MODULE 5, Lesson 1: Adapting to the Future: Looking at Designs for a Different Climate

Grades: 6-12

Duration: 4 class periods: 2 (45-50 minutes) lessons and 1 (90-100 minutes)

Objectives:

- Students will be able to explain the phenomena of climate change and distinguish how climate differs from weather
- Students will be able to synthesize data to assess climate trends and patterns over time
- Students will be able to apply spatial reasoning concepts to investigate how geography contributes to the effects of climate change
- Students will be able to analyze various types of data in order to construct well supported scientific explanations
- Students will be able to investigate how urban planning contributes to coastal climate resiliency

Materials: Activity 1- whiteboard, projector, Microsoft Excel, laptops for students; Activity 2- Biological Sciences Curriculum Study (BSCS) *Identify and Interpret (I^2) Strategy* document, Hurricane Sandy before/after photos, *Hurricane Sandy's Impact, By the Numbers* infographic, *I Used to Think…But Now I Know* worksheet; Activity 3- New York Department of City Planning's *Coast Climate Resilience: Urban Waterfront Adaptive Strategies* document, Lesson1_Activity3_worksheet, laptops for students

Suggested Standards

NYS Content Standards:

Grade 6-8 Science Standards:
Standard 1—Analysis, Inquiry, and Design
M2.1; M3.1; S1.1; S1.4
Standard 2—Information Systems
1.2
Standard 6—Interconnectedness: Common Themes
2.2; 5.2

6-8 Life Science Standards
Standard 4:
7.2d

Grades 6-8 Physical Setting Standards
Standard 4:
2.2i; 2.2j; 2.2r

Grades 9-12 Science Standards:
Standard 1**:**
1.1a; 1.2a; M2.1

Standard 6—Interconnectedness: Common Themes
Patterns of Change Key Idea 5

Grades 9-12 Living Environment Standards
Standard 4:
6.3c; 7.1b; 7.1c; 7.3b

Grades 9-12 Earth Science Standards
Standard 4:
2.1q; 2.2d

Grades 6-8 Social Studies Practice & Content Standards
6.A2; 6.B5; 6.E6
7.A2; 7.B5;7.B6; 7.C4
8.A2; 8B5; 8.C4

Grades 9-12 Social Studies Practice & Content Standards
A2; A5; B4; D1; D2; D3

Next Generation Science Standards:
Grades 6-8 Earth and Space Science Standards:
MS-ESS3-4; MS-ESS3-5
Grades 9-12 Earth and Space Science Standards:
HS-ESS3-1; HS-ESS3-5

Common Core State Standards:
Grade 6-8
CCSS.ELA-LITERACY.RST.6-8.1
CCSS.ELA-LITERACY.RI.6.1
CCSS.ELA-LITERACY.RI.6.7
CCSS.ELA-LITERACY.RI.7.1
Grade 9-12
CCSS.ELA-LITERACY.RI.9-10.1
CCSS.ELA-LITERACY.RI.11-12.7
CCSS.ELA-LITERACY.RH.9-10.7
CCSS.ELA-LITERACY.RH.11-12.7

ACTIVITY 1: (45-50 minutes) Introduction to Climate Change

The teacher will commence by discussing with students the basics of climate change. They should first pose the following questions:

- What causes climate change?
- How does it work? How does it happen?

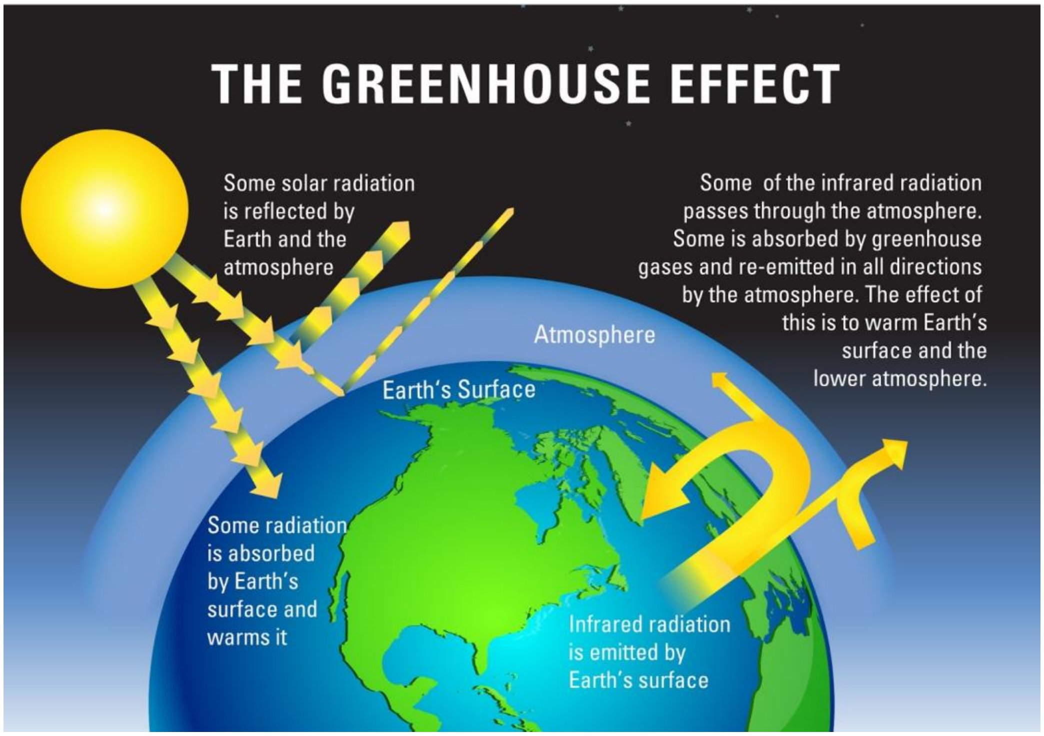
You might find that students do not know how to answer this question. Some might talk about potential impacts of climate change or factors that contribute to it, but you might find that few students are able to coherently discuss the natural mechanisms through which climate change occurs.

Teacher Reference:

Earth uses energy from the sun to heat our planet. According to National Oceanic and Atmospheric Administration's (NOAA) National Center for Environmental Information,

> Many chemical compounds present in Earth's atmosphere behave as 'greenhouse gases'. These are gases which allow direct sunlight (relative shortwave energy) to reach the Earth's surface unimpeded. As the shortwave energy (that in the visible and ultraviolet portion of the spectra) heats the surface, longer-wave (infrared) energy (heat) is reradiated to the atmosphere. Greenhouse gases absorb this energy, thereby allowing less heat to escape back to space, and 'trapping' it in the lower atmosphere.[1]

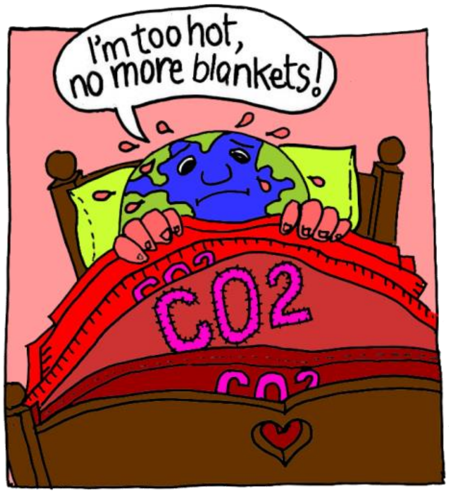
[1] National Oceanic and Atmospheric Administration, *Greenhouse Gases*, National Center for Environmental Information, https://www.ncdc.noaa.gov/monitoring-references/faq/greenhouse-gases.php.



Original Image: http://geologylearn.blogspot.com/2015/07/what-cause-global-warming-effect.html

Greenhouse gases are natural and necessary in order to heat the Earth. However, human activities such as burning fossil fuels are creating more greenhouse gases than the earth can naturally sustain. These excess gases are trapping more heat and contributing to the problem of climate change.

One way to frame this concept to students is to provide them with an explanatory metaphor. On Visionmaker, students' most common reference to greenhouse gases has been carbon dioxide (CO_2). Frame your message through the lens of CO_2 instead of greenhouse gases. Inform students that *CO_2 acts as a "heat trapping blanket".*[2] *We need that blanket to keep our planet from freezing, but human activities such as excessive burning of fossil fuels is putting too much CO_2 into the atmosphere. In essence we are putting multiple blankets around the Earth and it is getting too hot which is causing problems all over the world.*



Original Image: http://tiki.oneworld.org/planet-boundaries/pb5climate.html#!prettyPhoto/2/

[2] Frameworks Institute, *How to Talk About Climate Change and the Ocean*, http://www.frameworksinstitute.org/assets/files/PDF_oceansclimate/climatechangeandtheocean_mm_final_2015.pdf.

One of the important distinctions between weather and climate is the measure of time. Weather is short-term atmospheric changes, whereas climate represents long-term average changes in the atmosphere. In order to garner an understanding of climate change and the difference between weather and climate, students should export historical climate data from the World Bank's Climate Change Knowledge Portal[3]. This dataset ranges from 1900-2012. Students will be able to see trends and patterns that having been occurring over a 112-year span as it relates to our nation's monthly and yearly temperature ranges. Students should go to the following site: http://sdwebx.worldbank.org/climateportal/index.cfm?page=downscaled_data_download&menu=historical and download the dataset into excel. The class should be broken into four groups and each group should be responsible for reporting and graphing climate trends and patterns over the 112 years for 3 months each (i.e. Group 1- January through March [1900-2012]; Group 2- April through June; Group 3- July through September; Group 4- October through December). These groupings will allow students to see monthly trends over time without being overwhelmed by the volume of data present. It will also give student groups the opportunity to share out their findings to the rest of the class at the end of the activity, which strengthens their science communication skills.

Action steps to follow (directions specific to Microsoft Office Excel 2007):

1. Select historical tab option
2. Select Variable: Temperature; Time Period: 1900-2012; Country: USA
3. Download data to Excel
4. Switch columns A & B so that the Year values are in column A and the Temperature values are in column B
5. Go to the Data tab and select the Filter option for column C
6. Go to the dropdown option in column C for the months. Have each group select 1 of their assigned months at a time (i.e. Group 1 will uncheck the "select all" box and will only select month 1. Group 1 will then uncheck month 1 and select month 2, etc.). This is to allow students to see data for one specific month over the total time span.
7. The students will select all data values in columns A & B then hit the Insert tab.
8. Select a line graph with markers.

[3] The World Bank Group, *Climate Change Knowledge Portal: For Development Practitioners and Policy Makers*, http://sdwebx.worldbank.org/climateportal/index.cfm?page=downscaled_data_download&menu=historical.

9. Enlarge the graph if necessary to see all the data points. In the Design tab in the Chart Layout section, select the layout option that given title options for the x and y axis, as well as for the graph itself

10. Have students appropriately label and title the graph

11. Have student groups decipher any trends and patterns within their monthly graphs

12. Ask student groups to record their graphical observations in written format. What sort of summative statements can they produce from their data analysis?

13. Then double click with the left mouse button anywhere along the data peaks and falls. Have students select "add trendline" and then the linear trendline option.

14. Ask student groups to record their graphical observations in written format. What sort of summative statements can they produce from their data analysis? Have their statements changed once the trendline was added? Why or why not?

15. Have student groups repeat this process for the other 2 months that they were assigned.

16. Once all groups have completed their 3 graphs. Have each group share out their findings to the whole class. What sort of scientific explanations can they create as a whole class? What overall trends and patterns are they observing?

Extension Activity (to be completed in a separate lesson period or as homework):

Students should use the same spreadsheet to create average yearly temperatures for the 112 year range. There are formulas you can use in excel to make this process easier. They are as follows:

1. Select two empty columns to input your new data (i.e. Columns G & H). Note: Empty cell G1 before you create the line chart. Do not title it "Year". Do title H1 "Temperature". By doing this, Excel does not recognize the numbers in column G as a data series and automatically places these numbers on the horizontal (category) axis. After creating the chart, you can enter the text Year into cell G1 if you like.

2. Label cells G13 with "1901" and G25 with "1902". Highlight cells G13-G36. Then with your mouse click on the small box in the right hand corner of the highlighted cells. Without taking your finger off the mouse, drag the fill handle down to cell G1345. This should automatically fill the remaining years in through 2012. *Depending on your version of Excel you may need to highlight cells G14-G25 instead of G13-G36 to complete the automated cell population.*

3. In cell H13 input the following formula =Average(B2:B13). Hit enter. This should automatically create a numeric average for the yearly temperature for 1901.

4. Click cell H13 and "copy" it. Then scroll to cell H25 and hit "paste". This should automatically generate the formula for the yearly average temperature for 1902. Check to see if this is correct. The formula should be =Average(B14:B25).

5. Highlight cells H13-H36. Then with your mouse click on the small box in the right hand corner of the highlighted cells. Without taking your finger off the mouse, drag the fill handle down to cell H1345. This should automatically create and fill the average formula for yearly temperature through 2012. *Depending on your version of Excel you may need to highlight cells H14-H25 instead of H13-H36 to complete the automated cell population.*

6. Once all the data points are complete. Have students create a line graph. Highlight cells G1 & H1 through G1345 & H1345 (remember H1 should have a title, while G1 should not).

7. Enlarge the graph to more easily see the data point. If the graph is still too large, left click the x-axis values. Select the "format axis" option. Under the axis type options, select "date axis".

8. What trends and patterns do students observe? What is happening to yearly temperature averages from 1901-2012?

<u>ACTIVITY 2</u>: (45-50 minutes) Topography's Influence on Climate Change: A City Examination

The teacher should commence this lesson by displaying the following map from the Landsat project, a joint initiative between the U.S. Geological Survey (USGS) and NASA (a higher resolution image can be downloaded at https://landsat.usgs.gov/gallery_view.php?category=nocategory&thesort=mainRow):

The teacher should cover the description segment of the image. S/he should ask students to use their observation skills to explain what this particular map is showing us. What sort of claims can they make about the topography of the United States? What evidence is there to back up their claims?

Different maps tell different stories and they help us build our perceptive on a variety of topics. Maps help us develop our spatial thinking, which contributes to our understanding of geography, earth and life sciences, history, as well as the humanities/social sciences. For this activity students will be examining topographical/elevation maps and data at various scales to see what sort of information they can gather to create a comprehensive environmental picture.

The first map was of the United States as a whole. Next the teacher should show students a general topographic map that shows the elevation of New York State (displayed on the following page). From looking at the map, what inferences can students make about the physical features of the state? The teacher can use a strategy developed from the Biological Sciences Curriculum Study (BSCS) called the *Identify and Interpret (I^2) Strategy*.[4] Students will first identify what they see in the map; this is based solely on observations. They should then use those observations to interpret meaning out what they are seeing. Lastly they will write a summative caption to practice their explanatory reasoning and writing skills. *A step-by-step example from BSCS is provided in a separate attachment.*

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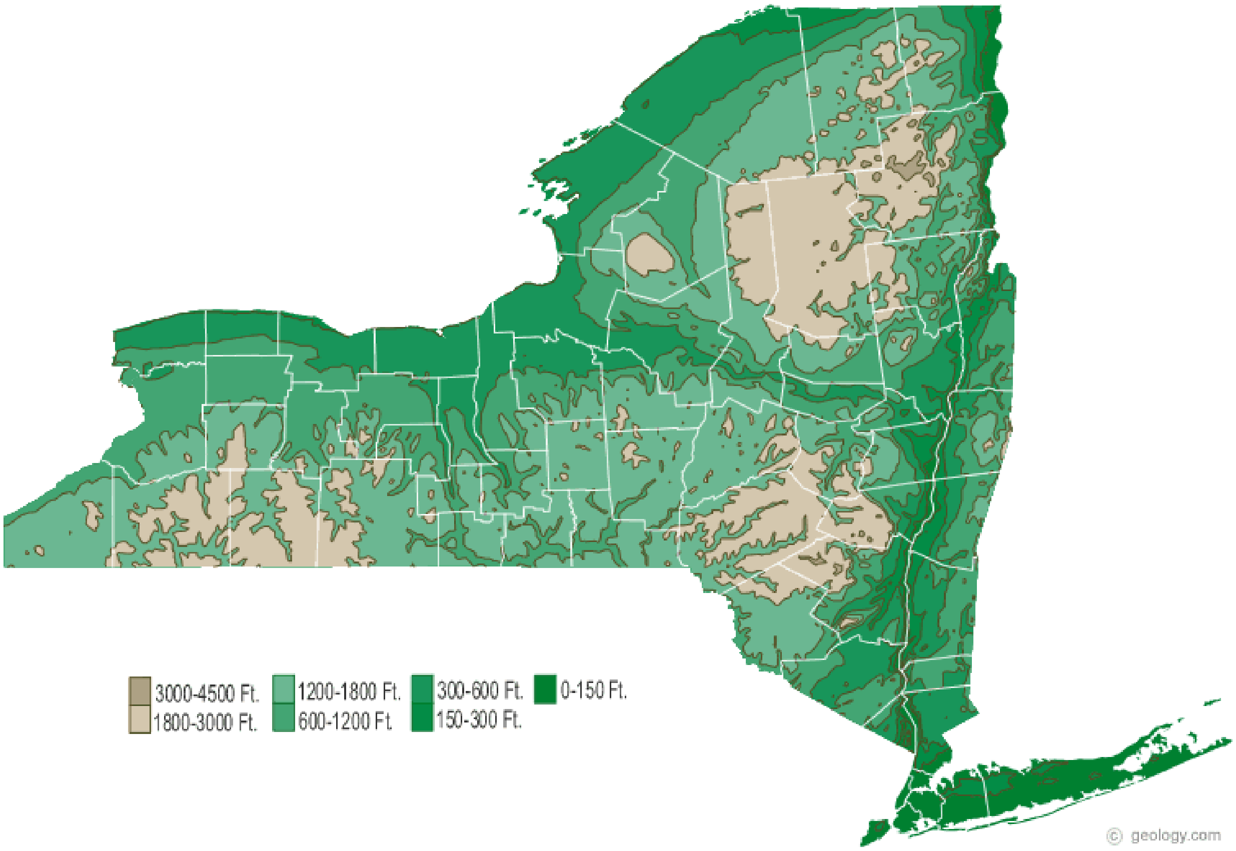
[4] Biological Sciences Curriculum Study (BSCS), *I Can Use the Identify and Interpret Strategy*, http://bscs.org/sites/default/files/_legacy/BSCS_PDI_Notebooking_Student_Version_NSTA_2012.pdf.



Original Image: http://geology.com/state-map/maps/new-york-state-map.gif

Next teacher will present data from USGS topographical surveys for both New York City and New York State. This data will be used to elaborate or reinforce the takeaways that students got from the exploring the state map.

Highest and Lowest Elevations of New York State[5]

State or possession	Highest point	County or subdivision	Elevation feet	Lowest Point	County or subdivision	Elevation feet
New York	Mount Marcy	Essex	5,344	Atlantic Ocean	- -	Sea level

[5] U.S. Geological Survey (USGS), "Elevations and Distances in the United States," *Elevations of the 50 Largest Cities (by population, 1980 census)*, http://egsc.usgs.gov/isb//pubs/booklets/elvadist/elvadist.html.

Elevation of New York City[6]

City	State	High Feet	Low Feet
New York	New York	410	Sea Level

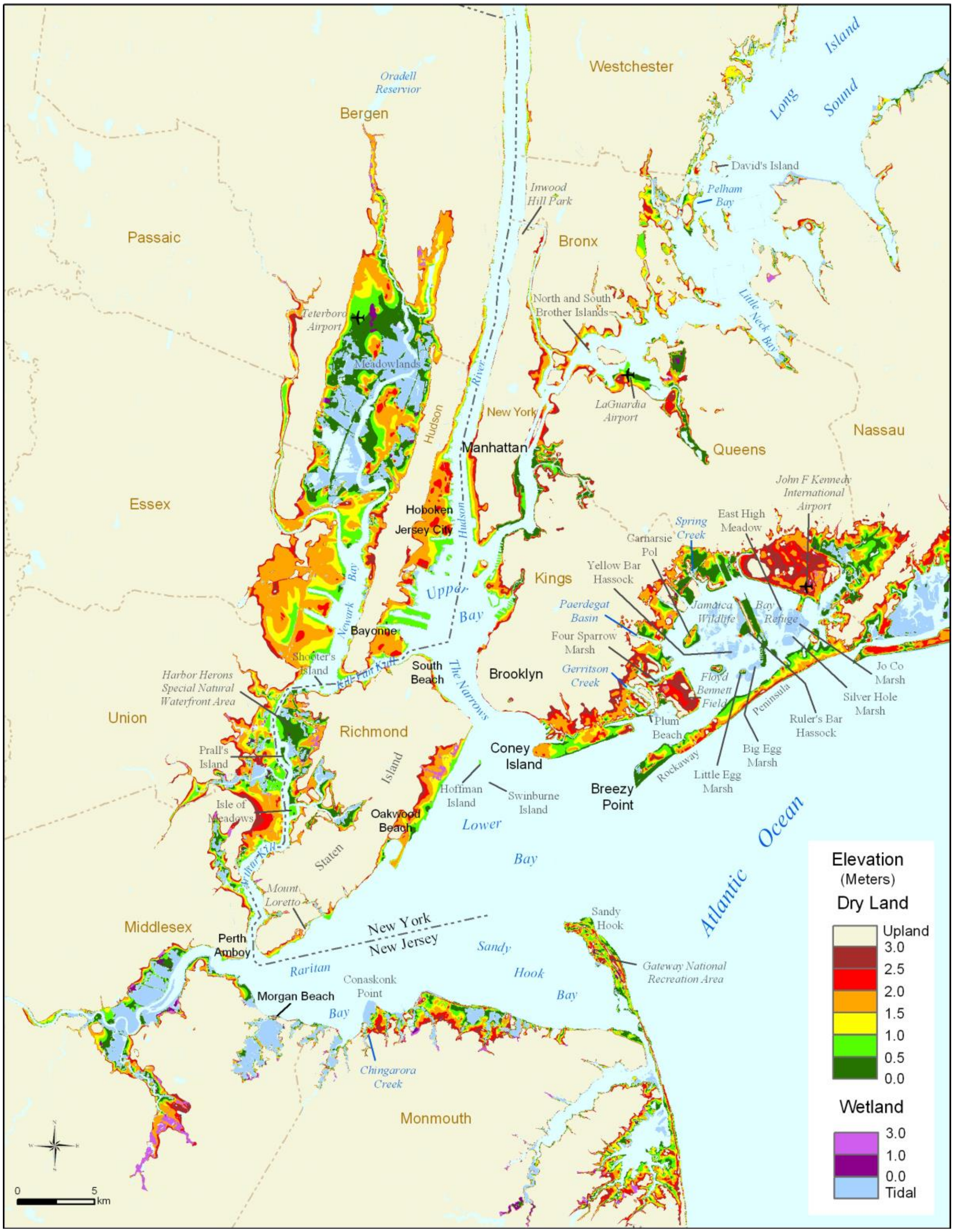
If necessary, teachers should pair this data with a county map of New York State to cross-reference the topographical map. Teachers should pose questions such as:

- How does looking at this data further your understanding of the map interpretation?
- What does this data tell you about the physical features of NY?
- Can you relate this information to any personal experiences that shape your understanding of NY geography? (*For example: students sharing outdoor experiences that involve hiking a mountain, students from different NYC neighborhoods share how one neighborhood has more hills as compared to another, etc.)*

Then teachers should show *Elevations of Land Close to Sea Level* map from the US Environmental Protection Agency (EPA) (found on the next page).[7] From the USGS data we know that the lowest point of elevation for New York is the Atlantic Ocean, which means parts of New York are at sea level. As a class, examine the elevation map of New York City which also highlights parts of New Jersey as well. The teacher should call on a few students to share observations of what they are seeing with the whole class. Be aware that elevation in this map is represented in meters and not feet. Once a few students have shared their observations, the teacher should switch gears to focus on climate change.

[6] U.S. Geological Survey (USGS), "Elevations and Distances in the United States," *Highest and Lowest Elevations*, http://egsc.usgs.gov/isb//pubs/booklets/elvadist/elvadist.html.

[7] J.G. Titus and J Wang, *Maps of Lands Close to Sea Level along the Mid-Atlantic Coast*, U.S. Environmental Protection Agency, http://maps.risingsea.net/CCSP/B.1_NewYorkCity50cm_Titus_and_Wang_2008.jpg.



Original Image: http://maps.risingsea.net/CCSP/B.1_NewYorkCity50cm_Titus_and_Wang_2008.jpg

The teacher should pose the following question- *What are some potential implications of parts of New York City being at sea level?* Give students a few minutes to think this question over individually, however ask them to wait on giving a response. The teacher should display some before and after photos of the damage done by Hurricane Sandy http://www.nydailynews.com/news/hurricane-sandy-gallery-1.1195831?pmSlide=1.1195843.[8] Additional damage photos can be found on the National Weather Service website at http://www.weather.gov/okx/HurricaneSandy.[9]

After the students have viewed the damage photos of Hurricane Sandy, the teacher should pose the same question as above- *What are some potential implications of parts of New York City being at sea level?* This should be a whole-class discussion where the teacher will select students' to share their responses. The teacher should also ask students if and how their answers changed before and after viewing the images.

The teacher should display an infographic from the Huffington Post entitled, *Hurricane Sandy's Impact, By the Numbers (http://www.huffingtonpost.com/2013/10/29/hurricane-sandy-impact-infographic_n_4171243.html).*[10] This infographic is already dated (2013), but it will still give students the opportunity to grapple with the large-scale impact that the storm had on both New York and New Jersey.

To conclude the lesson, the teacher should use an informal assessment called *I Used to Think…But Now I Know*.[11] Each student should individually write down their reflections because it is a self-assessment to track how their thinking has changed over the course of the lesson. Students should describe how their ideas on elevation/topography maps have changed or how they became more detailed compared to what they knew at the beginning of the lesson. They can frame their ideas under the context of how elevation/topography maps relate to our everyday lives.

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[8] Roseanne Salvatore and Dylan Entelis, *Hurricane Sandy Damage: Before and After Photos of New York and New Jersey*, New York Daily News, http://www.nydailynews.com/news/hurricane-sandy-gallery-1.1195831.

[9] National Weather Service, "Hurricane Sandy," *Photos*, National Oceanic and Atmospheric Administration, http://www.weather.gov/okx/HurricaneSandy.

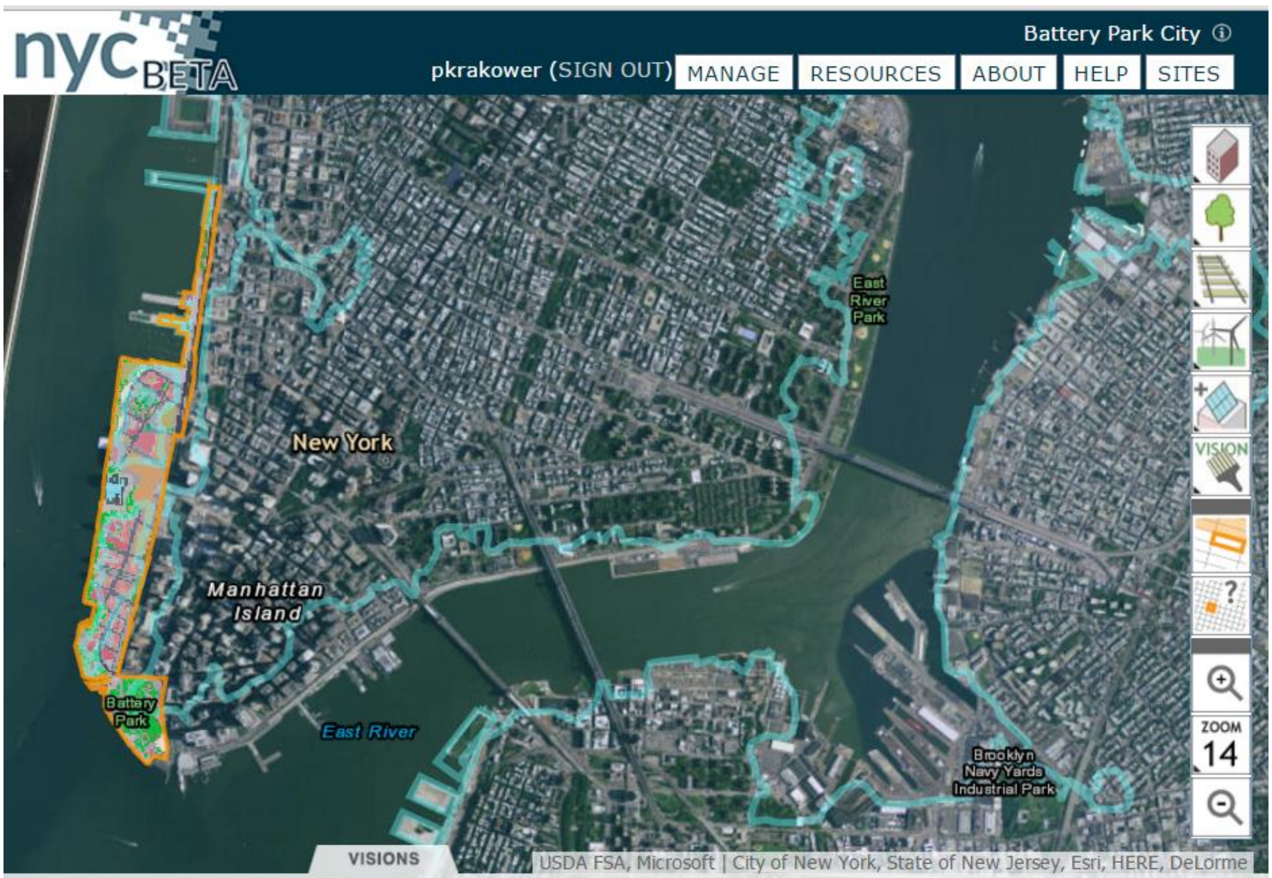
[10] Huffington Post, "Hurricane Sandy's Impact, By the Numbers (Infographic)," *Huffington Post Green*, October 29, 2013, http://www.huffingtonpost.com/2013/10/29/hurricane-sandy-impact-infographic_n_4171243.html.

[11] Page Keeley, *Science Formative Assessment: 75 Practical Strategies for Linking Assessment, Instruction, and Learning* (Thousand Oaks, California: Corwin Press, 2008), 119.

I Used to Think…	But Now I Know…

Activity 3: (90-100 minutes) Battery Park City: A Coastal Case Study

In the last two lessons, students have explored how temperatures are rising from historical data and how the elevation of New York City leaves part of the city at risk from storm surges. Students will now use Visionmaker to explore how a specific neighborhood in New York City might fare as a result of climate change risk. The teacher should create a vision based on New York City (2014) settings that encompasses Battery Park and Battery Park City (BPC) (example provided below). On separate computers, students can load the teacher's vision then select "copy and edit" to replicate the vision (the teacher should share "set up your new vision" details with students so they are uniform). Note that Activity 3 will most likely require two class periods.



Students should take a minute to observe the blue flood line of the vision area for the past climate in 1609. It will be helpful to select the Welikia (1609) tab on Vision Control setting to see the land/flood pattern more easily. The teacher should ask the students to share what they are seeing. How can it be that the landscape of NYC has changed from 1609 to present day?

(*Students should see that the area that houses Battery Park and Battery Park City did not exist in 1609. The Lower Manhattan coastline has been expanded over time by building on landfills. Teachers can show this map after students have had an opportunity to first answer the posed question*).

Orginial Image: http://www.nyc.gov/html/sirr/downloads/pdf/final_report/Ch18_Southern_Manhattan_FINAL_singles.pdf

After reviewing the map, the teacher should distribute to students a short reading (*Battery Park Urban Planning*) that discusses the initial aspirations for the development of the area and the actual design realizations made in 1979.

As that document tells us, the 1979 Master Plan by Alexander Cooper and Stanton Eckstut allocated the land as follows: [12]

- 42% residential up to 14,000 housing units
- 9% commercial: six million square feet of office space located opposite the World Trade Center
- 30% open space: includes public parks, plazas, and esplanade
- 19% streets and avenues.

Has the present day landscape followed similar or different land allocations? Let's find out! Have students return to Visionmaker. On the upper-right hand corner of the screen should be the name of your vision (i.e. Battery Park City) and a little "i" information icon. Click on that icon which will bring you to your vision's information page. Slide your mouse over the ecosystem distribution section to see the percentage breakdown analysis of your vision area (i.e. 5% estuary, 1% public assembly hall, etc.). Have students categorize the land breakdown in the same allocations categories as above (residential, commercial, open space, and streets/avenues) and then add the total percentages together for each category. Pose the following questions:

- Are the land allocations for the current vision similar to the 1979 Master Plan?
    - Why or why not?
- What differences do you notice?
- Which is the highest percentage allocation category(s) for present-day BPC?

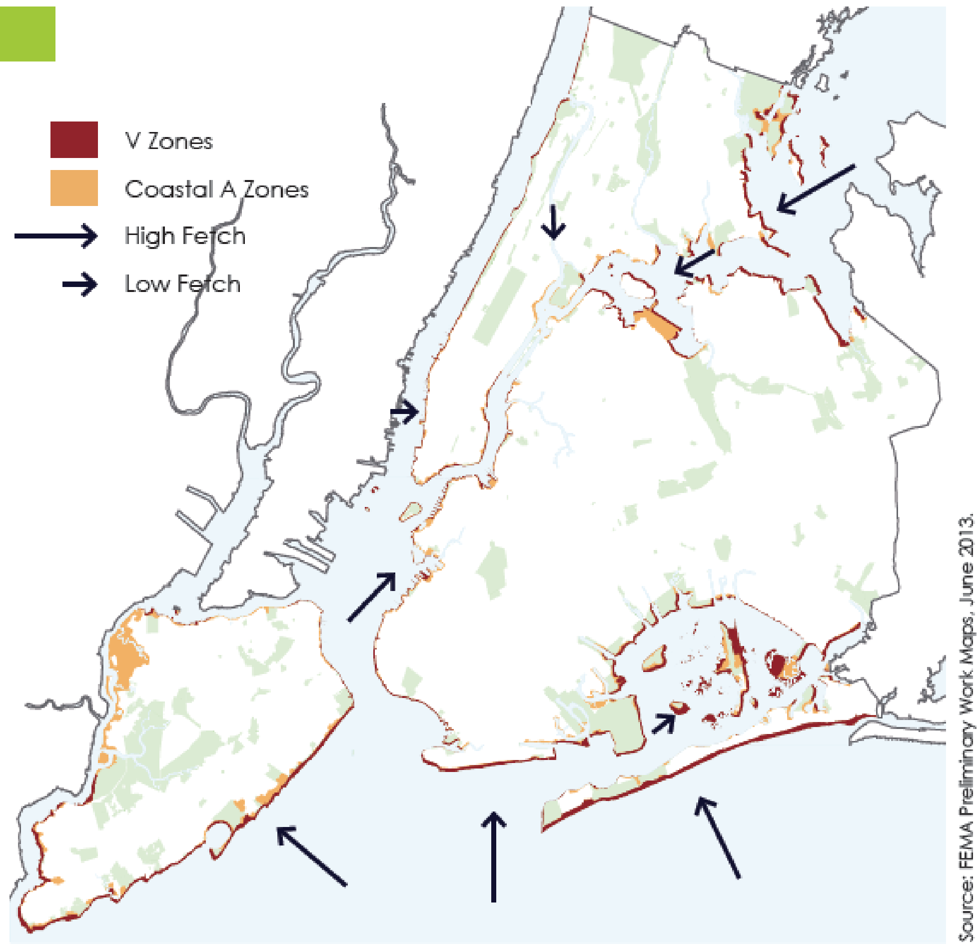
Interesting! Students should file this information away for the moment, but it will be returned to later on in the lesson.

[12] Andrew Cuomo, *Community*, Battery Park City Authority, http://www.batteryparkcity.org/page/page6.html.

Next the teacher should distribute to students a shortened copy of the New York Department of City Planning's *Coastal Climate Resilience: Urban Waterfront Adaptive Strategies* document. Students should read pages 6-9 which discusses coastal hazard concepts and terms (pages 6-7 focus on content while 8-9 is a glossary of terms).[13] After reading this segment of the document, ask students if they could provide an example of both event-based and gradual hazards in a local context (i.e. event-based = Hurricane Sandy; gradual hazard = rising sea levels from climate change). In activity 2 we saw the consequences of storm surges within New York City as a whole. Now let's examine the impacts on Battery Park and BPC. Examine the following figure and description from the *Coast Climate Resilience: Urban Waterfront Adaptive Strategies* document to identify the designated area's exposure to wave force.[14]

EXPOSURE TO WAVE FORCE

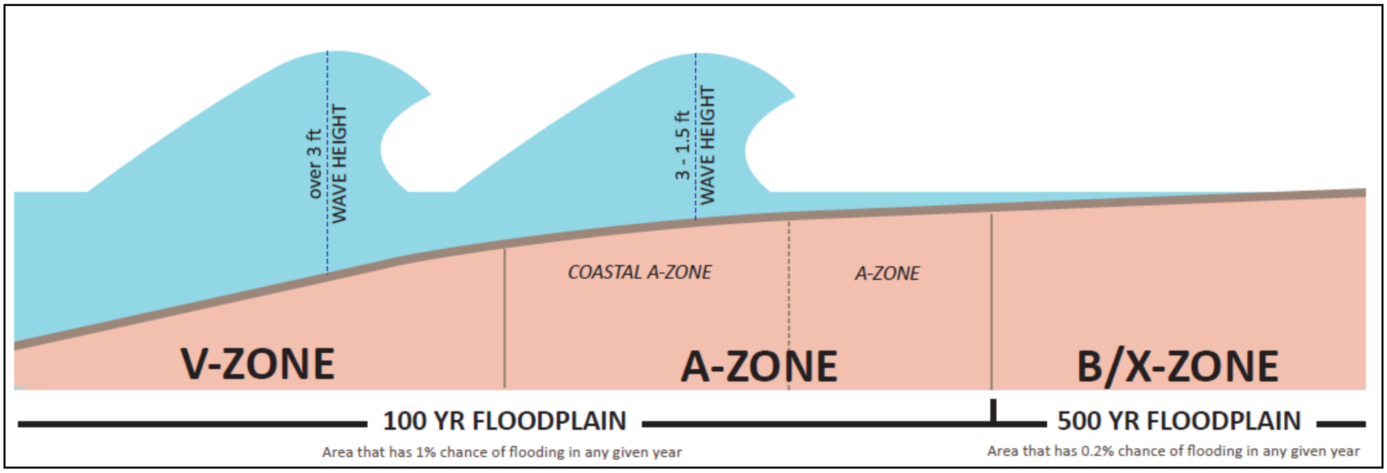
Areas of the city exposed to the open ocean have very large "fetch," meaning there is a great distance to any adjacent shoreline and ocean-going waves can generate extensive energy before breaking on the shores. The large waves along the Atlantic oceanfront are daily evidence of this. In the event of a storm, these areas experience much larger and more destructive waves than other areas. In places that are more sheltered from the open ocean, or have shorter fetch, such as bays, harbors, inlets, and creeks, the narrowing of the water body means that major waves are generally smaller and carry less force. The strength and direction of waves is highly dependent on a variety of factors for each storm, including storm track, speed, and winds. FEMA's flood maps identify V zones and Coastal A zones through modeling potential storms to identify areas where the 1 percent annual chance storm will likely be accompanied with wave action. The V zone is mapped in areas where wave hazards are most pronounced. The Coastal A zones are areas that will likely see waves of 1.5-3 feet .



[13] New York City Department of City Planning, *Coastal Climate Resilience: Urban Waterfront Adaptive Strategies*, The City of New York, 2013, 6-9, http://www1.nyc.gov/assets/planning/download/pdf/plans-studies/sustainable-communities/climate-resilience/urban_waterfront.pdf.

[14] Ibid., p 17

For further information on V and A zones, see the image below.[15]



Next have students examine the maps and figures on pages 18-19 on the same document.[16] Have students identify the coastal geomorphology category of the BPC area and the degree of exposure to coastal hazards within the area. We know both from the BPC Urban Planning document and the examination of land allocation on Visionmaker, that BPC has a mixed residential and commercial land use density. We also know that the area is categorized as a Hardened Sheltered Bay Plain. Let students elaborate upon this newfound information by having them explore the figure on page 28 (*Hardened Sheltered Bay Plains/Medium Density Residential*).[17] While students are looking at the image, remind them that a datum is defined as a "vertical benchmark in sea level that is commonly used to measure tide levels."[18] NAVD88 stands for North American Vertical Datum of 1988 which is a "vertical control datum of land elevation above sea level established for surveying in North America."[19] Ask students, *what information can we gather from this figure? What is it telling/showing us? Are there significant risks posed to BPC because of its location, geomorphology, and land use density? What are those risks?*

Using all the information we have learned so far, ask students to raise their hand to self-identify with 1 of 3 of the following categories: *1) I believe Hurricane Sandy caused severe damage to BPC; 2) I believe Hurricane Sandy caused moderate damage to BPC; 3) I believe Hurricane*

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[15] Ibid., p. 11

[16] Ibid., p. 18-19

[17] Ibid., p. 28

[18] Ibid, p. 8

[19] Ibid., p. 11

Sandy caused mild to no damage to BPC. The teacher should tally the number of students that fall into each category.

Next the teacher should provide students with a short excerpt from the City of New York's 2013 *PlaNYC: A Stronger More Resilient New York* document. The excerpt is entitled *Battery Park City: Construction of a New Coastal Edge* and is located on the following page and as a separate attachment.[20]

[20] The City of New York, *PlaNYC: A Stronger More Resilient New York*, The City of New York, 2013, 373, http://www.nyc.gov/html/sirr/downloads/pdf/final_report/Ch18_Southern_Manhattan_FINAL_singles.pdf

Battery Park City: Construction of a New Coastal Edge

Battery Park City landfill before start of development, circa 1974 Credit: The New York Times

Since the 1600s, the inhabitants of Manhattan have been expanding their island out into the water surrounding it. This has particularly been true in Lower Manhattan. There, the last major expansion occurred in the 1970s, with the creation of Battery Park City, a 92-acre housing and commercial development built on landfill along the western edge of Lower Manhattan in the Hudson River.

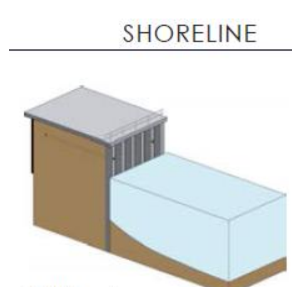
As a general matter, during Sandy, the parts of Lower Manhattan built on landfill proved to be among the most vulnerable to flooding. Battery Park City was one significant exception to this rule, escaping the storm with almost no building damage. This was a direct result of the elevation of the landfill site and the location of the buildings.

Around Lower Manhattan, most historic landfill was created to expand maritime activity. Though well-suited for their original purposes, as these areas transitioned from maritime to other uses, the land never was raised to higher elevations. By contrast, Battery Park City was planned for housing and commercial space from the start—one of the first examples of landfill being added to Manhattan for a non-maritime purpose. Therefore, the elevation of the site was not dictated by the need to access the water.

Though FEMA's 1983 Flood Insurance Rate Maps (FIRMs) for New York City did not exist when the landfill for Battery Park City was constructed, the engineers who designed the development relied on then-existing flood hazard information to inform their planning. As a result, the buildings at Battery Park City generally sit approximately seven feet higher than the elevation of the former island edge (now West Street) and generally at the highest points on the development. From the building sites, Battery Park City gently steps down two to three feet to a generous riverfront esplanade and park area along most of its waterfront edge. Even this edge, though, is approximately three feet higher than other bulkheads in Lower Manhattan.

During Sandy, the bulkhead and elevation of Battery Park City served the neighborhood well. The bulkhead absorbed wave impacts, and, though water eventually did flood the area's esplanade and parks, the buildings, set back from the water's edge and on higher ground, hardly were affected. In fact, the greatest danger many of the buildings at Battery Park City faced during Sandy came, ironically, from West Street, on the site's inland side. This is because Sandy's surge was able to inundate the roadway from the north and the south—primarily because it had been constructed on landfill at a lower elevation for the purposes of maritime activities.

Example of a bulkhead:[21]



[21] New York City Department of City Planning, *Coastal Climate Resilience*, 5.

From this reading, what stood out to students most? What were they most surprised about? The teacher should refer back to the self-identification category groups. If there were students who self-identified with category 3 (*I believe Hurricane Sandy caused mild to no damage to BPC*), the teacher should have a few of those students explain their rationale for selecting this category. Before reading the excerpt, what made them think there would be mild to no damage caused by Hurricane Sandy to the area?

Now that we know that BPC fared relatively well from the event-based hazard of Hurricane Sandy, do we think the same will be true for the gradual hazard of sea level rise?

The New York City Panel of Climate Change (NPCC) which consists of climate change and impact scientists, academics, and private sector practitioners, has projected the following key findings from their research and data from Global Climate Models:

NPCC Climate Risk Key Findings[22]		
Mean Annual **Temperatures** projected to increase by: • 1.5- 3^0 F by the 2020s • 3-5^0 F by the 2050s • 4-7.5^0 F by the 2080s	Mean Annual **Precipitation** projected to increase by: • 0-5% by the 2020s • 0-10% by the 2050s • 5-10% by the 2080s	Mean Annual **Sea Level Rise** projected to increase by: • 2-5 inches by the 2020s • 7-12 inches by the 2050s • 12-23 inches by the 2080s

Let's try our hand at forecasting climate change impacts on the area while utilizing Visionmaker once again. The teacher should break the class into 5 small groups to represent the baseline and all future climate options (Baseline Climate 1970-2010; Future Climate 2020s; Future Climate 2050s; Future Climate 2080s; Future Climate 2100s) within the Lifestyle/Climate Selectors dropdown section. The groups will not be making alterations to the vision they created of Battery Park and BPC. They will be more focused on monitoring the impacts of climate and precipitation changes, as while as how the blue flood line changes with time.

[22] New York City Panel on Climate Change, "Climate Risk Information," City of New York, 3-4, http://www.nyc.gov/html/om/pdf/2009/NPCC_CRI.pdf.

Each group will also be responsible for recording how alteration of precipitation events affect stormwater and floodwater levels under the Water performance indicator and greenhouse gas levels under the Carbon performance indicator (worksheets included as a separate attachment- one worksheet per respective group). Each group should have the Lifestyle dropdown set to Average New Yorker.

Once all groups have recorded their respective data, students should graph their data as a whole class to see if any trends and patterns emerge. If necessary, the teacher can have students practice the I^2 Strategy introduced in Activity 2 to better analyze the data they are seeing in their class graph.

Based off of the graph they just made and NPCC's data, how do students think Battery Park and BPC will fare as a result of climate change over time? Do they think it would fare as well as it did during Hurricane Sandy? Why or why not? What were they noticing with the blood flood line as the future climates changed? What are some lasting impressions or takeaways they have formed?

Form students into small groups (preferably different from their activity partners) to discuss these questions in think-pair-share format. The teacher should circulate the classroom and rotate between small groups. The think-pair-share can serve as a formative assessment for gauging student understanding.

As an extension activity, the teacher could have the 5 original small groups (Baseline Climate 1970-2010; Future Climate 2020s; Future Climate 2050s; Future Climate 2080s; Future Climate 2100s) make alterations to the Battery Park and BPC vision to best mitigate the effects of rising sea level as a result of climate change.