LESSON 1 Watersheds and Water Flow in Neighborhoods	Teacher's Guide

PROBLEM

How does flooding occur?

Suggested answers from the following website:
https://www.nationalgeographic.com/environment/natural-disasters/floods/

A flood occurs when water inundates land that's normally dry, which can happen in a multitude of ways.

Excessive rain, a ruptured dam or levee, rapid melting of snow or ice, or even an unfortunately placed beaver dam can overwhelm a river, spreading over the adjacent land, called a floodplain. Coastal flooding occurs when a large storm or tsunami causes the sea to surge inland.

Visit the following website to explore further
https://www.nationalgeographic.com/environment/natural-disasters/floods/

How might floods impact specific neighborhoods differently?

Let's explore the following map
https://pns.maps.arcgis.com/apps/View/index.html?appid=32d34feded3a4447a89aef932e5064be

1. Zoom into a view of the two schools designated by the flag star symbol.

2. Click on each school to explore and move through the tabs to learn information about the school, likelihood of the census block (neighborhood) for flooding, and the median income of the census block within which the school is located

3. Now look up the address of the school located in the first tab on google maps and try to identify the locations of all the residences and businesses that might be affected should the census block of your school flood (refer back to the income

census block on the ArcGIS map to make sure the areas on google maps you are examining are within the census block of the school)

4. Next, pick a neighborhood adjacent to the school (refer back to the income census block on the ArcGIS map to make sure the street you have selected is within the census block of the school) and explore a few streets in this neighborhood using google street view. Look out for neighborhood features such as on-street drainage, the level of greenspace compared to built up space, the style and construction material of the houses etc. You are looking out for features that might make this neighborhood either more or less flooded should there be an extreme weather event involving a lot of water.

5. Finally discuss the differences between the two neighborhoods based on the findings of steps 3 and 4

FACTS & QUESTIONS (Synthesize content; generate ideas and explanations)

How would you briefly describe the watershed for the region?

Refer to the following links for help with the above question:
https://rb.gy/yrspsn

https://rb.gy/51cwyz

The following information is culled from the above source:

The Pensacola Bay System *includes five interconnected estuaries: Escambia Bay, Pensacola Bay, Blackwater Bay, East Bay, and Santa Rosa Sound. The watershed also includes three major river systems: the Escambia, Blackwater, and Yellow rivers. The system also includes numerous tributaries of these estuaries and rivers including the Shoal River and Titi Creek tributaries of the Yellow River. The watershed covers nearly 7,000 square miles, about one-third of which are in Florida. The watershed includes the majority of Escambia, Santa Rosa and Okaloosa counties, northwestern Walton County, and a substantial area of southern Alabama. The entire system discharges into the Gulf of Mexico, primarily through a narrow pass at the mouth of Pensacola Bay.*

The Escambia River is a major alluvial river, which extends 240 miles northward from Escambia Bay to Bullock County, Alabama, as the Conecuh River. Its drainage area covers over 4,200 square miles, about 90 percent of which are within Alabama's borders. The Yellow River extends 110 miles from the eastern shore of Blackwater Bay to a point northeast of Andalusia, Alabama. Its drainage basin covers 1,365 square miles, with 64 percent within northwest Florida. The Blackwater River drains approximately 860 square miles, of which 81 percent are in Florida's Santa Rosa and Okaloosa counties. The river originates north of Bradley, Alabama, flows about 60 miles, and discharges into Blackwater Bay. The estuarine component of the system covers approximately 144 square miles and extends approximately 20 miles inland from the Gulf of Mexico.

The Pensacola Bay system supports an array of biological communities and species characteristic of a Gulf Coastal Plain riverine and estuarine system. Estuarine habitats include benthic microalgae communities, seagrass beds, oyster beds, salt marshes, planktonic and pelagic communities, and unvegetated soft bottoms. Freshwater habitats include alluvial and Blackwater rivers, bottomland hardwood forests, tupelo-cypress swamps, seepage swamps, and tidal fresh marshes. Primary land uses include an increasing urbanized area, silviculture, and state-owned forest lands

LEARNING ISSUES (listing information needed to solve the problem)

What are the current flood conditions in this watershed?

Refer to the following link for help with the above question: https://cutt.ly/uo0jvm

(Specifically examine data for rivers, streams, and creeks in the three counties in western most corner of Northwest Florida)

Have students refer back to the Pensacola Bay system watershed map (downloadable from this link https://rb.gy/yrspsn) to review the rivers, streams, and/or creeks they should be looking out for. Also point out the difference between waters that have experienced flooding and waters that have not.

What have the historic flood conditions in this watershed been like?

Explore the following links for help with the above question:

Hurricane Nate 2017: https://cutt.ly/ro0kfC

Hurricane Nate did not flood inland of the watershed but the coastal gauges (see map-you may have to align the map on the Pensacola Bay and zoom in) saw peak floods.

Have the students identify the peak stages of these coastal gauges and refer back to the inland gauges in the current flood conditions map (https://cutt.ly/uo0jvm) noting the difference between a high peak for an inland river gauge and high peak for a coastal gauge.

April 2014 floods: https://cutt.ly/Uo0kBZ

Refer back to Anchor video

If you really want to get into detail about the history of flooding in Escambia County with the students, you may share the following facts with the culled from the Escambia County Comprehensive Emergency Management Strategy (2015) pp. 11-12 available at this link https://cutt.ly/zoBh0g

History of Flooding in Escambia County

September 1998: Hurricane George dropped up to 24" of rain in the inland portions of the county causing severe damages and impacts from the resulting flooding, leaving hundreds of people isolated and stranded in and from their homes.

2002: Tropical Storm Isadore. Though it was only a tropical storm, the impacts and affects of the surge were greater than that of a typical tropical storm. Storm surge and wave action from this incident rose high enough to impact all the bayous and many homes along those waterways. Several homes became isolated. Ft. Pickens Road was closed and damages, while the dunes on Pensacola Beach significantly eroded.

June/July 2003: Tropical Storm (T.S.) Bill began what eventually became a wet month of rain with many "close calls" at it related to damaging flood impacts. T.S. Bill began with 8" of rain that was consistent throughout the county. However, with drainage systems full and standing water everywhere from Bill, severe weather continued throughout the month bringing heavy rain and in several instances, rain falling at the rate of 3+" an hour. With the drainage system, culverts, and holding pods at capacity, each day of heavy rain brought rising water into people's yards, with water threatening to flood homes. Little damage was incurred, but response operations dealing with rising water was a constant activity for the county road department. Fortunately, impacts were minimal in the city and the town, merely because of where the most significant rainfall occurred.

September 11, 2004: Hurricane Ivan brought significant storm surge and wave action with some areas seeing upwards of 15' of storm surge with wave action adding to that

height. Ivan impacted many areas of the county, but a few neighborhoods took a major impact and received significant damage. Grand Lagoon and Navy Point neighborhoods were a couple of the highlights where home slabs were the only identifiable marks left on private and commercial property. Within the City of Pensacola, many business and industrial districts were destroyed to include City Hall being shut down for almost two years. Inland areas of the county, to include the Town of Century escaped flooding issues, but did have to manage wind damage from the storm.

August 31, 2008: Hurricane Gustav also brushed by Escambia County on its way to Louisiana with little impact from rain and wind, but once again, storm surge in the range of 3'-5' impacted the coastal beaches, causing a few condominiums to be flooded on Pensacola Beach with additional beach erosion impacts estimated at $11.75 million.

September 11, 2008: Hurricane Ike, a Category 2 storm at landfall, brushed by Escambia County with less impact than Gustav, producing little to no rainfall and minimal gusty winds, but still produced approximately 3-5' of storm surge, causing similar flood impacts as Gustav and an additional $9.375 million in beach erosion damages.

June 9, 2012: A low pressure system stalled over the area and produced 15"-27" of rain over a three day period, with a significant portion coming over a 24-hour period. One report identified West Pensacola receiving 21.7" of rain in a 24 hour period. As it relates to residential property, there were 78 with major damage, 150 with minor damage, and an additional 55 that were impacted. Total public infrastructure damage was estimated at just over $23 million.

April 28-30, 2014: This flash flood/rain event was a record for the Pensacola/Escambia County area. On the 29th, Pensacola International Airport received 15.55" of rain on that calendar day, which is the greatest calendar day of rain since 1871. In one particular hour, 5.68" of rain fell. The two day total was 20.47" of rain. Applying the 1 hour total, this event could be considered a 200-500 yr event. This caused significant flooding, mostly outside of the designated 100 yr designated areas of the county causing significant road damage and washouts, significant structure damage and washout, and other significant infrastructure damage and washout, all within a significantly short period of time.

If climate change is a driver of both historic and current flood conditions, what does the historic and current precipitation data for Escambia County (the county within which the watershed is located) look like?

Refer to the following link for help with the above question https://crt-climate-explorer.nemac.org/ (Search for Escambia County, FL and explore precipitation data)

Have students click on the question mark (?) for each item listed under precipitation for more information about that data item and what the item tells us about flood risk

PURSUIT (Researching to acquire new information about the problem)

What was the impact of the 2014 flood like in the neighborhoods of the two schools?

Refer to the following map for help with the above question https://cutt.ly/1oDmca

(NB: that the map data might take a few minutes to populate)

What might future flood risk in the watershed look like under a scenario of rising sea levels?

Refer to the following link for help with the above question https://cutt.ly/IoDUg1
(type in Pensacola, FL as the location and begin exploring)

Explore the extent of projected sea-level rise for the coastal portion of the watershed in general, then zoom into the neighborhoods in the school to see if sea-level rise could possibly affect any of those neighborhoods within the projection scenario? **Why or why not?**

Point out to students that the school neighborhoods are too far inland to be flooded by rising sea-levels. However note the creeks flowing near those neighborhoods that could easily become flooded during a heavy rain event such as the 2014 rain event.

INTEGRATION & SHARING (Applying and sharing learned information with classmates)

Share with your classmates what you have learned about the watershed in general and the neighborhoods in particular

(*if you divided students into teams, have the teams report back their findings to the entire class for comparison*).

<u>OPTIONAL ACTIVITY</u> <u>(supplemental activity to further elaborate on content)</u>

Watershed modeling activity (Modified from Groundwork Hudson Valley 2018. Distance Learning Module for “Global, Local, Coastal: Preparing the Next Generation for a Changing Climate” pp 84-85)

Materials:

- Two plastic bins with holes drilled into the bottom to let water out, two more bins to let water drip into, wooden blocks or wide jars to hold up the models
- For marsh environment: collect sand, rocks, dried grasses, seashells, etc. and pile up into bin
- For built environment: collect larger rocks, Lego or other houses, toy cars, etc.

Either set up built environment/wetland environment models beforehand, or have students create their own as an extension activity.

Ask students which they think will absorb more water, and if/how that would help their local environment.

Have students pour water through their models and evaluate the results

Tie the findings back to the anchor video and the levels of natural and built infrastructure in the two neighborhoods