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Lesson: The Effect of Erosion and Runoff in the Hudson River

Guiding Question for Lesson: How do storm conditions promote erosion and affect the hydrologic (water) quality of the Hudson River?

Objective: Students will use data gathered from the Hudson River Environmental Conditions Observing System (HRECOS) to analyze the effects storms have on increasing erosion turbidity, dissolved oxygen and other measurable hydrologic variables that are important for the viability of the Hudson River and estuary system.

Grade Level: 10th Grade Earth Science
Topic: Surface Processes
Estimated Time Required: 3-4 Days (52 minute class period)

Justification/Rationale: Most students in New York City are familiar with the Hudson River, the massive flowing 315 mile waterway that starts in the Adirondack Mountains as freshwater flows southward and eventually drains into the Atlantic Ocean. As part of my Earth Science course students conduct chemical and physical water testing of a small section of the Hudson River that traverses our neighborhood. This project is called a Day in the Life of the Hudson River and it is a one day field experience in Mid-October. Many students are at first reluctant to even interact with the water in the river as they believe it is heavily polluted. After this field activity students are often left surprised to learn how much life is visible in our section of the Hudson River. This lesson on analyzing and interpreting hydrological and meteorological data from the Hudson River will allow my students to make connections with this previous activity and enhances the unit on Surface Process by promoting relevancy with the current content addressing the interconnectedness of Earth's Systems.

The lower Hudson River is a complex estuary system affected by many variables including tidal influence and storms. Many hydrologic variables are affected by meteorological conditions (wind, tides, current) or geologic processes (erosion). We will be using the data provided from HRECOS to make connections between storm produced erosion by looking at turbidity as the variable and changes in salinity and dissolved oxygen in the river as reported by the remote sensors. Math and technology are incorporated in this lesson as students abstractly and quantitatively interpret real time and historical data to answer relevant questions and purpose possible solutions.

Using this local data source is important because it represents information about a familiar and essential part of our community ecosystem. As a side note it is important that students learn about their local ecological communities as this helps to promote environmental stewardship. This lesson could be extended to include an engineering aspect where students could design a structure that would prevent storm and tidal surges from increasing soil erosion from the riverbank or prevent wastewater from seeping into the river.

Keywords: Erosion, Turbidity, storm surge, salinity, dissolved oxygen

Materials: Computers for students with internet access, projector, speakers, markers, chart paper, tape, & student handout.

Performance Expectation

HS-ESS2-2: Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems

HS-ESS2-5: Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes

NGSS Alignment

Science and Engineering Practices: Analyzing and Interpreting Data

- Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.

Crosscutting Concepts: Cause and Effect

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

Disciplinary Core Ideas

ESS2.C: The role of Water in Earth's Surface Processes
- The abundance of liquid water on Earth's surface and its unique combination of physical and chemical properties are central to the planet's dynamics. These properties include water's exceptional capacity to absorb, store, and release large amounts of energy, transmit sunlight, expand upon freezing, dissolve and transport materials, and lower the viscosities and melting points of rocks.

ESS2.A: Earth Materials and Systems
- Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes

Common Core Math State Standard

MP.2: Students will reason abstractly and quantitatively. (The data students are analyzing and interpreting in this lesson demonstrates a connection to technology as they are conducting research using real time and historical data.)

CCSS.MATH.CONTENT.HSS.IC.B.6
Evaluate reports based on data.

Lesson Level Learning Objectives

- Students will be able to generate data sets that show relationships between hydrologic variables and meteorological conditions.
- Students will be able to interpret and analyze data on the relationship between increased turbidity caused by storm conditions and changes in hydrologic parameters like dissolved oxygen and salinity in the Hudson River.
- Students will be able to present their claims and use evidence supported by their own data set and interpretation as evidence.
- Students will analyze feedback received from students and use this to revise their prior claims along with information from research

Assessment: Student understanding will be assessed using the following:

- **Claim-Evidence-Reasoning Table (summative)**
- **Driving Question Board (formative)**
- **Answers to phase 1/ phase 2 questions (formative)**
- **Gallery Poster (summative)**

Accommodations: Graphic organizers, tables and explicit directions provided to scaffold student learning. Learning connected to students experience and community. Employ purposeful grouping when creating student partnerships. Allows for revision of student generated questions and answers during feedback of poster presentation.

Background: Students should have prior knowledge of the water cycle, runoff, weathering and erosion, landforms, interpreting station models and weather variables (air pressure, temperature, wind speed). Based on previous field activity students should have knowledge of current direction, ebb and flow as related to the Hudson River Estuary.

Engage (Day 1) *The power of Water to Change the Shape of Land.(Phenomena)* **How do storm conditions promote erosion and affect the hydrologic (water) quality of the Hudson River?** *Video Resource* **https://www.youtube.com/watch?v=yiROI_DOcho** **Driving Question Board Sample student questions:** • **How can water change the shape of land?** • **How do floods change landforms?** • **When do flooding events occur?** • **What factors and physical causes contribute to a flood?** *https://www.ldeo.columbia.edu/edu/k12/*	Flash Floods Video: Have students watch the video from the National Severe Storms Laboratory. 1. Create a driving question board that address the phenomena above (water changing the shape of land) 2. Pair up students to discuss the video and come up with 3-5 questions on the power of water to change the shape of land. 3. Redirect students to recall previous field field activity collecting water samples and testing various properties for the *Hudson River Snapshot Day* 4. Review the term **turbidity** with students and discuss how levels can be increased in the Hudson River.

snapshotday/ **(Phase 1 Questions)** **How did we measure the turbidity of the Hudson River?** **What is the primary contributor for turbidity in the Hudson River?** **How is turbidity related to erosion and runoff?** **What is the impact of high turbidity in the Hudson River?**	5. Have students review and answer questions on turbidity on Student Recording Sheet. (Phase 1)

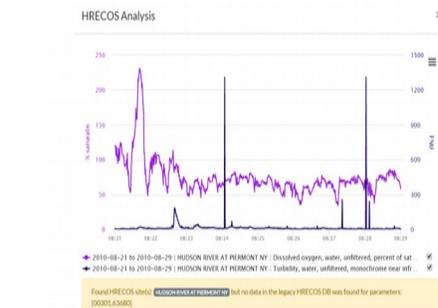|	

Explore: Storm Search (Day 1-2)
 	
Web Resources used:
1. **https://www.ncdc.noaa.gov/ stormevents/choosedates.jsp? statefips=36%2CNEW+YORK**
Sample Search Step 1:
 	
Sample Step 2
 	
2. .
https://ny.water.usgs.gov/maps/hrecos/
 	
Figure 1: Sample of Turbidity vs Dissolved Oxygen
	1. Provide student groups with a computer to research for the exact date of storms that affected our region in the last ten years. (For example: Hurricane Irene was a strong tropical cyclone that affected the East Coast during Late August of 2011.)
	
	2. Direct students to use the NOAA site to determine the **beginning date** and the **end date** for the storm events/ storm surge
	
	3. Students need to click Bronx County as the region associated with the event.
	
	4. Direct students to click on the hyperlink associated with the storm event and read the *Episode Narrative* on the Storm Events Database.
	
	5. Record all relevant information on the Research Handout sheet provided.
	
	6. Using the start day of the storm event as the mid-date, students will create a 7-9 day time frame.
	  Example: Hurricane Irene:
	  Start Date: 8/28/2011
	  Time Frame Range:
	  8/25/2011 -8/31/2011
	
	7. Students will log in to the **HRECOS** site and choose one recording station in the Hudson River that produces data for the storm event researched. (some remote sensors might not have data recorded; students will need to work with the website to find a recording station that was operating)
	
	8. Direct students to create graphs that show how the hydrologic conditions in the river were affected by meteorological conditions. Students can pick any combination of parameters along with **turbidity.**
	
	9. Direct students to save graph(s) to Google Doc's Account. (to be used later for Group Presentation)
	
	10. Record your observations and interpretations in Student Handout.

Explain: Revisit the Phenomena	11. Students will re-examine the Phase 1

	questions answered during the enage section and make changes if needed.
How does increased turbidity produced by storm events negatively impact the water quality of the Hudson River? **(Day3)**	12. Students will examine the graphs created and analyze if any relationships exist between erosion as evidenced by increased turbidity and the effect on other hydrologic variables. 13. Students will complete the **CER** table in the student package provided. 14. In their groups, students will create a short poster explaining their CER to the class that explains how storm conditions increase turbidity and affect the hydrologic quality of the Hudson River. **Students need to print out graphs created on the HRECOS site to include in poster.** 15. Students will circulate around the room in a gallery walk, and leave feedback or questions about their peers work using Post it notes. 16. Have students return to their posters and make revisions to their explanations if needed.
Elaborate (Day 3-4) **Video Resource:** **https://www.youtube.com/watch?v=en0XBycAos8**	12. Show students the short video on Hurricane Sandy and in groups have students discuss how we can use our understanding of storm erosion to prevent/reduce damage to coastal areas. *opportunity for extended research 13. Students complete Solution and Feasibility Table and after class share circle which possible solutions are most likely to be applied in NYC.
Evaluate	Students will be assessed on the following 1. CER table (summative) 2. Presentation(gallery poster rubric) (summative) 3. Driving question board (formative)

Student Recording Document

Engage: *The Power of Water to Change the Shape of Land .(Phenomena)*

Directions: After watching the Flash Flood Video by the National Severe Storms Laboratory discuss the video with your partner and create 3- 5 questions on the **power of water to change the shape of land**. Be prepared to share out your questions with the entire class as we build our *Driving Question Board* for this lesson.

Question Box

Recall our field experiences with the Day in the Life of the Hudson

Define: Turbidity_____

_____

How did we measure the turbidity of the Hudson River?

What is the primary contributor for turbidity in the Hudson River?

How is turbidity related to erosion and runoff?

What is the impact of high turbidity in the Hudson River?

Explore Phase: How do storm conditions promote erosion and affect the hydrologic (water) quality of the Hudson River?

To better understand what conditions increase turbidity and how this impacts the ecosystem of the Hudson River we will make observations of and collect data from NOAA Storm Database and the HRECOS site.

Procedure

1. Log in to the website below
   https://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=36%2CNEW+YORK
2. Click on State Area **NEW YORK** and County **BRONX.**
3. Find the exact date for a storm event that affected our region in the last 10 years
   For example: Hurricane Irene was a strong tropical cyclone that affected the East Coast *late August of 2011*.

   Storm Events may include:
   - *Tropical Storms,*
   - *Storm Surge Tide*
   - *Heavy Rain*
   - *Hurricane*
   - *Thunderstorm Wind*

Example: Hurricane Irene

Location	County/Zone	St.	Date	Time	T.Z.	Type	Mag	Dth	Inj	PrD	CrD
Totals:								1	0	0.00K	0.00K
BRONX (ZONE)	BRONX (ZONE)	NY	08/28/2011	01:58	EST-5	Tropical Storm		0	0	0.00K	0.00K
BRONX (ZONE)	BRONX (ZONE)	NY	08/28/2011	08:45	EST-5	Storm Surge/tide		1	0	0.00K	0.00K
Totals:								1	0	0.00K	0.00K

4. Fill in the table below with your storm event information.

Location	Date	Storm Type

5. Click on the hyperlink associated with the storm event and read the *Episode Narrative* on the Storm Events Database and write a summary of the event in the space provided. Record all important information including beginning and end date of event, death, injury, and property damage if available.

Storm Event Episode Narrative

6. Using the **begin date** of the storm event as the mid-date, create a 7-9 day time frame.

Example: Hurricane Irene: Begin Date August 28, 2011

Time Frame: 8/25/2011- 8/31/2011

Record Time Frame Range : _____

7. Log into HERCOS website **https://ny.water.usgs.gov/maps/hrecos/**

8. Choose one recording station in the Hudson River that produces data for the storm event researched. (some remote sensors might not have data recorded; You will need to work with the website to find a recording station that was operating)

9. From the drop down menu choose any combination of **_Meteorological Parameters_** that you think would be associated with your storm event.

Examples may include:
   ● Wind Speed (knots)
   ● Temperature
   ● Precipitation

10. From the drop down menu choose any combination of **_Hydrologic Parameters_** that you think would be associated with your storm event. You must click on **_TURBIDITY_** as one of your hydrologic parameters.

Examples may include:

   ● Dissolved Oxygen
   ● Salinity
   ● Water Temperature
   ● Gage Height

11. Click on **Show Graph** to create a graph of the data parameters chosen. (you can make more than one graph as long as you keep the date range, recording station, turbidity the same.

12. Save your graph(s) to your Google Doc's Account. (to be used later for Group Presentation)

13. Record your observations and interpretations of the graphs produced in the table below.

Hydrologic Variables Explored	Meteorological Variables Explored	Noted Observations and Connections with Turbidity

Explain Phase: How does increased turbidity produced by storm events negatively impact the water quality of the Hudson River?

Revisit Questions from Engage: Take a few minutes to discuss with your partner if any changes need to be made to the previous answers to these questions. Write down any new answers/changes that you and your partner have made.

How did we measure the turbidity of the Hudson River?

What is the primary contributor for turbidity in the Hudson River?

How is turbidity related to erosion and runoff?

What is the impact of high turbidity in the Hudson River?

With your partner, you will examine and analyze your graphs and determine if any relationships exist between **turbidity** as caused by storm related erosion and the effect on **hydrologic** (water) variables in the Hudson River by complete the *Claim-Evidence-Reasoning* table below.

How does increased turbidity produced by storm events negatively impact the water quality of the Hudson River?

# C (CLAIM) Write a statement that responds to the question.	
# E (Evidence) Provide scientific data (refer to graphs) to support your claim. Free to use bullet points instead of sentences.	
# R (Reasoning) Use scientific principles and knowledge about why your data supports your claim. (explain how your data proves your point)	

14. Use the information in the **CER** to create a short presentation of your findings to the class. Make sure to print out any graphs that your team created and used to answer the claim question and proves your point.

Elaborate: After watching the Video on Hurricane Sandy; discuss with your partner how we can use our understanding of storm erosion to prevent /reduce damage to coastal areas.
Write down ideas generated in the space provided.   (*opportunity for extended research)

Solutions/Feasibility Table

Group Ideas	Class Ideas

Circle the possible solutions to prevent/reduce damage to coastal areas that you and your partner feel are most feasible to apply in NYC.

Class discussion/Share out. (formative assessment)

Why do you think this idea can be implemented in NYC as a solution to prevent/reduce coastal damage?

Evaluate: Use the rubric when creating your Galley poster and when making revision

Storm Produced Turbidity and the Impact on the Water Quality of the Hudson River

CATEGORY	4	3	2	1
Required Elements	The poster includes all required elements as well as additional information.	All required elements are included on the poster.	All but 1 of the required elements are included on the poster.	Several required elements were missing.
Labels	All items of importance on the poster are clearly labeled with labels that can be read from at least 3 feet away.	Almost all items of importance on the poster are clearly labeled with labels that can be read from at least 3 feet away.	Many items of importance on the poster are clearly labeled with labels that can be read from at least 3 feet away.	Labels are too small to view OR no important items were labeled.
HRECOS Graphs with related explanations	All graphs are explained and show clear relationship/connections with parameters chosen including turbidity	All graphs are explained and show some connections with parameters chosen and connection with turbidity	All graphics relate to the topic do not show clear connections with turbidity and parameters chosen.	Graphs do not relate to the topic.
Attractiveness	The poster is exceptionally attractive in terms of design, layout, and neatness.	The poster is attractive in terms of design, layout, and neatness.	The poster is acceptably attractive though it may be a bit messy.	The poster is distractingly messy or very poorly designed. It is not attractive.
Grammar	There are no grammatical/mechanical mistakes on the poster.	There are 1-2 grammatical/mechanical mistakes on the poster.	There are 3-4 grammatical/mechanical mistakes on the poster.	There are more than 4 grammatical/mechanical mistakes on the poster