Hurricanes and Ocean Organisms

Materials

For the leader:

-Projector

-Copy of graphs

-Copy of maps depicting region of study

For the activity:

-Copy of graphs for each group

-Divide the graphs into 2 groups:

1: Rainfall, Wind-speed,

2: Water Depth, Salinity and, Dissolved oxygen

Overview

Hurricanes are intense low-pressure weather systems that form in tropical waters. Hurricanes are classified into 5 categories by wind speeds, ranging from a Category 1 with wind speeds of 74 mph to a Category 5 with wind speeds above 155 mph. Hurricanes begin as an area of low pressure known as a disturbance, if the circulation becomes more organized the storm is upgraded to a tropical storm and when sustained winds reach 74 mph it is classified as a hurricane. Hurricane season begins on June 1st and continues through November 30th in the Northern Atlantic Ocean.

Hurricanes can cause catastrophic damage to areas in their path. Atlantic hurricanes have strong impacts predominately in the Gulf Coast region and the eastern seaboard. Hurricane Sandy made land fall on October 29th, 2012 near Atlantic City, NJ. At the time of landfall Sandy had a maximum sustained winds of 130km/h (81mph). The storm surge created by Sandy was most dramatic along the New York/New Jersey coasts. The National Hurricane Center lists Sandy as the second costliest hurricane in history with damages totaling $60+ billion.

As Sandy developed scientists collected data on both atmospheric and ocean conditions to monitor the storm's progress. For example scientists measured barometric pressure, which is a measure of force per unit area exerted on the Earth's surface by the weight of air above the surface. Barometric pressure ranges from 980 to 1050 mb (millibars). Areas where the barometric pressure is lower are associated with warm air and increased wind-speeds, this often produces clouds, precipitation, and other strong weather events, like hurricanes. Ocean condition measurements include: salinity, dissolved oxygen, and pH. Salinity is a measure of the dissolved salt content in a body of water. Typical ocean salinity is 30 ppt (parts per thousand), while freshwater has an average salinity of 0-0.5 ppt. Dissolved oxygen is the measure of the amount of gaseous oxygen (O_2) dissolved into an aqueous solution, in this case water (H_2O). Many ocean organisms use dissolved oxygen to breath, thus if dissolved oxygen levels are too low (below 80% saturation) organisms are physiologically stressed due to insufficient oxygen. pH is a measure of how acidic or basic an aqueous solution is, it is measured on a log scale with levels above 7 being basic and levels below 7 being acidic. The average pH of the ocean is close to 8.

Hurricane Sandy not only had an impact on humans, it also had a strong impact on many organisms that live along the eastern seaboard. These organisms were affected by the winds associated with the storm, for example many seabirds relocated from their habitats, as well by the storm surge which brought saltwater into freshwater habitats, thus affecting organisms that live in freshwater. Other organisms may also have been affected due to flooding in different regions.

Motivating Questions: How does the ocean and atmosphere change in a hurricane? How do hurricanes affect ocean organisms?

Take Home Message

Hurricanes cause physical changes in both the atmosphere and the ocean. These changes not only have an impact on humans, but can also affect marine organisms.

Structure

In this activity, students will be exposed to two different data sets that show how physical features of the ocean and atmosphere change during a hurricane. First they will look at how atmospheric conditions change, and discuss how storms have an impact on the students. They will then look at how ocean conditions change as a result of storms. Finally, the students will brainstorm ways that these changes could possibly affect ocean organisms.

Time required:

55-75 minutes

Activity Outline:

Engage: Students explore graphs of wind speed, and rainfall to interpret what is occurring. Lead the class in a discussion on how they were impacted by Hurricane Sandy. What do they remember?	20-30 minutes
Explore: Facilitate a Think, Pair, Share discussion on how non-humans/organisms are impacted/ survive storms. Explore graphs on ocean conditions to determine how these conditions might affect ocean organisms.	20-30 minutes
Make Sense: Lead a class discussion on how ocean conditions could impact marine organisms.	10-15 minutes
Total:	**55-75 minutes**

Audience

Late Elementary/Early Middle School (4-8th grade).

New Jersey Core Curriculum Content Standards - Science

Grade	Content Statement	CPI#
4	Organisms can only survive in environments in which their needs are met. Within ecosystems, organisms interact with and are dependent on their physical and living environment.	5.3.4.C.1
4	Some changes in ecosystems occur slowly, while others occur rapidly. Changes can affect life forms, including humans.	5.3.4.C.2
8	Science involves practicing productive social interactions with peers, such as partner talk, whole-group discussions, and small-group work.	5.1.8.D.1
8	Carefully collected evidence is used to construct and defend arguments.	5.1.8.B.3
6	Weather is the result of short-term variations in temperature, humidity, and air pressure.	5.4.6.F.1

Next Generation Science Standards

Performance Expectation	Science and Engineering Practices	Disciplinary Core Ideas	Cross-cutting Concepts
Earth's Systems, **MS-ESS2-5**	Planning and carrying out investigations	**ESS2.D** – Climate and weather	Cause and effect
Earth's Systems, **5-ESS2-1**	Developing and using models	**ESS2.C** – The roles of water in Earth's surface processes	Scale, proportion, and quantity
Engineering Design, **3-5-ETS1-2**	Constructing explanations and designing solutions	**ETS1.B** – Developing possible solutions	Influence of science, engineering, and technology on society and the natural world.
Earth and Human Activity, **MS-ESS3-2**	Analyzing and interpreting data	**ESS3.B** – Natural hazards	Patterns

Preparation (5 minutes)

1. Write the motivating questions on the board:

   Q. How does the ocean and atmosphere change in a hurricane?

   Q. How do hurricanes affect ocean organisms?

2. Prepare copies of all graphs for each group (attached at the end of this document), separate the graphs into 2 groups:
   a. Group 1: Graphs for the engage section are:
      i. Eastern Seaboard Wind-speeds
      ii. Eastern Seaboard Rainfall
   b. Group 2: Graphs for the explore section are:
      i. Salinities at the JCNERR SWMP Stations
      ii. Dissolved Oxygen at the JCNERR SWMP Stations
3. Prepare maps of New Jersey to be projected on the white board to use during class.
4. Prepare map of the weather station locations to be projected on the white board to use during class.

Engage (20-30 minutes)

1. Explain to the students that they will be looking at graphs of atmospheric conditions, and together they create a story of a weather event that occurred in New Jersey. The graphs illustrate data collected from the Jacques Cousteau National Estuarine Research Reserve (JCNERR) in Tuckerton, NJ. (Note – if your students are not familiar with where Tuckerton, NJ is located it will be helpful to project a map of New Jersey to show them.) The two graphs are:
   a. Eastern Seaboard Wind-speeds: This graph illustrates the recorded wind-speeds, before, during, and after when Hurricane Sandy made landfall in JCNERR.
   b. Eastern Seaboard Cumulative Rainfall: This graph illustrates the recorded cumulative rainfall, before, during, and after when Hurricane Sandy made landfall in JCNERR.
2. Project the graph of wind-speeds on the board for the whole class to see, include a map of New Jersey with JCNERR marked to give the students a reference point.
3. Explain that their goal as a class is to try and determine what these graphs are showing and to try and determine what weather event may have occurred.
4. As a class lead a discussion on this graph, using the following prompt questions as discussion starters. Be sure to answer any other questions students may have regarding this graph.
   a. What is included in this graph?
   b. What conclusions can they draw from the graph?
   c. What does this graph tell us about the weather event?
5. After a few minutes, display the graph of cumulative rainfall on the board for the whole class to see, include a map of New Jersey with JCNERR marked to give the students a reference point.

6. As a class lead a discussion on this graph, using the following prompt questions as discussion starters. Be sure to answer any other questions students may have regarding this graph.
    a. What is included in this graph?
    b. What conclusions did they draw from the graph?
    c. What does this graph tell us about the weather event?
7. Have the students work together in small groups to use the different pieces of data to understand that the relationship among wind-speed, rainfall, and time. They should be able to see that as the weather event (Hurricane Sandy) approached land the wind-speed increased and cumulative rainfall increased in Tuckerton. (Note-it might be helpful to write this on the board as the students are working through how the graphs are connected).
8. As their discussions begin to slow, have the students report what relationship they saw among wind-speed, rainfall, and time. Make sure the students understand the two graphs provide evidence for a storm system known as a hurricane, and that these graphs show data collected from Hurricane Sandy.
9. Have the class spend 5 minutes reflecting on what they remember about Hurricane Sandy. How did it impact them? What do they remember?
10. To assist with the students' reflections, display images of notable New Jersey locations, before and after Hurricane Sandy on the board for the students to see.
11. After students have had time to reflect, allow students to share with the class what they remember about this storm.

Explore (20-30 minutes)

1. Ask the students the following question:

    Q. How are non-human organisms impacted by storms such as hurricanes?

    Q. How are the organisms able to survive?
2. Have the students brainstorm possible answers to this question, on their own for a couple of minutes. After they have had some time to think, have them pair up with another student in the class to discuss the questions. Then allow the students share with the class what they were talking about.
3. Explain to the class that they are going to take a look at a couple more graphs to determine how hurricanes have an impact on the water conditions in an estuary , or bay. Explain that the data displayed in these graphs were collected during Hurricane Sandy from two locations near the JCNERR in Tuckerton, NJ. Buoy 126 is located near the Great Bay opening and the Chestnut Neck station is located further up bay. Project the map of New Jersey with a close up view of Great Bay to give the students a reference point.
4. Explain to the class that the students will be working with a partner to interpret a graph of one variable from one location in the bay (either Buoy 126 or Chestnut Neck). But the groups will be given different graphs to interpret. They discuss their original graph with their partner for 10 minutes; then they will then find a partner group that has the same variable from the other location (for example a group with Water Depths at JCNEER SWMP Station: Buoy 126, will pair with the group who has Water Depths at JCNEER SWMP Station: Chestnut Neck).

5. Break them into partner groups and distribute the graphs to each group (each group should only receive one graph). The graphs to distribute are (the description is for you and not to share with the students):
    a. Water Depths at the JCNERR SWMP Stations: Buoy 126- This graph shows the water depths on top of high tides, before, during, and after Hurricane Sandy for Buoy 126. As Hurricane Sandy made landfall there was a large spike in increased water depths.
    b. Water Depths at the JCNERR SWMP Stations: Chestnut Neck- This graph shows the water depths on top of high tides, before, during, and after Hurricane Sandy for Chestnut Neck. As Hurricane Sandy made landfall there was a large spike in increased water depths.
    c. Dissolved Oxygen at the JCNERR SWMP Stations: Buoy 126- This graph shows the dissolved oxygen levels in percent saturation at Buoy 126 before, during, and after Hurricane Sandy. After Hurricane Sandy made landfall dissolved oxygen levels decreased at the Chestnut Neck region, and remained relatively constant at Buoy 126.
    d. Dissolved Oxygen at the JCNERR SWMP Stations: Chestnut Neck- This graphs shows the dissolved oxygen in percent saturation at Chestnut Neck before, during and after Hurricane Sandy, shortly after the storm made landfall dissolved oxygen levels decreased at the Chestnut Neck region.
    e. Salinity at the JCNERR SWMP Station: Buoy 126- This graph shows salinity levels at buoy 126 before, during, and after Hurricane Sandy. After the storm made landfall there was a slight decrease in salinity levels at this station, but overall it remained relatively constant.
    f. Salinity at the JCNERR SWMP Station: Chestnut Neck- This graph shows salinity levels at Chestnut Neck before, during, and after Hurricane Sandy. After the storm made landfall there was a large decrease in salinity levels at this station.
6. As the groups are working to interpret their graphs, walk around to each group to answer any questions they may.
7. After 10 minutes have each group find another partner group with the same variable (water depths, dissolved oxygen, salinity), for example a group with a graph of Water Depths at JCNEER SWMP Station: Buoy 126, will pair with the group who has a graph of Water Depths at JCNEER SWMP Station: Chestnut Neck.
8. The students should work in their new groups to interpret both of the graphs, to determine how the storm affected different parts of the bay. Have the students think about how their two graphs are similar, different, and overall what conclusions can they draw about their variable in the bay due to Hurricane Sandy.
9. After ten minutes have passed (or the students being to wrap-up their work), have each group share with the class what they were interpreting and their responses to the following prompting questions:
    a. What is included in the graphs?
    b. What conclusions did they draw from the graphs?
    c. Were there any differences between data collected at Buoy 126 and Chestnut Neck for their water condition variable?
    d. How do you think these changes in ocean conditions would impact bay organisms?

10. Have the students work together to use all of the graphs and the reports from each group to understand that: as hurricane Sandy approached water depths increased, salinity levels decreased, and dissolved oxygen levels decreased. They should also understand that these effects were felt more strongly the more inland than they were in the open bay.

Make Sense (10-20 minutes)

1. Lead a class discussion on how these changes to the water conditions in the bay/estuary environment could have an impact on the marine organisms. Some questions to lead the discussion could include:
    a. How could increased water depth affect marine organisms?
    b. How could a change in salinity affect marine organisms?
    c. How could decreased dissolved oxygen levels affect organisms?
    d. How could all of these changes together impact marine organisms?
    e. What are some ways that marine organisms can protect themselves from these changes in the environment during storms such as hurricanes?
2. Have the students reflect on all of the graphs that they have looked at during the class period.
3. After the students have had some time to reflect on the day, have the students take a couple of minutes to discuss in their groups the motivation behind today's lesson.

    Q. How does the ocean and atmosphere change in a hurricane?

    Q. How do hurricanes affect ocean organisms?

4. Have each group briefly share with the class their opinions on how these changes to the environment could affect ocean organisms.
5. Finally, ask if the students have any final questions about what they learned today.