Know Your Flood Protection System

# Keepin' Your Head Above Water

## Middle School Science Curriculum

Published by the Flood Protection Authority – East
floodauthority.org

# PREFACE

## Purpose and Mission

Our mission is to ensure the physical and operational integrity of the regional flood risk management system in southeastern Louisiana as a defense against floods and storm surge from hurricanes.
We accomplish this mission by working with local, regional, state, and federal partners to plan, design, construct, operate and maintain projects that will reduce the probability and risk of flooding for the residents and businesses within our jurisdiction.

## Middle School Science Curriculum

This Middle School Science Curriculum is part of the Flood Protection Authority – East's education program to enhance understanding of its mission. The purposes of the school program are to ensure that future generations are equipped to deal with the risks and challenges associated with living with water, gain an in-depth knowledge of the flood protection system, and share their learning experiences with family and friends.

The curriculum was developed and taught by Anne Rheams, Flood Protection Authority – East's Education Consultant, Gena Asevado, St. Bernard Parish Public Schools' Science Director, and Alisha Capstick, 8th grade Science Teacher at Trist Middle School in Meraux. La. The program was encouraged and supported by Joe Hassinger, Board President of the Flood Protection Authority – East and Doris Voitier, St. Bernard Parish Public Schools Superintendent.

The curriculum was developed in accordance with the National Next Generation Science Standards and the Louisiana Department of Education's Performance Expectations. The lessons and activities are based on the 5 Es Learning and Instruction Model (Engage, Explore, Explain, Elaborate, Evaluate). Major topics covered in the program are: Geographical Orientation (where do the students live in relation to the water surrounding them); Storm Surge (what is the science behind it); the Hurricane and Storm Damage Risk Reduction System (where and what is it); the Lake Borgne Surge Barrier (field trip and model building); Risk and Preparedness (what is it and how can they protect themselves and educate others). Included in this curriculum are a number of classroom activities under each topic resulting in a comprehensive understanding of flood protection and risk reduction.

Special thanks go to the Flood Protection Authority – East's staff including, Derek Boese, Chief Administrative Officer, Bob Turner for the connection to St. Bernard Parish Schools, and Stevan Spencer, Elbert Williams and Audrianna Bluthgen for great and informative field trips to the Lake Borgne Surge Barrier.

# Keepin' Your Head Above Water


## Lesson 1
## Geographical Orientation

## GEOGRAPHICAL ORIENTATION

Where Do I Live and Where is the Water?

**LESSON PLAN #1** of 3 **DURATION:** 2 days

## BRIEF LESSON DESCRIPTION

Through this lesson, students will learn how to analyze and interpret various maps and data contained on those maps. These maps will orient the students to the geographic area they will be studying and the waterbodies that can impact this area during flood events.

## RESOURCES

Types of Maps Video: https://safeshare.tv/x/fupNPrRg2uA
Google Maps: https://www.google.com/maps/@29.956708,-90.0046633,15z
BASE Map Handout 1D

## PERFORMANCE EXPECTATIONS

### 8-MS-ESS3-2

Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.

### CLARIFICATION STATEMENT

Emphasis is on how some natural hazards, such as volcanic eruptions and severe weather, are preceded by phenomena that allow for reliable predictions, but others, such as earthquakes, occur suddenly and with no notice, and thus are not yet predictable.

- Examples of natural hazards can be taken from interior processes (such as earthquakes and volcanic eruptions), surface processes (such as mass wasting and tsunamis), or severe weather events (such as hurricanes, tornadoes, and floods).
- Examples of data can include the locations, magnitudes, and frequencies of the natural hazards.
- Examples of technologies can be global (such as satellite systems to monitor hurricanes or forest fires) or local (such as building basements in tornado-prone regions or reservoirs to mitigate droughts).

### SCIENCE AND ENGINEERING PRACTICES

1. Asking questions (for science) and defining problems (for engineering).
2. Developing and using models.
3. Planning and carrying out investigations.
4. Analyzing and interpreting data: Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.
   - Analyze and interpret data to provide evidence for phenomena.
5. Using mathematics and computational thinking.
6. Constructing explanations and designing solutions.
7. Engaging in argument from evidence.
8. Obtaining, evaluating, and communicating information.

### 8-MS-ESS3-3

Apply scientific principles to design a method for monitoring and minimizing human impact on the environment.

### CLARIFICATION STATEMENT

Examples of the design process may include examining human environmental impacts, assessing the kinds of solutions that are feasible, and designing and evaluating solutions that could reduce that impact.

Examples of human impacts may include water usage (such as the withdrawal of water from streams and aquifers or the construction of dams and levees), land usage (such as urban development, agriculture, or the removal of wetlands), and pollution (such as of the air, water, or land).

### SCIENCE AND ENGINEERING PRACTICES

1. Asking questions (for science) and defining problems (for engineering).
2. Developing and using models.
3. Planning and carrying out investigations.
4. Analyzing and interpreting data.
5. Using mathematics and computational thinking.
6. Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.
   - Apply scientific ideas or principles to design, construct, and/or test a design of an object, tool, process or system.
7. Engaging in argument from evidence.
8. Obtaining, evaluating, and communicating information.

## DISCIPLINARY CORE IDEAS

### Natural Hazards

Mapping the history of natural hazards in a region, combined with an understanding of related geologic forces can help forecast the locations and likelihoods of future events. (MS.ESS3B.a)

## DISCIPLINARY CORE IDEAS

### Human Impacts on Earth's Systems

Human activities, globally and locally, have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things. (MS.ESS3C.a)

Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise. (MS.ESS3C.b)

### Developing Possible Solutions

A solution needs to be tested to prove the validity of the design and then modified on the basis of the test results in order to improve it.

There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. Models of all kinds are important for testing.

## CROSSCUTTING CONCEPTS

### Patterns

Graphs, charts, and images can be used to identify patterns in data.

## CROSSCUTTING CONCEPTS

### Cause and Effect

Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation.

## SPECIFIC LEARNING OUTCOMES

Students will be able to analyze and interpret data from maps regarding the effects of natural hazards (flooding, storm surge) on local communities. Through the use of maps, students will discuss the topographical region in which they live including how water in the area affects the way they live.

## BACKGROUND INFORMATION

Google Maps Site https://www.google.com/maps/

This site allows students to type in their home address/school address to learn about their neighborhoods such as the location of bodies of water near them, infrastructure of the parish, and green area locations. Students will have the opportunity to use both the map and satellite images.

BASE Map Handout

This map includes well-known regional features that will help orient the students to the location of the study area of St. Bernard Parish.

## PRIOR STUDENT KNOWLEDGE

Students should have some background knowledge of the topography of their area especially the fact that it is below sea-level and relatively flat. For this reason, when we have major rain events we often have street flooding. Also, when the east winds blow over the lower end of the parish, water is pushed into the neighborhoods in that area to cause flooding. In addition, hurricanes can cause flooding by moving water from Lake Borgne into the parish.

## POSSIBLE PRECONCEPTIONS/MISCONCEPTIONS

1. Students think that maps are too complicated to understand.
2. Students don't think they live close to major waterbodies that can cause flooding.
3. Students at this level have not seen satellite maps where they are responsible for identifying landmarks for their own area.

# 5Es TEACHING & LEARNING MODEL

## DAY 1

### ENGAGE: Maps

1. Students will view the short video on types of maps found at https://safeshare.tv/x/fupNPrRg2uA
2. Class discussion to follow on the different types of maps with special attention paid to the physical maps since those are the types of maps that this lesson will revolve around.

**Teacher Prep For Engage Activity 1:** Chromebooks will be required for this activity along with the Promethean for teacher to follow along with students as they complete these activities.

**Google Map Activity**—Students will view their home and school addresses to identify various structures and the location of water in the area.

### EXPLORE — Part 1: Google Map Activity

1. On their Chromebooks, students will logon to https://www.google.com/maps/
2. Students will use their home address and then their school address to answer questions about the items on the map that are found in their neighborhood or around their school. At the end of the activity the students will switch to the satellite view to answer a set of questions regarding the new view.
3. Students will need the Google Map Handout 1B.

### EXPLAIN — Google Map Activity

1. After the completion of the Google Map Activity, teacher will have students come back together for a whole class discussion on their answers for this activity.

## DAY 1-2

### EXPLORE — Part 2: BASE Map Activity

1. Students will need Handouts labeled 1C, and 1D.
2. Students will answer the questions on the Handout 1C using the map on Handout 1D.
3. This map is the BASE Map of the New Orleans Metropolitan Area and provides students with another view of the area in which they live. Several landmarks are labeled for students to identify. They may not get all of the answers correct but this map gives students a differing view of areas they have already viewed via other maps.
4. After students have attempted to label all the areas designated on the map, have them come back together for a whole class discussion on their answers.
5. The teacher will review the different areas with them during the next step so just allow them to tell you what they think each landmark represents.

### EXPLAIN — BASE Map Activity

The teacher will now review the correct identities of the landmarks on the base map.

**Causeway over Lake Pontchartrain**—spans 24 miles and is the longest bridge over water in the world. The bridge's parallel spans are made of prestressed panels supported by over 9,000 concrete pilings. The first span opened to the public in 1956, the second in 1969. The result was one-way driving safety on straight, two-lane railed surfaces 80 feet apart connected by seven crossovers that function as pullover areas for auto emergencies.

## DAY 1-2 continued

**Twin Span Bridge over Lake Pontchartrain** — is probably one of the most well-known bridges in Louisiana. It covers about 6 miles and it consists of two bridges, each running parallel to one another. The bridge runs across the east end of Lake Pontchartrain.

**Lake Pontchartrain** —is not a true lake but the largest water feature of the entire Pontchartrain estuary. An estuary is a semi-enclosed body of water that has a free connection to the salty sea and is mixed with fresh water from rivers. It was named for the Count de Pontchartrain who served as minister of finance during the reign of France's "Sun King," Louis XIV for whom Louisiana is named.

**Lake Borgne** — is a lagoon of the Gulf of Mexico in southeastern Louisiana and considered an arm of the Gulf of Mexico. Its name comes from the French word borgne, which means "one-eyed."

A lagoon is a shallow body of water separated from a larger body of water by barrier islands or reefs.

**Mississippi River** — the longest river of North America, draining with its major tributaries an area of approximately 1.2 million square miles (3.1 million square km), or about one-eighth of the entire continent. The Mississippi River lies entirely within the United States. Rising in Lake Itasca in Minnesota, it flows almost due south across the continental interior, collecting the waters of its major tributaries, the Missouri River (to the west) and the Ohio River (to the east), approximately halfway along its journey to the Gulf of Mexico through a vast delta southeast of New Orleans, a total distance of 2,340 miles (3,766 km) from its source. With its tributaries, the Mississippi drains all or part of 31 U.S. states and two provinces in Canada.

**Flood Wall** — This concrete barrier is designed to reduce the risk of flooding from storm surge coming from the Gulf of Mexico and Lake Borgne into some of the region's most vulnerable areas including New Orleans East, metro New Orleans, the 9th Ward, and St. Bernard Parish.

**Marsh/Wetlands of St. Bernard** —Often found alongside waterways and in floodplains, wetlands vary widely due to differences in soil, topography, climate, water chemistry, and vegetation. Large wetland areas may also be comprised of several smaller wetland types.

Wetland habitats serve essential functions in an ecosystem, including acting as water filters, providing flood and erosion control, and furnishing food and homes for fish and wildlife. They do more than sustain plants and animals in the watershed, however. Many wetlands are not wet year-round because water levels change with the seasons. During periods of excessive rain, wetlands absorb and slow floodwaters, which helps to alleviate property damage and may even save lives.

Wetlands also absorb excess nutrients, sediments, and other pollutants before they reach rivers, lakes, and other waterbodies.

**St. Bernard Parish** —has a total area of 2,158 square miles (5,590 km2), of which 378 square miles (980 km2) is land and 1,781 square miles (4,610 km2) (83%) is water. It is the second largest parish in Louisiana by total area and has the largest percentage of area in water of any parish.

The parish of St. Bernard embraces numerous small islands. The parish is classed among the alluvial lands of the state. The ridges comprise the arable lands of the parish and have an area of 37,000 acres (150 km$^2$). The principal streams are the Bayous Dupre, Bienvenue, Terre aux Boeufs and La Loutre. There are numerous smaller streams which are efficient drainage canals. The dominant tree species is bald cypress, of which the most valuable trees have been cut and processed.

## ELABORATE

1. The teacher will use the Promethean to display the Google and Base Maps so all students can see the answers to the worksheet questions. The teacher records the students' answers by drawing or writing descriptions on the blown-up map.
2. Ask: What do the students think about the geographic area in which they live and go to school?
3. Think of all the water around us. (Teacher should make a list on chart paper of the areas of water that are around us.)
4. Does that water ever cause us problems? (Let them look at the list of bodies of water from question 1 and think of ways that the water can be both beneficial and harmful to those who live in the area; list these on the chart paper.)
5. What manmade features on the maps may be affected by flooding from the waterbodies on the map and what is the distance between these features and the water source?

## EVALUATE: Essay

1. Exit Ticket—Handout 1E
2. Homework: Students will write a one-page essay that summarizes and personalizes (includes their actual community) their answers of the geographic area in which they live and go to school.

## HANDOUT 1B — GOOGLE MAP ACTIVITY

**1.** Go to the following link: https://www.google.com/maps/

**2.** In the search area, type in your school or home address. See Figure 1.

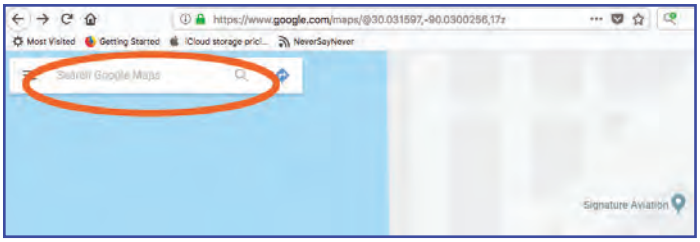



Figure 1

**3.** On the left side of the screen, a picture of your school or house street, and maybe your school or house will appear. Click on the arrow button to close this picture. See Figure 2.

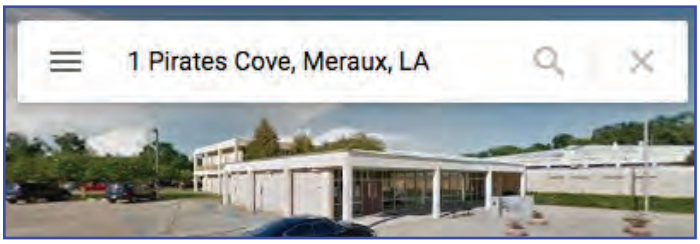



Figure 2

This will allow you to see a map of the neighborhood. See Figure 3.


Figure 3

**4.** On your worksheet, look at question #1, identify the symbols that you see on the piece of map.

**5.** Go back to Google Map. Press the "–" button on the lower right side of your screen, three times. See figure 4.

Figure 4

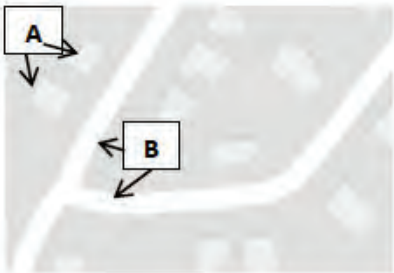
This will zoom out from your address. Now go back to your worksheet and answer question #2.

**6.** Now press on the "–" button three more times. Look at the map on your computer screen now. Answer question 3 on your worksheet.

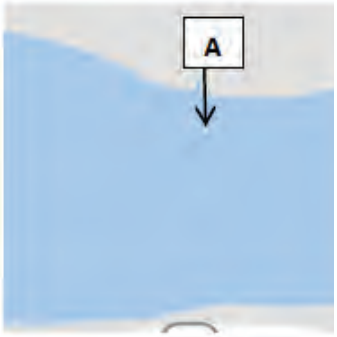
**7.** Now go back to your map and click on the Satellite box on the bottom of the screen on the left. Answer questions 4 & 5 on your worksheet.

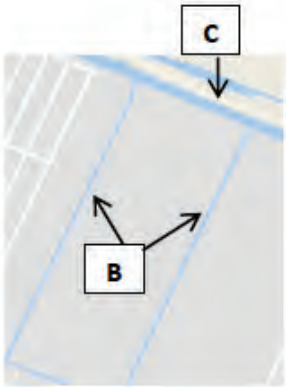
## HANDOUT 1B (cont'd.) — GOOGLE MAP ACTIVITY WORKSHEET

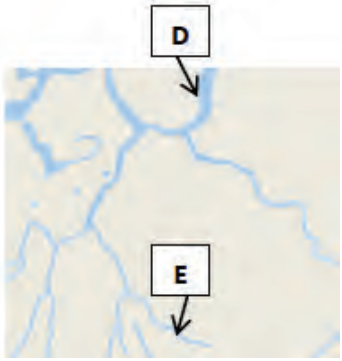
Name: _____ Date: _____




**1.** Identify each item that has a letter next to it.




**2.** Identify each item that has a letter next to it.

**A.** _____

**B.** _____

**C.** _____

**D.** _____

**E.** _____

For question #2, what do all of the items with a letter next to them have in common?

_____

**3.** What do you see now? Has the common item from question #2 increased or decreased? How do you know?

_____

**4.** How did the image on the screen change?

_____

Where is this image coming from?

_____

Why did the colors change? Describe what the different colors represent.

_____

**5.** Which image gives you more detailed information? Why?

_____

## HANDOUT 1C — BASE MAP ACTIVITY

Name: _____ Date: _____

**Look at the BASE Map that your teacher has given you.**
We will revisit this map throughout this unit.

- What area is being shown on the map?
- There are white markers on several locations on the map. Predict what each marker represents. Write your predictions in the spaces provided below. Use the HINTS provided.

**A.** What is this structure?

_____

_____

_____

_____

**B.** What is this structure?

_____

_____

_____

**C.** What is this body of water?

_____

_____

**D.** What is this body of water?

_____

_____

_____

**E.** What is this body of water?

_____

_____

_____

**F.** What is this structure?

_____

_____

_____

**G.** What is this land area called?

_____

_____

**H.** In the red circle, what is the name of this parish?

_____

_____

**1.** When would a map of this type be useful? Why?

_____

_____

_____

**2.** When you look at this BASE map, what stands out to you the most?

_____

_____

_____

_____

_____

**3.** From the class discussion about this map, what have you learned about the purpose of this map?

_____

_____

_____

_____

_____

_____

## HANDOUT 1D — BASE MAP

# Keepin' Your Head Above Water: *Know Your Flood Protection System*

## HANDOUT 1E — EXIT TICKET

Name: _____ Date: _____

1. Why are BASE Maps useful?

2. What types of information were you able to gather from the BASE Map activity today?


# Keepin' Your Head Above Water: *Know Your Flood Protection System*

## HANDOUT 1E — EXIT TICKET

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# Keepin' Your Head Above Water: *Know Your Flood Protection System*

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# Keepin' Your Head Above Water

## Lesson 2
## Storm Surge

# STORM SURGE AND HURRICANE & STORM DAMAGE RISK REDUCTION SYSTEM (HSDRRS)

What is storm surge?
How do we protect against storm surge and flooding?

**LESSON PLAN #2** of 3 **DURATION:** 6 days

## BRIEF LESSON DESCRIPTION

Through this lesson students will learn about the science of storm surge, what protection surrounds them and how to design and build a flood protection structure to defend against storm surge.

## RESOURCES

Fieldtrip
Storm Surge Barrier Model material list and design plan
Handout 2E: Blank BASE Map and Handout 1D from Lesson 1
Flood Protection Authority website: https://www.floodauthority.org

## PERFORMANCE EXPECTATIONS

### 8-MS-ESS3-2

Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.

### CLARIFICATION STATEMENT

Emphasis is on how some natural hazards, such as volcanic eruptions and severe weather, are preceded by phenomena that allow for reliable predictions, but others, such as earthquakes, occur suddenly and with no notice, and thus are not yet predictable.

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### 8-MS-ESS3-3

Apply scientific principles to design a method for monitoring and minimizing human impact on the environment.

### CLARIFICATION STATEMENT

Examples of the design process may include examining human environmental impacts, assessing the kinds of solutions that are feasible, and designing and evaluating solutions that could reduce that impact.

Examples of human impacts may include water usage (such as the withdrawal of water from streams and aquifers or the construction of dams and levees), land usage (such as urban development, agriculture, or the removal of wetlands), and pollution (such as of the air, water, or land).

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## DISCIPLINARY CORE IDEAS

### Natural Hazards

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## DISCIPLINARY CORE IDEAS

### Human Impacts on Earth's Systems

Human activities, globally and locally, have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things. (MS.ESS3C.a)

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### Developing Possible Solutions

A solution needs to be tested to prove the validity of the design and then modified on the basis of the test results in order to improve it.

There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. Models of all kinds are important for testing solutions. (ETS.MS.1B.a).

## CROSSCUTTING CONCEPTS

### Patterns

Graphs, charts, and images can be used to identify patterns in data.

## CROSSCUTTING CONCEPTS

### Cause and Effect

Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation.

## SPECIFIC LEARNING OUTCOMES

Students will understand the science of storm surge, the infrastructure that protects them, and engineering principles of a surge barrier design. Student will use provided construction materials to build a storm surge model.

## BACKGROUND INFORMATION

### Storm Surge

Tropical cyclones are low-pressure rotating weather systems that are created in the atmosphere by the transfer of heat from the ocean basins to the atmosphere. These low latitude systems (23.5 N and S of the equator) spin clockwise in the Southern hemisphere and counterclockwise in the Northern hemisphere and are referred to by different names depending on the ocean basin.

In the Atlantic Ocean, they are known as tropical storms and hurricanes when the wind speed exceeds 119 km/hr, whereas in the western Pacific Ocean, they are referred to as tropical cyclones and typhoons, respectively. In both cases, tropical cyclones have the capability to generate very large, high waves that have the potential to devastate the natural environments of a coastal zone as well as any human infrastructure that is present where the storms make landfall.

Another critically important component to understand about tropical cyclones are the storm surges, or elevated levels of sea level, that occur as these low pressure systems move through an ocean basin. Very large storm surges can be created depending upon the morphology of the coast, the gradient and width of the neighboring continental shelf, the strength of the storm, and the rate of forward motion of the storm.

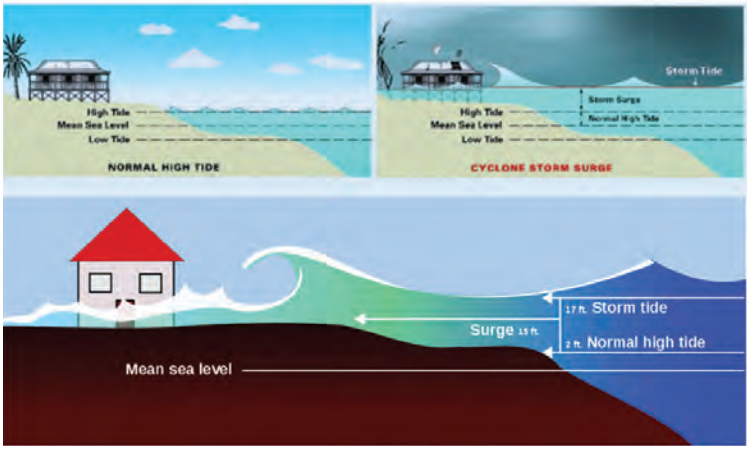
For example, a storm surge in excess of 7m was created along parts of the northern Gulf of Mexico shore by Hurricane Katrina in 2005 and resulted in inland flooding several kilometers from the non-storm-surge shoreline.

## What is Storm Surge?

**Simple, generalized online dictionary definition:** "...a rising of the sea as a result of atmospheric pressure changes and wind associated with a storm."

**National Hurricane Center/ NOAA definition:** an abnormal rise of water generated by a storm, over and above the predicted astronomical tide. This is differentiated from storm tide: Storm tide is the water level rise during a storm due to the combination of storm surge and the astronomical tide.

Figure 1




## NHC Storm Surge Unit important points

**How does a storm surge form? Wind vs. Pressure**

**Factors and variables that determine a storm surge:**

- Wind speeds of the storm are the most important factor for formation and development of a storm surge.
- Central pressure of the storm the low pressure of a tropical cyclone contributes to the elevation on the surface of the ocean but its influence is minor compared to the winds.
- Storm intensity.
- Forward speed of storm.
- Width and slope of ocean bottom (continental shelf).

Figure 2A

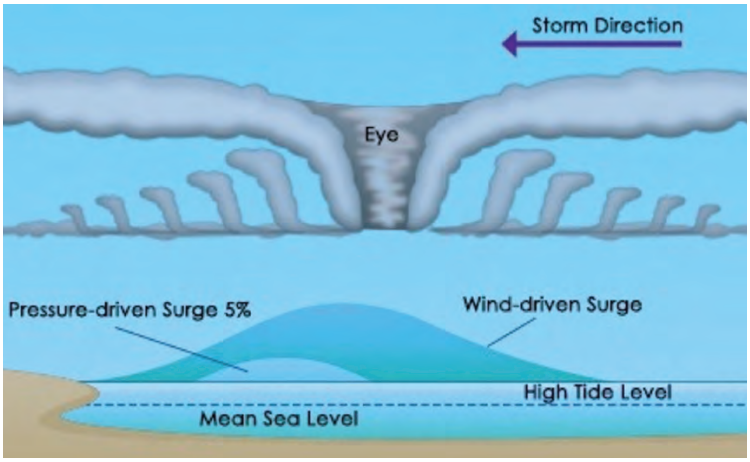



Figure 2B

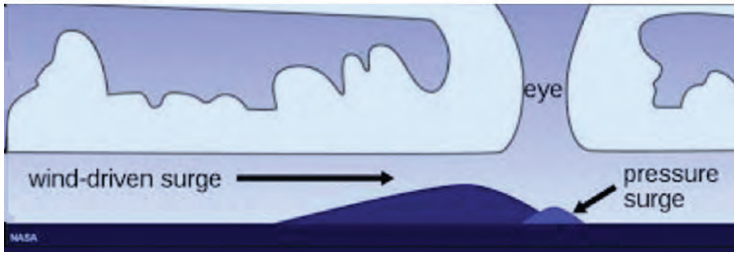
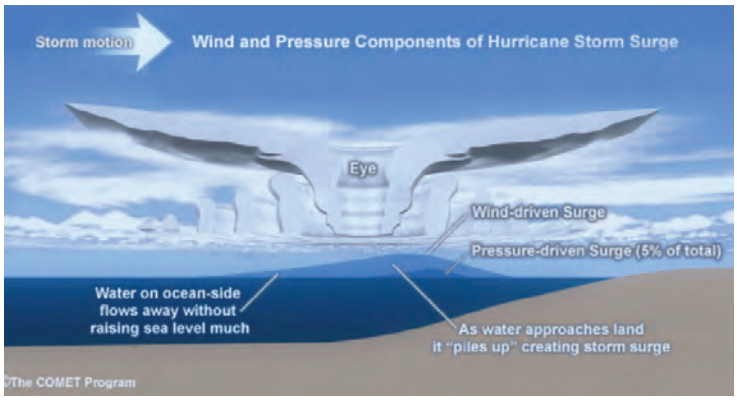



Figure 3




## Important resource — National Hurricane Center/NOAA Storm Surge Unit:

http://www.nhc.noaa.gov/surge/surge_intro.pdf

Visualization of a Storm Surge SLOSH model: Example SLOSH animations, including Hurricanes Katrina and Ike.
http://www.nhc.noaa.gov/surge/#EVENTS

*This storm surge background is adapted from a lesson written by Dinah Maygarden.*

## HURRICANE AND STORM DAMAGE RISK REDUCTION SYSTEM

After Hurricane Katrina, the U.S. Army Corps of Engineers constructed the $14.5 billion Hurricane and Storm Damage Risk Reduction System (HSDRRS). It is one of the most technically advanced coastal flood protection systems in the world. Together, this system of barriers, sector gates, floodwalls, floodgates and levees provide a veritable "wall" around East Jefferson (EJLD), Orleans (OLD) and St. Bernard Parishes (LBBLD). The System significantly reduces the risk of flooding for over 1 million residents in the New Orleans Metropolitan area from a 100- year storm. The 100-year level means reduced flood risk from a storm surge that has a 1% chance of occurring or being exceeded in any given year.

The Flood Protection Authority — East operates and manages this flood defense system which is displayed on the map on the homepage of its website, https://floodauthority.org.

## SYSTEM FEATURES

### Lake Borgne Surge Barrier

Often referred to as ***The Great Wall of Louisiana***, the 1.8 mile-long, $1.3 billion Lake Borgne Storm Surge Barrier is the largest civil-works, design-build construction project in the history of the U.S. Army Corps of Engineers. After its construction in 2013, the Corps transferred operation and maintenance responsibilities to the Flood Protection Authority —East. The Surge Barrier is a complex system made of concrete and steel that is located at the intersection of the Gulf Intracoastal Waterway (GIWW) and the Mississippi River Gulf Outlet (MRGO). It includes a monolithic flood barrier of 1,071 "soldier" pilings at 140 feet in length, 26 feet above sea level, and extending to 200 feet underground. Adjoined to the barrier wall is a 150-foot-wide sector gate and a bypass barge gate. Combined with other features of the Hurricane and Storm Damage Risk Reduction System, it is designed to

prevent a 100-year storm surge from Lake Borgne, the Mississippi River Gulf Outlet (MRGO) and the Gulf Intracoastal Waterway (GIWW) from inundating the Metropolitan New Orleans area, including New Orleans, New Orleans East, the Ninth Ward, Gentilly, St. Bernard Parish, and the East Bank of Jefferson Parish.

### Bayous Bienvenue and Dupre Sector Gates

These two Sector Gates are part of the Hurricane Storm and Damage Risk Reduction System that was constructed by the U.S Army Corps of Engineers after Hurricane Katrina. They connect to the levees and floodwalls that run parallel to the south bank of the Gulf Intracoastal Waterway (GIWW) and the Mississippi River Gulf Outlet (MRGO). Each consists of a 56' wide navigable sector gate at a height of 32 feet above sea level that is designed to prevent storm surge from impacting highly populated areas of St. Bernard Parish and the Lower 9th Ward of New Orleans. In addition, there are two, 56 feet-wide navigable lift gates that accommodate boat traffic and can be closed in advance of a storm event. These structures are designed to reduce the risk of flooding caused by a 100-year storm that has a 1% chance of occurring each year.

### Caernarvon Complex

After Hurricane Katrina, the U.S. Army Corps of Engineers constructed a complex of flood control structures along the Mississippi River at Caernarvon in St. Bernard Parish. The new Caernarvon Complex includes a 56' foot-wide navigable sector gate at a height of 26 feet above sea level, floodwalls, and land based floodgates across Highway 39 and the Norfolk Southern Railroad tracks. It ties the 23 miles of new floodwalls in St. Bernard Parish to the Mississippi River Levee at the southeast end of the Hurricane and Storm Damage Risk Reduction System (HSDRRS).

### Seabrook Floodgate Complex

After Hurricane Karina, the Seabrook Floodgate Complex was constructed by the U.S. Army Corps of Engineers at a cost of $165 million. This complex operates in tandem with the Lake Borgne Surge Barrier to prevent storm surge from Lake Pontchartrain, during a 100-year storm event, from entering the Inner Harbor Navigation Canal (IHNC), as happened with Hurricane Katrina. The entire Seabrook Floodgate Complex is made of concrete and steel that spans 600 feet long at a height of 16 feet above sea level. It consists of a 95' foot-wide navigable sector gate that has two curved "wings" weighing 220 tons a piece. In the event of a storm, they are swung tightly closed, sealing the canal from storm surge, thereby protecting the City of New Orleans from flooding. In addition, it has two 50' foot-wide vertical lift gates that can be lowered to block the waters of Lake Pontchartrain.

### Levees, Floodwalls and Floodgates

After the levees broke during Hurricane Katrina, people realized the vital role levees play in flood protection. The U.S. Army Corps of Engineers and the Flood Protection Authority-East have enhanced the levees, floodwalls and floodgates surrounding the Greater New Orleans area to a standard of protection from a 100-year storm with a 1% chance of occurring in any given year.

Levees are composed of compacted soils formed in a linear, pyramid shape at heights to reduce the risk of flooding from storm surge and the Mississippi River.

Floodwalls are made of concrete and located at points along the levees to prevent erosion or where there is insufficient space for the wide slope of a levee. Floodwalls are referred to by their shapes such as T-walls that provide extra stability where conditions warrant, and I-walls that require less fortification.

Floodgates are needed where levees or concrete walls cross a road or railroad or where they intersect waterways. They remain open for car, train and boat traffic but are closed during a storm event.

The Flood Protection Authority is responsible for maintaining 192 miles of levees and floodwalls, 3,530 acres of levee turf, and 244 land-based floodgates in East Jefferson, Orleans and St. Bernard Parishes.

## PRIOR STUDENT KNOWLEDGE

Students will be required to apply the content from Lesson 1 in this lesson. They will design a composite map from the data they have interpreted that shows where the flood protection structures are located. The students will be able to identify the flood protection structures and explain the importance of each structure for the area where it reduces flood risk.

Students will be required to use the materials from Lesson 1 in the design of this lesson along with new resources listed above.

## POSSIBLE PRECONCEPTIONS/MISCONCEPTIONS

1. The general public has the misconception that the flood protection system will prevent all types of flooding. They believe there is no chance of flooding if they live near one of the flood protection structures.
2. There is nothing that individuals can do decrease the risk of flooding.

## 5Es TEACHING & LEARNING MODEL

### DAY 1
### FIELDTRIP LAKE BORGNE SURGE BARRIER

- Review the information on Storm Surge with the students. View Lake Borgne Surge Barrier Short Documentary again at https://www.floodauthority.org/videos/
- Review the Safety Procedures with students on the bus.
- Post Field Trip Activity: On a blank sheet of paper, students will complete a written reflection on the events from today. Ask them the following questions to prompt them in writing their reflections.
- What did you view today?
- What did the various Flood Authority Personnel discuss with you about their jobs?
- Why are those jobs important?
- Why is what they do important to the Greater New Orleans area?

### DAYS 2, 3, 4
### BUILD A STORM SURGE MODEL

#### ENGAGE

1. Have students share their reflections about the field trip to the Surge Barrier and review the Lake Borgne Surge Barrier Short Documentary again at https://www.floodauthority.org/videos/

#### EXPLORE

1. Divide into groups of no more than 6 students each.
2. Determine the roles for each member in your group.
3. Your group will be tasked with building a surge barrier using the materials you will find in a box in your assigned construction area.
4. Look at all of the materials and decide how they will be used.
5. On your worksheet, Handout Lesson 2B:
   - Explain how you will use the materials and why you will use each material for the purpose you chose.
   - What are the pieces for? Purpose? Engineering purpose?
   - Why is it designed in certain ways?
   - Why are the angles like the way that they are?
   - Why is the shape important?
6. Now with your group, draw a design on the model that you would like to build. Draw your design in the space provided on the Handout Lesson 2B.
7. Build your model. (You can only use the materials that have been provided for you.)

#### EXPLAIN

**Gallery Walk**

Each group will present their models to the class. Then explain why they chose their design and how it worked. Allow other groups to ask the questions.

## ELABORATE

If time permits, you have one class period to make adjustments to your design and paint your model.

## EVALUATE

Record your observations about each model that you viewed. Record what worked, what didn't work, and what would you suggest to improve their model.

## DAYS 5, 6
## HSDDRS & ST. BERNARD PROTECTION SATELLITE MAP ACTIVITY

### ENGAGE

1. Review St. Bernard Flood Protection Structures video at https://www.floodauthority.org/videos/
2. After video ask students these questions for discussion:
   - What geographical area was being shown?
   - What important structures did you view?
   - What is their relationship to the bodies of water that are near?
   - Why are those structures situated near those areas of water? What is the role of those structures as related to the water?
   - What would have to happen to the structures if a storm approaches to make it fulfill its purpose? Would all the structures have to be operated to protect St. Bernard Parish from flooding?

### EXPLORE

Students need to have the following available to use:
- Handouts/work from Lesson 1
- Blank Base Map Lesson 2C Handout
- Chrome Books

Using Handouts from Lesson 1 students will compare their map with the map on the Flood Protection Authority's webpage: http://www.floodauthority.org. Answer questions from 2D Handout

- St. Bernard Parish Storm Surge Protection Map Activity—Handout Lesson 2E
- Using the blank BASEMAP, students will follow the instructions in Handout 2F to revise their map based on the comparison with the Flood Protection Authority's map.

### EXPLAIN

Review all of the content with the class on the worksheets completed for this engage activity. Have the students explain the process of making the compilation map.

## HANDOUT 2B — BUILD A STORM SURGE BARRIER MODEL

Name: _____ Date: _____

**1.** Information obtained from video.

**2.** Additional notes after second viewing:

**3.** Explain how you will use the materials and why you will use each material for the purpose you chose.

**3-A.** What are the pieces for? Purpose? Engineering purpose?

## HANDOUT 2B — BUILD A STORM SURGE BARRIER MODEL

Name: _____ Date: _____

**3-B.** Why is each piece designed in certain ways?

**3-C.** Why are some shaped with angles?

**3-D.** Why is the shape important?

**4.** Draw Your Model Design.

**5.** Build Your Model.

**6.** Based on the Gallery Walk what worked or did not work?

## HANDOUT 2B — BUILD A STORM SURGE BARRIER MODEL

Name: _____ Date: _____

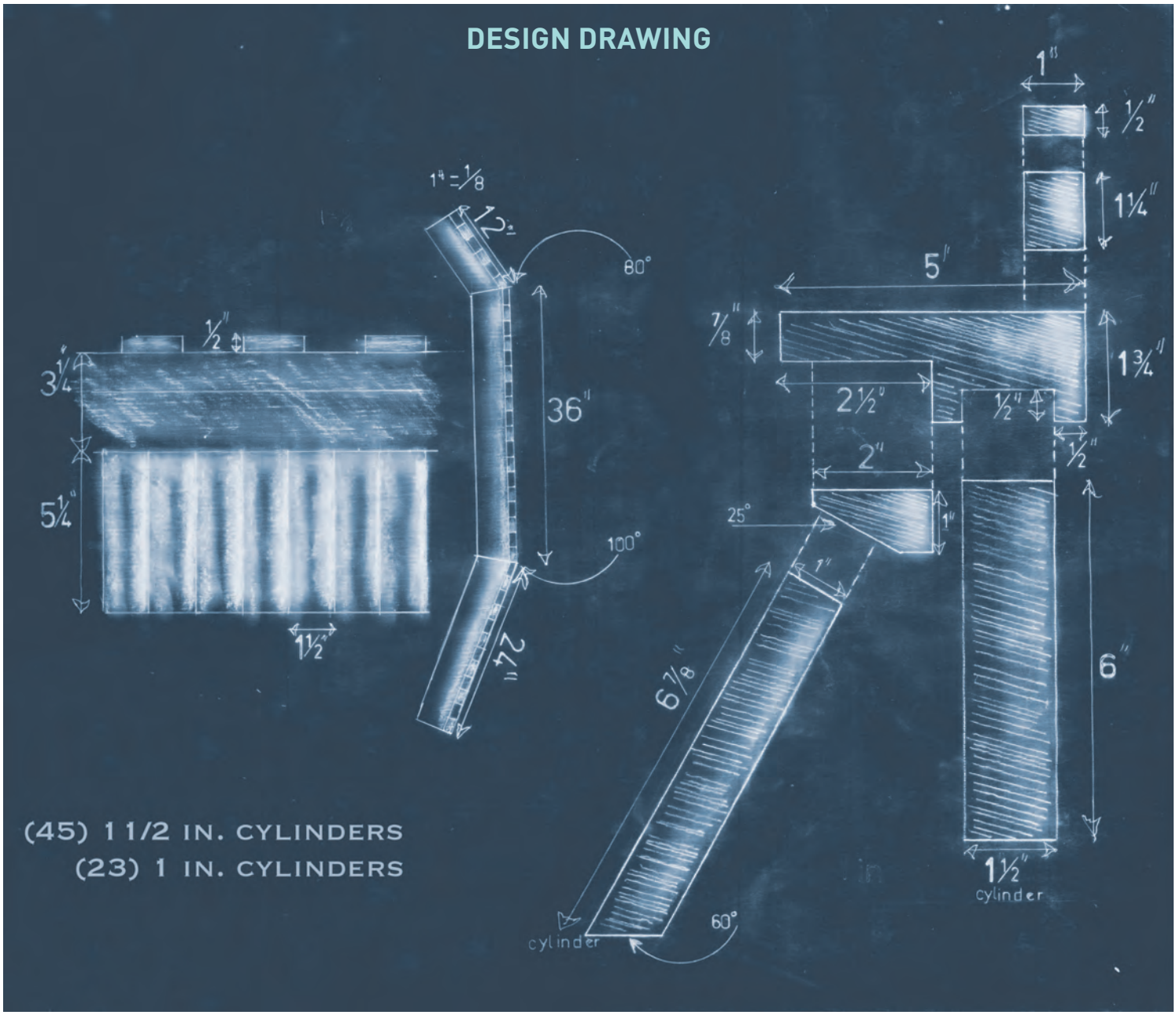
## MATERIALS LIST

**Styrofoam**
(can be ordered online from a craft website)
12 boards/sheets at 2"x12"x36"
48 poles at 24"x1"
68 poles at 24"x1 1/2"

**Glue**
6-8 large bottles of Elmer's Glue
6 small paint brushes for gluing
6 small containers to put glue into (plastic or aluminum)

**Paint**
6 small cans of grey, outdoor paint
6 small paint brushes for painting
6 medium brushes for painting

## LAKE BORGNE SURGE BARRIER MODEL



## HANDOUT 2C — BASE MAP

## HANDOUT 2D — FLOOD AUTHORITY BASE MAP ACTIVITY

Name: _____ Date: _____

Go to the website: https://floodauthority.org/
Scroll down to the image of the Base Map—it should look familiar from Lesson 1.

**I.** Look at the legend. Identify all of the numbered objects by using the key.

**1)** _____

**2)** _____

**3)** _____

**4)** _____

**5)** _____

**6)** _____

**II.** Click on the small boxes at the bottom of the map. Read the information about each structure. Then with your group, develop a concise two sentence description of the function of this structure.

**1)** _____

**2)** _____

**3)** _____

**4)** _____

**5)** _____

**6)** _____

## HANDOUT 2D continued — FLOOD AUTHORITY BASE MAP ACTIVITY

Name: _____ Date: _____

III. Reflect: Choose one of the structures that protects St. Bernard Parish you discussed above and answer this question: If the structure you chose did not exist, what would happen if there was a major flood event?

# HANDOUT 2E — ST. BERNARD PARISH STORM SURGE PROTECTION MAP ACTIVITY

Name: _____ Date: _____

https://earth.google.com/web/@29.92415957,-89.89695766,5.77117522a,35394.68776122d,35y,-0.00000002h,5.38895628t,0r

1. Go to the link above.
2. Zoom in on St. Bernard Parish. HINT: Look at the map below. The area in yellow is St. Bernard Parish.
3. Look for the St. Bernard Parish flood protection structures.
4. Label all the structures that protect St. Bernard Parish from storm surge within the yellow oval on the map below.

# HANDOUT 2F — HSDDRS/ST. BERNARD PARISH STORM SURGE PROTECTION/BASE MAP COMPILATION ACTIVITY

Name: _____ Date: _____

For this activity you will need to refer to the maps that you used in Lesson 1 and compare them to the map that you just looked at on the Flood Authority website.

The goal is for you to transfer all of the information you have learned from your Google Map activity (Lesson 1B Handout), Base Map Activity (Lesson 1C Handout) and your Flood Authority Map Activity, to this new map. (The blank BASE Map Handout 2C)

Water should be highlighted or colored blue, levee protection systems should be outlined in black, bridges should be outlined in yellow,

This means that your map should now include the following: (Check off each box as you complete the labeling process on the BASE Map)

- ❑ The location of your school or house — indicated with a school/house shaped drawing
- ❑ The Causeway Bridge
- ❑ The Twin Spans
- ❑ Lake Pontchartrain
- ❑ Lake Borgne
- ❑ Mississippi River
- ❑ The St. Bernard Parish Protection System

# Keepin' Your Head Above Water


## Lesson 3
## Risk and Preparedness

Natural Disasters

# RISK AND PREPAREDNESS

## LESSON PLAN #3 of 3 DURATION: 2 days

## ESSENTIAL QUESTIONS

What is natural disaster risk? How do we reduce our exposure to natural disasters?

Through this lesson, students will learn how risk is determined, how they can take action to reduce the risks from hurricanes and communicate this gained knowledge to others.

**RESOURCES:** Risk Background Booklet and Flood Protection Authority website:
https://www.floodauthority.org/education/what-you-can-do/

## PERFORMANCE EXPECTATIONS

### 8-MS-ESS3-2

Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.

### CLARIFICATION STATEMENT

Emphasis is on how some natural hazards, such as volcanic eruptions and severe weather, are preceded by phenomena that allow for reliable predictions, but others, such as earthquakes, occur suddenly and with no notice, and thus are not yet predictable.

- ~ Examples of natural hazards can be taken from interior processes (such as earthquakes and volcanic eruptions), surface processes (such as mass wasting and tsunamis), or severe weather events (such as hurricanes, tornadoes, and floods).
- ~ Examples of data can include the locations, magnitudes, and frequencies of the natural hazards.
- ~ Examples of technologies can be global (such as satellite systems to monitor hurricanes or forest fires) or local (such as building basements in tornado-prone regions or reservoirs to mitigate droughts).

### SCIENCE AND ENGINEERING PRACTICES

1. Asking questions (for science) and defining problems (for engineering).
2. Developing and using models.
3. Planning and carrying out investigations.
4. Analyzing and interpreting data: Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.
   - ~ Analyze and interpret data to provide evidence for phenomena.
5. Using mathematics and computational thinking.
6. Constructing explanations and designing solutions.
7. Engaging in argument from evidence.
8. Obtaining, evaluating, and communicating information.

### 8-MS-ESS3-3

Apply scientific principles to design a method for monitoring and minimizing human impact on the environment.

### CLARIFICATION STATEMENT

Examples of the design process may include examining human environmental impacts, assessing the kinds of solutions that are feasible, and designing and evaluating solutions that could reduce that impact.

Examples of human impacts may include water usage (such as the withdrawal of water from streams and aquifers or the construction of dams and levees), land usage (such as urban development, agriculture, or the removal of wetlands), and pollution (such as of the air, water, or land).

### SCIENCE AND ENGINEERING PRACTICES

1. Asking questions (for science) and defining problems (for engineering).
2. Developing and using models.
3. Planning and carrying out investigations.
4. Analyzing and interpreting data.
5. Using mathematics and computational thinking.
6. Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.
   - ~ Apply scientific ideas or principles to design, construct, and/or test a design of an object, tool, process or system.
7. Engaging in argument from evidence.
8. Obtaining, evaluating, and communicating information.

## DISCIPLINARY CORE IDEAS

### Natural Hazards

Mapping the history of natural hazards in a region, combined with an understanding of related geologic forces can help forecast the locations and likelihoods of future events. (MS.ESS3B.a)

## DISCIPLINARY CORE IDEAS

### Human Impacts on Earth's Systems

Human activities, globally and locally, have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things. (MS.ESS3C.a)

Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise. (MS.ESS3C.b)

### Developing Possible Solutions

A solution needs to be tested to prove the validity of the design and then modified on the basis of the test results in order to improve it.

There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. Models of all kinds are important for testing.

## CROSSCUTTING CONCEPTS

### Patterns

Graphs, charts, and images can be used to identify patterns in data.

## CROSSCUTTING CONCEPTS

### Cause and Effect

Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation.

## SPECIFIC LEARNING OUTCOMES

Students will understand the risk related to natural hazards and prepare action plans to protect themselves, their families and their property.

## BACKGROUND INFORMATION

See Risk Background.

## PRIOR STUDENT KNOWLEDGE

Students will be required to apply the content from Lessons 1 and 2 to this lesson.

## POSSIBLE PRECONCEPTIONS/MISCONCEPTIONS

The general public has the misconception that the flood protection system will prevent all types of flooding to the point that they believe there is no chance of flooding if they live near one of the flood protection structures.

There is nothing that individuals can do decrease the risk of flooding.

## TEACHER PREPARATION

Handout Risk Background and review the with the students.

Handout Risk Background questions worksheet.

# HOW TO REDUCE YOUR RISKS

## ENGAGE: Risks

~ Ask: What is a risk? Are risks good or bad?
~ Ask: When do you hear the term risk used?
~ Ask: Thinking about your activity from yesterday, the Multiple Lines of Defense Model, and HSDRRS and St. Bernard Parish Storm Surge Protection what types of risk did you encounter?

## EXPLORE

1. Students will go to the Flood Authority Website: https://www.floodauthority.org/
2. Students are to follow the directions on Lesson 3B Risks and What You Can Do Handout

## EXPLAIN

1. Give students a copy of Lesson 3C Handout: Helping Others Reduce Their Risk. Students will use the questions below to guide them in developing a plan on how they would educate others.

~ From all that you have learned about the risks and our vulnerability to the risks associated with flooding, how would you educate your family and friends about ways to reduce the risk, especially as part of their hurricane preparedness plan?
~ What method would you use to educate them: public service announcement (write a script), brochure, poster, other?
~ What would you tell them?
~ Who would need to evacuate in the event of a storm/hurricane?
~ What areas of the parish do you think are most vulnerable?
~ Where would they evacuate?
~ In what direction would you evacuate?

## ELABORATE: Applications and Extensions

Students will finalize their plan for educating others on ways to reduce risk.

## EVALUATE

Students will create a PSA script, brochure, poster, other.

# RISK BACKGROUND

Why is it important to understand the risk from disasters that we may experience?

Questions we hope to answer for each possible natural disaster are:

- Where is each type of hazard likely to be present and why?
- What scientific principles govern (regulate) the processes responsible for the disasters?
- How often do these hazards develop into disasters?
- How can each type of disaster be predicted and/or mitigated?

## PART I: RISK RELATED TO NATURAL HAZARDS

### What is Disaster Risk?

Disaster risk includes the loss of life, injury, or destruction and damage to property that result from a natural hazard.

Disaster risks also involve how a hazard effect's the people and places that are vulnerable (weak) exposed (unprotected).

### How is the risk determined?

**Risk** — severity and frequency of a hazard + numbers of people and property exposed to the hazard + their vulnerability to damage.

### What are the types of risk?

There are two types of risk:

**Intensive Risk** means that there is a low-probability, high-impact event; (which is more effected by exposure to the risk than how vulnerable we are to the risk).

**Examples of Intensive Risks:**

- Earthquakes
- Tsunamis
- Hurricanes
- Large volcanic eruptions

**Extensive Risk** means there is a high-probability (more frequent, low-impact events). This risk is more effected to how vulnerable we are rather than how exposed we are to the risk.

**Examples of Extensive Risks:**

- Weather-related hazards like flash floods.
- Storms, fires.
- Agricultural and water-related drought.

Sometimes these risks can include different hazards like the impact of volcanic ash on an island.

The disaster risks are the result of the consequences of the interaction that occurs between a hazard (the examples from above) and the characteristics that make people and places vulnerable and exposed to the risk. See Figure 1 right column for the risk formula.

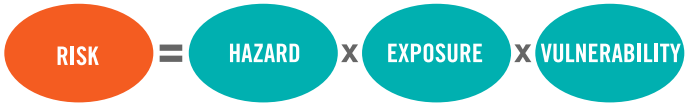



Figure 1 — Disaster risk is widely recognized as the consequence of the interaction between a hazard and the characteristics that make people and places vulnerable and exposed.

## PART II: WHAT ARE HAZARDS?

### A. What is a hazard?

- A hazard is a process, phenomenon or human activity that may cause loss of life, injury or other health impacts, property damage, social and economic disruption or environmental degradation (less than satisfactory).
- Hazards can be natural, anthropogenic (originating from human activity), or socio-natural (interaction of natural hazards with overexploited (overused) or degraded (altered) land and environmental resources).

### B. Risk v. Hazard:

**How are risks and hazards related?**

**Natural Hazard** is the threat of a naturally (occurs without something making it happen—we can't stop it) occurring event that will have a negative impact on humans (without humans there would be no threat of damage, and natural hazards would be natural events instead). Natural hazards are the result of naturally occurring processes (most are Geological Processes).

**Examples of Natural Hazards:**

- Earthquakes
- Tsunamis
- Hurricanes
- Tornadoes

**Risks** are the specific damage done to humans by an event and it often affects us personally and at different levels depending on how we perceive the risk. (it is personal and often subjective).

- When we talk about risks we most often are talking about how we can reduce the risk associated with the hazard to humans. We can understand risks in a way that can minimize the hazard to humans.
- Natural events are only termed hazards when they have the potential to harm people or damage property.

## RISK BACKGROUND

### C. Why is the location of the hazard important?

The location of the hazard depends on the natural processes present such as the movement of tectonic plates that cause earthquakes or the influence of weather systems, but the location (and frequency and frequency of occurrence) can also depend on processes such as: urbanization, environmental degradation and climate change are also known as risk drivers.

### D. What are the types or classifications of hazards?

Classifications for different hazards can be divided into:

**Biological Hazards** are of organic origin or transmitted by biological vectors (organisms that spread infection by carrying pathogens from one host to another), such as mosquitoes;

**Examples of Biological Hazards include:**

~ Bacteria
~ Viruses
~ Venomous wildlife
~ Insects

**Environmental Hazards** can include chemical, natural and biological hazards. They can be created by environmental degradation or physical or chemical pollution in the air, water and soil (these are also known as drivers of hazards and risk, rather than hazards in themselves).

**Examples of Environmental Hazards include**:

~ Sea-level rise
~ Soil degradation
~ Deforestation

**Geographical or Geophysical Hazards** originate from internal earth processes such as earthquakes, volcanic activity and emissions, and are related geophysical processes such as mass land movements, rock slides, surface collapses, and debris or mud flows.

**Hydrometeorological Hazards** which consist of atmospheric, hydrological, or oceanographic origin.

**Examples of Hydrometeorological Hazards include:**

~ Tropical cyclones (which we know of as typhoons and hurricanes)
~ Floods and flash floods
~ Drought
~ Heat-waves and cold spells
~ Coastal storm surges

These conditions can be a factor in other hazards such as landslides, wildland fires, locust plagues, epidemics.

**Technological Hazards** originate from technological or industrial conditions, dangerous procedures, infrastructure failures or specific human activities.

**Examples of Technological Hazards include:**

~ Industrial pollution
~ Nuclear radiation
~ Toxic wastes
~ Dam failures
~ Transport accidents
~ Factory explosions
~ Fires
~ Chemical spills

Technological hazards can also arise as a direct result from the impacts of a natural hazard event.

**IMPORTANT NOTE:** Each hazard can cause a cascading effect by triggering a sub-set of hazards such as tropical cyclones which can lead to intense winds, storm surge and heavy rainfall, which can then trigger secondary hazards like landslides.

### E. Characteristics of Hazards

~ Hazards can be characterized by their magnitude or intensity, speed of onset, duration, and the area it covers.
~ Often, when there is a long return period which means the hazard does not occur frequently, communities forget that when the hazard does occur, the potential threat will occur with a greater intensity and therefore they prepare less.
~ Different hazards can cover different spatial scales (amounts of geographical area) such as tornadoes which are typically localized, while droughts can occur over several tens of thousands of kilometers.
~ Single countries can be prone to multiple hazards (such as the USA that is prone to tropical cyclones, tornadoes, floods, and earthquakes), so all risks related to those hazards must be considered.

### F. Can We Reduce Hazards?

~ Hazards and their impacts, especially natural hazards, usually cannot be prevented fully, but their scale and severity can be decreased by using various strategies and actions.
~ Severity and scale can be mitigated by implementing engineering techniques and hazard-resistant construction as well as improved environmental and social policies and public awareness.

## RISK BACKGROUND

**Examples include:**
Flood protection structures such as surge barriers, floodwalls and floodgates; elevated homes; buyouts of flood prone homes and businesses; Habitat conservation and restoration, such as rebuilding wetlands; Public awareness, Public Service Announcements and community meetings.

- Improving our knowledge of hazards can help us locate, and in some cases, anticipate return periods.
- Implementing warning systems that are accompanied by strategies for disaster risk reduction. This needs to take place in order to reduce vulnerability and aid people in responding and recovering from a disaster.

**Effective early warning systems (EWS) include:**

- Detection, monitoring and forecasting of the hazards by scientific organizations such as the National Hurricane Center.
- Analysis of the risks involved.
- Dissemination (broadcasting) of timely and authoritative warnings.
- Activation of emergency preparedness and response plans.
- All components of the EWS need to be coordinated across many agencies at both the national and community levels for it to work.
- Some hazards cannot be anticipated but measures can be set in place, such as proper, resilient construction in the area, to prepare for the events such as frequent flooding.

## PART III: EXPOSURE

### A. Exposure to Hazards

- Exposure of infrastructure, people, housing, and businesses located in hazard-prone areas.
- There is no risk if a hazard occurs in an area with no exposure (ex) In October 2013 a Category 5 Super Typhoon Lekima hit the Northwest Pacific Ocean, with winds reaching 240 km/h, but it caused no impact, because there were no people or structures located in the zone of impact.
- In November, 2013 another category 5 Super Typhoon Haiyan hit the same region, with winds reaching 315 km/h, and it affected 11 million people.
- None of the people or assets were in the path of Lekima, meaning there was no exposure, so no damage was done then, unlike Haiyan.
- It is possible to be exposed but not vulnerable, so risk is generally determined by vulnerability; however, when it comes to extreme hazards which have an intensive risk, the degree of disaster risk is due to exposure more than it is vulnerability.

### B. What Drives Exposure

- The population, urbanization and development of an area determine the amount of exposure an area has. The more concentrated these are, the greater the impact to exposure will be.
- When people are displaced to new areas due to previous disasters, such as the flooding from Hurricane Harvey in Texas or the effects of Hurricane Maria in Puerto Rico, they are at times forced to move into less safe areas due to the number of those having been affected.
- Areas prone to hazards, such as coastlines, volcanic slopes and flood plains, are more likely to have increased urban and economic development because of their value as tourist areas. This then adds to the risk of the number of people and the amount of property that becomes exposed which means a more concentrated risk.
- Risk spreads as cities expand and as urban and economic development transform what were once sparsely populated areas into developed businesses or neighborhoods.

### C. Reducing Exposure

- Without decreasing the amount of economic developments in the high-hazard areas, there will continue to be an increase in the disaster risk for that area.
- There is a need to build capacity and resilience in the areas of growing exposure. Examples include: improved building codes, buyouts of frequently damaged structures, relocation of people in these areas, types of infrastructure such as green infrastructure that manages flooding from stormwater.
- Sometimes it is not possible to avoid exposure to hazards, so decisions regarding the plan to use land by structural and non-structural means, risk will not be mitigated.

### D. Vulnerability

- Vulnerability concerns environmental and social conditions that negatively affect how a community or an individual can cope with the impact of a hazard. It is determined by social, economic, physical, and environmental factors.

## RISK BACKGROUND

**Which individuals are most vulnerable?**

- A person's vulnerability is influenced by their ability to anticipate, cope with, resist, and recover from the impact of a natural disaster.
- (Ex) During Katrina 65% of elderly households did not have a car, meaning they did not have a way to escape the storm.
- Vulnerable populations should be paid special attention to help prepare for and respond to life-threatening hazards.
- The most vulnerable group to disaster risk is the poor. This is because people with lower income are forced to live in unsafe, exposed locations and conditions.

**Factors that influence vulnerability include:**

- Physical Factors— poor design and construction of buildings and unregulated land use.
- Social Factors — poverty and discrimination (race, gender, social status, disability, and age) banishment, and social exclusion.
- Economic Factors — farmers and agricultural industries, reliance on vulnerable locations for imported goods, dependence on single industries, the uninsured.
- Environmental Factors — poor management of the environment, a decrease in agencies that oversee ecosystem protection, overconsumption of natural resources, and climate change.

## Hurricane Categories

**Category One Hurricane**

- Winds 74-95 mph. Storm surge generally 4–5 ft above normal. No real damage to building structures. Damage primarily to unanchored mobile homes, shrubbery, and trees. Some damage to poorly constructed signs. Also, some coastal road flooding and minor pier damage.

**Category Two Hurricane**

- Winds 96-110 mph (83-95 kt or 154-177 km/hr). Storm surge generally 6-8 feet above normal. Some roofing material, door, and window damage of buildings. Considerable damage to shrubbery and trees with some trees blown down. Considerable damage to mobile homes, poorly constructed signs, and piers. Coastal and low-lying escape routes flood 2-4 hours before arrival of the hurricane center. Small craft in unprotected anchorages break moorings.

**Category Three Hurricane**

- Winds 111-130 mph (96-113 kt or 178-209 km/hr). Storm surge generally 9-12 ft above normal. Some structural damage to small residences and utility buildings with a minor amount of curtainwall failures. Damage to shrubbery and trees with foliage blown off trees and large trees blown down. Mobile homes and poorly constructed signs are destroyed. Low-lying escape routes are cut by rising water 3-5 hours before arrival of the center of the hurricane. Flooding near the coast destroys smaller structures with larger structures damaged by battering from floating debris. Terrain continuously lower than 5 ft above mean sea level may be flooded inland 8 miles (13 km) or more. Evacuation of low-lying residences with several blocks of the shoreline may be required.

**Category Four Hurricane**

- Winds 131-155 mph (114-135 kt or 210-249 km/hr). Storm surge generally 13-18 ft above normal. More extensive curtainwall failures with some complete roof structure failures on small residences. Shrubs, trees, and all signs are blown down. Complete destruction of mobile homes. Extensive damage to doors and windows. Low-lying escape routes may be cut by rising water 3-5 hours before arrival of the center of the hurricane. Major damage to lower floors of structures near the shore. Terrain lower than 10 ft above sea level may be flooded requiring massive evacuation of residential areas as far inland as 6 miles (10 km).

**Category Five Hurricane**

- Winds greater than 155 mph (135 kt or 249 km/hr). Storm surge generally greater than 18 ft above normal. Complete roof failure on many residences and industrial buildings. Some complete building failures with small utility buildings blown over or away. All shrubs, trees, and signs blown down. Complete destruction of mobile homes. Severe and extensive window and door damage. Low-lying escape routes are cut by rising water 3-5 hours before arrival of the center of the hurricane. Major damage to lower floors of all structures located less than 15 ft above sea level and within 500 yards of the shoreline. Massive evacuation of residential areas on low ground within 5–10 miles (8–16 km) of the shoreline may be required.

## RISK BACKGROUND

**Why Vulnerability Matters**

- Vulnerability means that the risk does not only depend on the severity of the hazard or the number of people or assets affected but the actual susceptibility of people and assets to damage.
- Different groups can be more or less susceptible to different hazards, and people within those groups can be more or less susceptible than one of their groups members.
- These groups can find it hard to reconstruct their lives, making them even more susceptible when the next hazard strikes.
- To reduce risk, we must reduce vulnerability.

**How is vulnerability measured?**

- There is not one single method for assessing vulnerability
- The vulnerability of the built environment to hazards should be assessed for things such as: use of building materials and engineering practices that respond well to risks and whether those practices can be implemented in the location where the building is being built, and can help reduce disaster risk.
- A vulnerability and capacity assessment (VCA) is developed that is used to identify vulnerabilities and then identify strategies for immediate and long-term risk reductions.

**The VCA is used as a** diagnostic tool to understand problems and their underlying causes; a planning tool to prioritize actions to be taken; a risk assessment tool to help assess specific risks and a tool for empowering and mobilizing vulnerable communities.

**How can vulnerability be reduced?**

- The disaster risk cannot be reduced by reducing the severity and occurrence of natural hazards (which no one can control) but the vulnerability to the risk can be reduced.
- Vulnerability needs to be addressed at three different levels:
  - Local
  - National
  - International
- Ways to reduce the vulnerability:
  - Implementing building codes.
  - Social Programs such as shelters.
  - Emphasizing economic diversity and resilient livelihoods.
  - Knowledge and awareness raising of ways to reduce vulnerability.
  - Preparedness measures raising homes and businesses, purchasing insurance, and installing green infrastructure.
  - Restoring natural resources such as wetlands that can buffer/protect developed areas.
- To reduce vulnerability, we must focus on people's ability to resist and recover from natural hazards.
- People already have local and traditional knowledge of how to respond to a disaster, this knowledge should act as the starting point for outside interventions to reduce risk.

## PART IV: RESPONSE TO RISK FROM THE PUBLIC

**How to communicate risks and get the desired response:**

- There must be a plan that informs citizens on what needs to happen and how it will be done during a time the community is at risk.
- The plan must address the needs of the community interests and not of those designing the plan. The plan needs to be presented in such a way that it has emotional significance to the community.
- Explain the risk in a manner appropriate for the audience — Use stories and visuals; they make the impact of the hazards more personal.
- Offer options for reducing risks — Conversations should be held that discuss what would prevent the needed actions from taking place and how these actions can be most easily carried out.
- Work with trusted sources and the public — It is easier for people with a community to accept the steps in an action plan if those plans come from sources involved in the planning process that they trust.
- Test messages or products on public — Before presenting a plan to the general public, it should be tested on a sample of the target audience to check for the understanding of the plan and their ability to carry out the plan.
- Use different ways to communicate — Audiences like to receive info in different ways; understand what the audience responds to.

## PART V: RISK IN RELATION TO HURRICANES

**Tropical cyclone** is a rotating, organized system of clouds and thunderstorms that originates over tropical or subtropical waters and has a closed low-level circulation.

The classifications of a cyclone are based on the differences in wind speeds.

# RISK BACKGROUND

## Four classifications of a tropical cyclone:

**Tropical Depression** is a tropical cyclone with maximum sustained winds of 38 mph or less.

**Tropical Storm** — A tropical cyclone with sustained wind speeds between 39 to 73 mph.

**Hurricane** is a tropical cyclone with maximum sustained winds of 74 knots or higher (in the western North Pacific they are called typhoons, and in the Indian Ocean and South Pacific Ocean they are called cyclones).

**Major Hurricane** — A tropical cyclone with maximum sustained winds of 111 mph or higher, corresponding to a Category 3, 4, or 5 on the Saffir-Simpson Hurricane Wind Scale.

- Saffir Simpson Hurricane Scale information from https://www.weather.gov/mfl/saffirsimpson.
- The Atlantic (includes the Atlantic Ocean, Caribbean Sea, and Gulf of Mexico) hurricane season runs from June 1 to November 30, and in the Eastern Pacific hurricane season runs from May 15 to November 30.
- Storms can form outside of the months listed above.
- September is the most common month for hurricanes.

## Risks associated with a hurricane include:

**Storm surge and storm tide** — large waves produced by hurricanes that pose the greatest threat to life and property along the coast; Storm surge is an abnormal rise of water generated by a storm's winds; Storm tide is the water level rise due to the combination of storm surge and the astronomical tide.

**Heavy rainfall and inland flooding** — Hurricanes often produce widespread, torrential rainfalls that can sometimes exceed 6 inches and lead to flooding; people living inland can experience flash flooding (rapid rise in water levels).

- **High winds** — Hurricane-force winds (74 mph or more) can destroy buildings and mobile homes; debris, such as signs, roofing material, and small objects left outside, can be sent flying through the air due to high wind.
- **Rip currents** — Large waves that break along the coast can produce rip currents, which are channeled currents of water that flow away from shore and can pull people or property with them.
- **Tornadoes** — most occur in thunderstorms embedded in rain bands; most are relatively weak and short-lived, but they are still dangerous.

**Exposure:** The geographic area where people, infrastructure, housing, and businesses are located in hazard-prone areas.

## New Orleans & Jefferson Parish Exposure

- Half of New Orleans is below sea-level (although the other half of the city and surrounding metropolitan area is above-sea level).
- Albert Baldwin Wood, a New Orleans Sewerage and Water Board engineer invented giant screw pumps in 1913; these pumps were put at the ends of outfall canals to lift the water from the low-lying areas to the south of the ridges into the canals. This meant that the swamps north and south of the Metairie and Gentilly ridges (which at that time were just marsh or swamp) could be drained and changed into a habitable area for the growing city. The city was left much more vulnerable to storm surge entering from Lake Pontchartrain, because the outfall canals bounded by low levees contained water at higher levels than the surrounding land.
- Pumping stations and canals are also in place in Jefferson Parish which is protected by the levee along Lake Pontchartrain.

**Natural causes for exposure include:**

- Our close proximity to the Gulf of Mexico.
- Low elevation (Parts of the city are either at, near, or below sea-level).
- Subsidence that is caused by compaction of river deposited sediments.
- Erosion of the inactive delta lobe.
- Sea-level rise caused by global warming.
- The levees on the Mississippi River that protect us from flooding also deprive the floodplain of sediment that would normally lead to the deposition of new sediment.
- Louisiana's coastline is eroding at a fast rate that has been made faster by human changes to the system.

**Causes of coastal erosion include**:

- Navigation and exploration canals; the levee/floodwall breaches during Katrina happened on manmade navigation and drainage canals throughout the city.
- South Louisiana wetlands for the past 100 years—salt water has intruded into the fresh water swamps and marshes which kills fresh-water vegetation that holds soil in place; storms and boat traffic can then easily erode the soil.

**Petroleum extraction** — When oil and natural gas are extracted from the subsurface, sediment that once held the oil in the pore spaces, compacts, which results in subsidence.

**Invasive Species** — Nutria were imported from South America in the early 1900s to expand the fur trade.Nutria eat marsh grass and their roots. Without the grasses, storms erode the soil and turn land into water.

## RISK BACKGROUND

**Increased Population and its Expansion into Lower Lying Areas** — An increase in population puts more people and infrastructure at risk; when swamps are drained to make habitable dry land, the groundwater table is lowered without the groundwater in the pore spaces between sediment grains, the grains compact and cause subsidence.

### Exposure in St. Bernard Parish

- Most of the barrier islands and wetlands that defend the parish are eroding or going underwater.
- When the Industrial Canal levee walls failed during Hurricane Katrina, St. Bernard Parish was the only parish that was completely inundated. Most of it was flooded in the early-dawn of August 29, 2005, and the rest of the area that had been spared was then flooded mid-morning.
- In St. Bernard Parish marshland is growing more fragile every year due to canals that have been built and cause disruptions in the stability of the land.
- When the Mississippi River Gulf Outlet (MRGO) was in use, it made the parish more vulnerable, because it lent to the erosion of the shoreline and canal banks and acted as a funnel for hurricane storm surge. It acted as a funnel because it allowed the storm surge to flow at a faster rate than normal to the point where it reached its peak at the height of the levees which then caused the water to overflow the levees flooding New Orleans and St.Bernard Parish.

### Vulnerability During Katrina

- This mistake proved critical when Hurricane Katrina arrived and levees on the 17th Street and London Avenue Canals failed and Lake Pontchartrain was able to drain into the city. When the Industrial Canal wall broke it inundated the lower 9th ward of New Orleans.
- Nearly half of the fatalities in Louisiana were people over the age of 74.
- Special needs populations were affected, meaning institutionalized people, those with low capacity for self-care, long-term or chronically ill patients, and nursing home residents.
- 1/3 of the people in the hardest hit areas were African American.
- Nearly 30% of the population affected by Hurricane Katrina was poor). It is estimated that 112,000 people were without a car and had nowhere to go.
- Some people chose to wait out the storm at home.

### How does one prepare for a hurricane?

- Have an evacuation plan. This means you need to know the hurricane evacuation routes in your area and where you are going to stay.
- In the event that you cannot evacuate, either because you don't have transportation, nowhere to stay, and/or you have a disability that inhibits a way of escape, there are services that you can pre-register for that help citizens evacuate. Pets are considered part of the family and are included in assistance.
- Put together a "go-bag," meaning a disaster supply kit; fill the kit with flashlights, batteries, cash, first aid supplies, medications, and copies of your critical information.
- If you are not in an area that has been ordered or advised to evacuate and you decide to stay home, make sure you adequately stock up for the possibility that you could lose power and/or water for several days and may not be able to leave due to flooding or blocked roads.
- Make a family emergency communication plan.
- Find out what type of alert systems are in your area so that you are always kept up-to-date.
- Have flood insurance. In most areas of Southeast Louisiana, homeowners are required to carry it, but even if you're not in a flood zone, you should buy enough to at least cover the contents of your home or apartment.
- Flood-proof your home by elevating it or, if that's not a possibility, raise the height of your air conditioning and heating units and other outdoor utilities.
- Use green infrastructure. Green infrastructure can be used as a cheaper alternative to the usual pipes and concrete to move rainwater away from your property. Use your lawns and gardens to absorb rainwater, which includes small ponds, bioswales (vegetative drainage channels with gently sloping sides), and rain gardens. You can also change your driveway from concrete to gravel or grass to allow rainwater to percolate into the ground
- Purchase sand bags (many parishes hand out a limited number of sand bags to residents of their parish) and pre-cut plywood for your windows.
- Write down emergency agencies' contact information. These agencies provide emergency support for citizens including evacuation routes, education about how citizens can protect themselves and their property, and provide shelters.
- Trim or remove damaged trees and limbs to keep you and your property safe in the case of high wind speeds.

## RISK BACKGROUND

- Secure rain gutters and downspouts and clear clogged areas to prevent water damage.
- Secure and reinforce the roof, windows and doors, including the garage doors.
- Purchase a portable generator or get one installed to prepare for power outages.

The websites, **http://floodauthority.org** and **http://getagameplan.org/** provide resources on how to put together an emergency kit, make preparations, and stay informed.

## RISK BACKGROUND
### Citations

All information was directly or closely adapted from one of the following resources:


http://www.preventionweb.net/risk/disaster-risk
Disaster risk. (2015, November 12).

http://www.preventionweb.net/risk/intensive-extensive-risk
Intensive and extensive risk. (2015, November 12).

http://www.preventionweb.net/risk/vulnerability
Vulnerability. (2015, November 12)

http://www.unisdr.org/we/inform/terminology
Terminology. (2017, February 2).

https://www.sciencedaily.com/terms/vector_(biology).htm
Vector (biology). (2017, November, 2013).

http://www.nhc.noaa.gov/climo/
Tropical Cyclone Climatology. (n.d.).

https://w1.weather.gov/glossary/

https://www.iii.org/fact-statistic/hurricanes
Facts Statistics: Hurricanes. (2017, September 19).

https://www.tulane.edu/~sanelson/New_Orleans_and_Hurricanes/New_Orleans_Vulnerability.htm
Nelson, S. A. (2012, December 10). Why New Orleans is Vulnerable to Hurricanes: Geological and Historical Factors.

https://www.wunderground.com/education/Katrinas_surge_part05.asp
Kieper, M. (2017). Katrina's Surge, Part 5.

http://www.nhc.noaa.gov/prepare/hazards.php
Hurricane Preparedness - Hazards. (n.d.).

http://www.sciencedirect.com/science/article/pii/S2212420915300935
Rufat, S., Tate, E., Burton, C. G., & Maroof, A. S. (2015, October 13). Social vulnerability to floods: Review of case studies and implications for measurement.

https://www.ready.gov/hurricanes
Hurricanes. (n.d.).

https://www.weather.gov/mfl/saffirsimpson
Saffir-Simpson Hurricane Scale.

## HANDOUT 3A — RISK BACKGROUND QUESTIONS

Name: _____ Date: _____

Place your name on the packet that you were given to use with this worksheet. You will need to turn it in when you are finished answering the questions on this worksheet. Circle or highlight the information that you did not understand or that you found confusing.

**1.** In your own words, define disaster risk.

**2.** How is a disaster risk determined?

**3.** In your own words, what are the types of disaster risks and give an example of each.

**4.** Describe a hazard.

**5.** What is the difference between a risk and a hazard?

**6.** In your own words, describe the 5 classifications of hazards and give an example of each.

## HANDOUT 3A — RISK BACKGROUND QUESTIONS

Name: _____ Date: _____

**7.** What is important for you to know about the characteristics of hazards?

**8.** How can hazards be reduced?

**9.** What does "exposure to hazard" mean?

**10.** What causes people to be more exposed?

**11.** How can exposure to risk be reduced?

**12.** What is vulnerability and who is most vulnerable?

## HANDOUT 3A — RISK BACKGROUND QUESTIONS

Name: _____ Date: _____

**13.** What factors make a person more vulnerable to the risk?

**14.** Vulnerability matters because:

**15.** How can you determine how vulnerable a person is to the risk?

**16.** What can we do to help reduce our vulnerability to the risk of things such as natural disasters.

**17.** What are some ways that risks should be communicated to the public?

**18.** What is a tropical cyclone?

## HANDOUT 3A — RISK BACKGROUND QUESTIONS

Name: _____ Date: _____

**19.** List and describe the four classes of tropical cyclones.

**20.** What is a hurricane and what are the categories of hurricanes?

**21.** In your own words, describe the risks associated with hurricanes.

**22.** Describe how our area is exposed to tropical cyclones.

**23.** Why were people vulnerable during Hurricane Katrina?

## HANDOUT 3A — RISK BACKGROUND QUESTIONS

Name: _____ Date: _____

**24.** Someone asks you how to get ready for a hurricane, what would you tell them?

## HANDOUT 3B — RISKS AND WHAT YOU CAN DO

Name: _____ Date: _____

**I.** Go the website: https://www.floodauthority.org/
**II.** Click on the **Education** tab and then on the **What You Can Do** link

**1. PROTECT YOUR HOME:** Click on the **Learn More** in each of the 3 ways to protect your home. **Write a summary of each way that you can protect your home.**

**A.** _____

**B.** _____

**C.** _____

**2. HURRICANE PREPAREDNESS:** Click on the **Learn More**. Look on the right-hand side of the page and list the 3 steps and what is covered under each step.

**STEP 1:** _____

~ _____

~ _____

**STEP 2:** _____

~ _____

~ _____

~ _____

~ _____

**STEP 3:** _____

~ _____

~ _____

## HANDOUT 3B — RISKS AND WHAT YOU CAN DO

Name: _____ Date: _____

**I.** Go the website: https://www.floodauthority.org/
**II.** Click on the **Education** tab and then on the **What You Can Do** link
**III.** Scroll down to **Evacuation Plan**

**3. EVACUATION PLAN:**

Click on the **Learn More**. Summarize the important information for A — residents with transportation and a destination in the space provided.

**A.** _____

Click on the **St. Bernard Parish Homeland Security and Emergency Preparedness** link (if it does not appear go to http://sbpg.net/DocumentCenter/View/109)
Summarize the important information for B — residents without means of transportation or an evacuation destination in the space provided.

**B.** _____

## HANDOUT 3C — HELPING OTHERS REDUCE THEIR RISKS

Name: _____ Date: _____

Use the questions below to formulate a plan for educating others on how to reduce their risks to flooding.

From all that you have learned about risk and our vulnerability to the risks associated with flooding, how would you educate your family and friends about ways to **Reduce the Risk** especially as part of their hurricane preparedness plan?

_____

What method would you use to educate them: public service announcement script—morning news, brochure, poster, etc.?

_____

What would you tell them? _____

_____

Who would need to evacuate in the event of a storm/hurricane?

_____

What would you tell them? _____

_____

What areas of the parish do you think are most vulnerable?

_____

Where would they evacuate? _____

_____

In what direction would you evacuate? _____

_____

Write a rough draft of your plan here. You may continue your plan on the back of the page.

_____