, or if each small group will work on one of the three challenges (in which case, ideally, the number of small groups will be 3 or a multiple of 3).</p> <p>With access to a tablet or computer connected to the internet, direct each small group to <a href="http://bostonlivingwithwater.org/about">bostonlivingwithwater.org/about</a>, and have them click on the briefing booklet (“view now”) for each challenge. Ask students to take 10 minutes to review the briefing pages for their challenge, beginning on page 9.</p> <p>In lab notebooks, or on a teacher-created worksheet, ask students to draft a design proposal for the challenge they were presented with. How would they change, redesign, or replace the space to be more adaptable to rising sea levels?</p> <p>Students should describe the issue (2-4 sentences), solution (6-8 sentences, plus drawings/diagrams, if desired), and potential outcome of an engineering solution (4-6 sentences) and prepare to present their solution to the class.</p> <p>As the teacher, you can decide how intensively students will work on their proposal. This could be a 15-20 minute project, or a more intensive <a href="#">engineering design process</a> project over the course of a number of class periods.</p>
<p><b>Discussion/ Debrief</b></p>	<p>Invite each small group to share their issue, solution and outcomes with the classroom.</p> <p>Then, review the City’s winning design choices for each site/challenge students worked on (<a href="http://bostonlivingwithwater.org/submission-gallery">bostonlivingwithwater.org/submission-gallery</a>). These can be reviewed in small groups, or as a whole class.</p> <p>Point out some of the design aspects that are similar and different between the winning submissions and students’ designs. Affirm</p>

	<p>students' ingenuity and creativity in developing their designs.</p> <p><i>Possible extension:</i> Introduce students to the Imagine Boston 2030 project and have them respond to the Climate Ready City design proposal, as a class or in small groups.</p> <p><b>Climate Ready City design proposal (City of Boston) -</b> <a href="http://imagine.boston.gov/emerging-ideas/">http://imagine.boston.gov/emerging-ideas/</a></p>
<p><b>Formative Assessment</b></p>	<p>Ticket to Leave: What is another feature of Boston that you expect might be affected by sea level rise and flooding? List a few design adaptations we might consider to protect and maintain it.</p> <p>For an additional assessment, the teacher can create a rubric to assess the effective aspects of a proposed design solution.</p>

**Notes:**



Taken from MA Curriculum Framework, 2016