

**Houston's Geological Hazards:
Living With, and Surviving Floods, Tropical Storms, and Hurricanes**

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*I've known rivers:
I've known rivers ancient as the world and older than the flow of blood in human veins
My soul has grown deep like the rivers...*
~ Langston Hughes

August 1963 was the time of my arrival as a bright-eyed, fresh out of high school, college student on the campus of Texas Southern University in Houston, Texas. The city was continuously growing, but still had the “small town” atmosphere in its respective communities. Little did I know that the city had been born on the banks of Buffalo Bayou and developed on swampland. The only two major thoroughfares at that time were the 45 and 59 freeways. Much of the city was still wooded and underdeveloped. Over the years, Houston has become a metropolitan area that invites people from all cultures, from all over the world, to come to taste and savor life, and to bask in the warmth of southern hospitality in our wonderful city.

It seems that overnight the development accelerated, and other major thoroughfares were constructed (Loop 610, Highway 288, and Beltway 8). NASA, and Clear Lake City became focal points of the world, and subdivisions and planned communities surrounding the Houston area proper seemed to grow like a perfectly tended garden.

When my family and I moved into our second home, our main thoroughfare (South Post Oak Road) was a two-lane road. The land across from my subdivision was nothing but a mini-forest, and flooding was unheard of. As the years passed, South Post Oak became a four-lane highway, new developments were built, and the flooding (temporary mini-rivers) seemed to come out of nowhere. (Little did I know then, that flooding had always been a problem, which challenged the founding fathers since the first settlement was completed.) Serene, picturesque neighborhood streets became dusky rivers like the ones mentioned in Langston Hughes' poem. The flooding was caused by hurricanes, tropical storms, or simply heavy rains dumping too much water on too little natural space to hold it until it could drain away on its own. I watched as my friends and neighbors had to endure starting over again and again because flooding had destroyed their properties. I would observe herons walking next to the side of the roads, displaced too, because of the urbanization that had destroyed their habitats either by flooding or by the hands of man. Rebuilding and starting over became a way of life.

This new dilemma has, in my opinion, created a need for a more in-depth study of Houston's weather-related disasters and their causes for the children who will inevitably experience them. Such a study will allow the lessons learned by previous and current generations to be used by our next generation to better plan for the continued demographic and geographic growth of our city.

People have always built their communities in places they thought were desirable, either for economic prosperity or out of necessity. Time and time again they have had to brave geologic hazards and Mother Nature's fury. Through trials and errors they have adapted themselves to the

land. Children need to be knowledgeable of the history of their cities and communities so that they are aware of the changes that have been made in order for their environment to be inhabitable.

The objective of this unit is to make my third grade students aware of the causes and effects of events such as tropical storms, flash flooding, hurricanes, tornados, and other natural disasters in Houston. Such events affect the planning and running of our city and both directly and indirectly affect the lives of its citizens. This study will also provide them with methods and simulated activities to understand these natural phenomena. They will gather research that will explain why and how these natural events occur and the lessons learned by those who experienced and survived them. They will make time-lines as they draw conclusions about the frequency of these events. As their awareness and knowledge grows, hopefully a seed will be planted to keep this perception alive and motivate them to make changes as adults in our society to keep these events from affecting our city so devastatingly. It is my passionate belief that knowledge is power, and that continuous study of the mysterious becomes knowledge. If children know the reasoning behind any fearful or unknown encounter, they can face it with courage. They can literally apply the theory “there is nothing to fear, but fear itself.”

The study of these natural phenomena covers a very broad area. We will define the previously mentioned weather-related disasters, but focus specifically on flooding caused by hurricanes, tropical storms, and flash floods in the Houston and Harris County area. Most serious floods in this region are caused by hurricanes and tropical storms. Because of Houston’s flat topography, heavy rain can cause flash flooding in localized areas. This study will be incorporated into the Houston Independent School District’s CLEAR curriculum, Science Model Lessons, Unit 4 Earth’s Forces. Model Lessons and activities contained in the guide will provide more activities for the students to have hands-on experiences to clarify the more abstract concepts.

This unit will introduce, maintain, and apply language arts, map skills, science, social studies, Houston’s history, and the geographical awareness of our environment. Such knowledge and skills are needed to exist amicably with nature’s geographical formation and the founding fathers’ and current city planners’ visions of growth and development for our city. The students will acquire a better understanding of why our communities have flooding after unanticipated downpours and heavy rains (some, but not all of which result from tropical storms and hurricanes). The integration of this study into a previously written unit on Houston urbanization (Embracing the Wild Things Next Door, 2002-2003 Seminar), and the state-mandated TAKS (Texas Assessment of Knowledge and Skills) and TEKS (Texas Essential Knowledge and Skills) objectives, will aid the students in their understanding of the geological hazards affecting our city. The HISD CLEAR curriculum and model lessons in Language Arts, Science and Social Studies will also be integrated in the lessons and activities of this unit of study. The geography and weather patterns of surrounding areas (from adjacent cities to bordering states) will be studied together, in order to connect the students’ knowledge to the “big idea.” The students will experience and engage in hands-on studies and activities and have “real” experiences (through simulations, dramatizations and experiments) rather than just digesting abstract facts and pictures taken from textbooks and the Internet. Interactive websites will be used in order for the students to focus on more specific simulations of weather occurrences in order to gain a more in-depth comprehension.

During our study, the students will read books and articles and view PowerPoint presentations, videotapes, and film clips that focus on storms and other natural disasters. We will focus primarily on the Houston area, but will compare and contrast other areas in which similar disasters have occurred. They will discuss how the cities and people recovered, what changes were made in specific weather-warning systems, and how the communities and families were

affected by such changes. Literature Study Groups and Research Teams will read and discuss books with flood- and hurricane-related themes, and share them in Book Talks with the other members of the class. Musical compositions about storms will be incorporated in the writing lessons, as students listen for specific storm-related musical passages with instruments representing specific parts of the storms.

During these sessions I will collaborate with our deaf partner's teacher on the special needs of those students, in order to include them in our research projects and discussions. Other collaborative efforts will include the music teacher (students will compose musical representations and dramatic presentations of the sounds, causes, and effects of a storm, etc.); art teacher (students will draw or make models of "storms" and collaborate on their final projects), computer technologist (students will make power point presentations of their research and study specific websites as a whole group), and the science teacher (the students will have an in-depth study unit on weather).

We will conduct scientific experiments in our classroom to examine weather phenomena in detail. We will draw our own weather maps and delineate local watersheds in order to better understand these phenomena. After the unit is introduced and the students spend a class period in the computer lab studying the "how stuff works" website, they will design their own hurricane. Weather journals will be set up next, to record observations and alerts of weather forecasting. In order to address our TAKS (Texas Assessment of Knowledge and Skills) and TEKS (Texas Essential Knowledge and Skills) components, the students will write questions about their unit of study using the TEKS and SDAA (State Developed Alternative Assessment) formats.

We will form buddy groups with sixth, seventh, and eighth grade students in order for the third grade students to get immediate feedback, reassurance, and help as they do their research. These collaborative efforts are possible because of the vertical alignment with our ancillary, and deaf and vanguard teams at T. H. Rogers. These teams meet bi-monthly for collaboration and alignment of objectives, and email our lesson plans to each other and our assistant principal so that each member knows what the other is doing in class. Our assistant elementary principal is always involved in our work. This way, when we plan activities that can include other members of the student body or staff, those activities can be included in our weekly newsletter and monthly calendar. Of course, this information also keeps the parents informed and more likely to volunteer to help, thereby making the bond between home and school even stronger.

Culmination of the study will require the students to construct before-and-after models of an imaginary city or Houston affected by either a natural disaster or other geological hazard that they have created. They will be required to write a composition (including research) explaining their models, which will enable them to apply and exhibit the knowledge they have required. It will meet the research component of the Houston Independent School District's Language Arts CLEAR curriculum. The students will take their own TAKS and SDAA tests to prove mastery of the concepts. Another written presentation of their study will be an ABC book of Flooding, Tropical Storms, or Hurricanes. The students will choose their book titles. Students will design rubrics for assessment of each of the unit's projects.

During the unit, students and their families will conduct safety assessments of their homes and routes traveled in order to be prepared in case of the occurrence of any of these events, and to further give the study credibility and reality. Results of these assessments will be shared at a time to be determined later in our study.

This eleven-week unit will start at the beginning of the first nine-week period and extend two weeks into the second nine-week period. The first weeks will be used for researching and experiencing (hurricane season begins June 1), and the remaining weeks for the construction of the models, and completion of research, PowerPoint presentations, setting up displays of projects,

and general presentations to parents and other classes. Once the entire study is completed, the students will leave the exhibits of their work in the foyer of the Vanguard hallway at T. H. Rogers School until Thanksgiving vacation. (Hurricane season officially ends November 30.)

UNIT BACKGROUND

Our study will gain credibility from the sources quoted or cited in this unit. We will begin with definitions of specific vocabulary needed to complete a thorough study.

What is a Hurricane?

The name Hurricane comes from “Hurican,” the Caribbean god of evil.

A hurricane is a **tropical cyclone** with wind speeds above 75 miles per hour. Speeds higher than that are classified to sustained winds by the Sarrif-Simpson Scale, a scale used to categorize hurricane intensity potential and to give officials and the public an idea of what to expect from an approaching hurricane (Williams). The scale is named after Herbert Saffir, a consulting engineer, and Robert Simpson, director of the National Hurricane Center from 1967-1973). The World Meteorological Organization was preparing a report on structural damages due to windstorms. Dr. Simpson added information about storm surge heights that accompany hurricanes in each category.

Hurricanes are given names by the National Hurricane Center. These names are taken from a six-year rotating list of male and female names. When a powerful hurricane makes landfall and causes death and damages, the name is retired from the list to avoid confusion. (Example: Andrew, 1992)

Hurricanes are categorized by their sustained wind speed. To be a hurricane, the sustained winds must be at least 74 miles per hour (mph). The different categories of hurricanes and their associated damages are listed below in table 1.

Sarrif-Simpson Scale	Sustained Wind Speed	Damage
1	74-95 mph	Primary damage to mobile homes, shrubbery and trees, some coastal road flooding
2	96-110 mph	Major damage to vegetation, small craft in unprotected anchorages break moorings
3	111-130 mph	Structural damage to small homes, destruction of mobile homes, flooding near the coast, may be flooded inland 8 miles or more
4	131-155 mph	Complete roof structure destruction on small dwellings. Major erosion of beach, mass evacuation may be required of residential areas inland as far as 6 miles
5	>155 mph	Major damage to residences and industrial buildings, small utility buildings blown away, massive evacuation of residential areas within 5 to 10 miles of the shoreline

Table 1: Hurricane Categories and associated damages (“The Saffir-Simpson Hurricane Scale.” NOAA)

Category 4 and 5 hurricanes are very destructive, however even those with lower speeds can cause extensive destruction and loss of life. One reason they are so destructive is that they cause storm surges and severe flooding. Flooding is the cause of most of the non-wind-related destruction during a hurricane. Students will focus on two types of flooding that occur in our city and surrounding counties. Street flooding, (when the streets and thoroughfares are impassable because of high water), and over bank flooding (when the bayous and other water bodies cannot contain the excess water caused by flash flooding) (Moore).

A tropical cyclone consisting of swirling masses of air moving general westerly direction and occurs in the Caribbean and the Gulf of Mexico is called a hurricane. It is a very intense 'Depression' with extremely low atmospheric pressure. This gives rise to winds of great force, which are extremely destructive. The winds circulate round the center or eye of the storm in an anticlockwise direction (north of the equator). The eye of the hurricane has a diameter of approximately 150-300 km. It is accompanied by dense black clouds, torrential rainfall, often thunder and lightning and storm surges that cause flooding in coastal areas" ("Natural Hazards").

Hurricanes do not start out as hurricanes. They have four stages of development. They begin as a **tropical disturbance** (tropical means they generated in tropical areas of the ocean near the equator). In Houston, water bodies affected would be the North Atlantic Ocean and the Gulf of Mexico). It is a cluster of showers and thunderstorms with little or no circulation. The tropical storm develops into a **tropical depression**, which is a tropical disturbance that is more organized and has a closed circulation and wind speeds from 25 to 28 miles per hour.

A tropical storm is next and develops when a tropical depression gains wind speeds.

Hurricane is the final stage. It can take from hours to several days for a thunderstorm to develop into a hurricane.

A hurricane has three parts: the **eye** (calm center of circulation, usually 20 to 30 miles in diameter, characterized by low pressure and clear skies), the **eye wall** (area around the eye with the fastest, most violent winds), and **rain bands** (bands of thunderstorms circulating outward from the eye that are part of the evaporation condensation cycle that feeds the storm) ("How Hurricanes Work").

Two other terms related to hurricanes that the students need to be familiar with before they begin their study are: **storm surge** (the large dome of water that accompanies the landfall of a hurricane), and **wind shear** (upper level winds blowing from east to west against a westward bound hurricane).

The students should also know about hurricane watches and warnings. A storm **watch** is the informing the public of potential danger when a tropical storm is 48 hours from landfall. A storm **warning** is issued to inform the public that danger is developing, as a tropical storm is 24 hours from landfall.

What is a Flood?

Flooding is the rising of a body of water and it's overflowing onto normally dry land. It is a great flow of water over land that is usually dry. It is also a general and temporary condition of partial or complete inundation (flooding) of normally dry land areas from overflow of inland or tidal waters, unusual or rapid accumulation or runoff of surface waters (HISD CLEAR Unit 4 Earth Forces, 37).

A **flash flood** is a condition in which rainfall is so rapid that it precludes recording and relating it to stream stages and other information in time to forecast a flood condition. ("Natural Disasters: Floods" library.thinkquest).

Identified as the fastest-moving type of flood, heavy rain collects in a stream or gully, turning the normally calm area into an instant rushing current. ("Flash Floods!")

What Causes Flooding?

A common cause of floods is tropical storms. They form over the warm waters of the tropics, so they are full of moisture. When certain conditions form, these storms are brought toward land, and many inches of rain fall. This precipitation is too much for the streams to handle, causing

water to overflow and produce inland floods. Many of the tropical storms that flood our area form over the Gulf of Mexico.

What Damages do Floods Cause?

Floods disrupt normal drainage systems and cause sewage spills. This of course causes a serious health hazard when coupled with standing water and wet materials in the home. The water encourages bacteria, mold and viruses that cause disease, and trigger allergic reactions. They ruin homes and businesses and destroy personal property. The water left behind causes further damage to property and contents. The environment and wildlife is also at risk when the damage to business releases toxic materials like paints, pesticides, gasoline, etc. The waters from flood can disrupt public and personal transportation by cutting off roads as well as communication links when telephone lines are damaged. Personal tragedies are another result of floods when people are swept away and drowned. (“Flooding” environment-agence.gov)

“Floods can distribute large amounts of water and suspended sediment over vast areas, restocking valuable soil nutrients to agricultural lands.” (“Flooding.” environment –agency.gov) This is a good effect caused by flooding, however; on a not so positive note, it erodes the soil with fast flowing water, ruining crops, and destroying agricultural land, buildings and drowning farm animals. (“Flooding” environment-agency.gov).

“Flash flood waters move at very fast speed. They are powerful enough to move boulders, tear out trees, destroy buildings and dismantle bridges. These waters can reach heights of 10 to 20 feet and generally carry a huge amount of debris with them (“Flash Flood!”).

Most Texas coastal areas are underlain by soils that allow rainwater to slowly soak into the underlying aquifer systems. When the storage capacity of the soil becomes exhausted (in the case of urbanization, it becomes “impermeable” because it is paved over) and the ground cannot absorb water added by storms. When that happens, the runoff is diverted to our bayou system or a reservoir.

Now that I have established the basic definitions, causes and effects, the next step is to learn where floodwaters drain in Houston.

Where Does the Water Go Before Flooding Begins?

Houston’s streams and bayous are affected by the size of the areas they drain, and the ability of the land surface to absorb the amount of water it receives. The area drained by a river is referred to as its watershed.

“The initiation of large-scale urbanization within a watershed causes an unintended alteration of the natural hydrologic system. When urbanization renders soil impervious, the net result of overdevelopment severely limits the capacity of the soil. Additionally, the volume of water stored in the drainage channels is more quickly concentrated-the same volume of water must drain out of the system, but in the urbanized system it will happen in a matter of hours instead of days or weeks. The quick response makes the watershed susceptible to flooding from relatively short intense rainfalls (“Flooding and Flood Policies”).

This explanation shows immediately why Houston floods because of a heavy downpour. During our discussions, the students will be able to draw this conclusion and give reasons from experience why a specific area they are familiar with floods often. As evidence of this knowledge and observations, they will be required to keep a “weather” journal. Days of rainfall and its intensity will be recorded in these journals. The journal will provide a record-keeping document of flooding and other weather occurrences as their lives are affected directly. As an extension of this knowledge, we can pinpoint specific areas on our campus that flood and give

reasons why we think this happens. Perhaps this study will allow the students to arrive at solutions they can present to our campus administrators.

We all live in a watershed “in the city, in the country, on a mountaintop, or in a swamp. Water drains from wherever we live to a river, bayou, lake, or a bay. Our choice of a place to live has a direct impact on the rivers or bays where we drain. Water drains into the watershed (a land area that drains runoff, (storm water) to a common outlet point—typically a body of water which is mostly creeks and bayous). Watersheds can be large or small, and smaller watersheds exist within larger watersheds. We can also live in more than one watershed. Each watershed is like a bowl within an outlet” (“Texas Coastal Watershed Program”).

Houston has 22 watersheds that each drain into 22 major waterways. Some of Houston’s larger watersheds are: Buffalo Bayou, Braes Bayou, Addicks Reservoir, Armand Bayou, White Oak Bayou, and Sims Bayou. As we study our “water run-off geography,” the students will study their own watersheds. They will learn that T. H. Rogers is in the Buffalo Bayou Watershed. They will study the map that shows all of them, and the water bodies into which they drain.

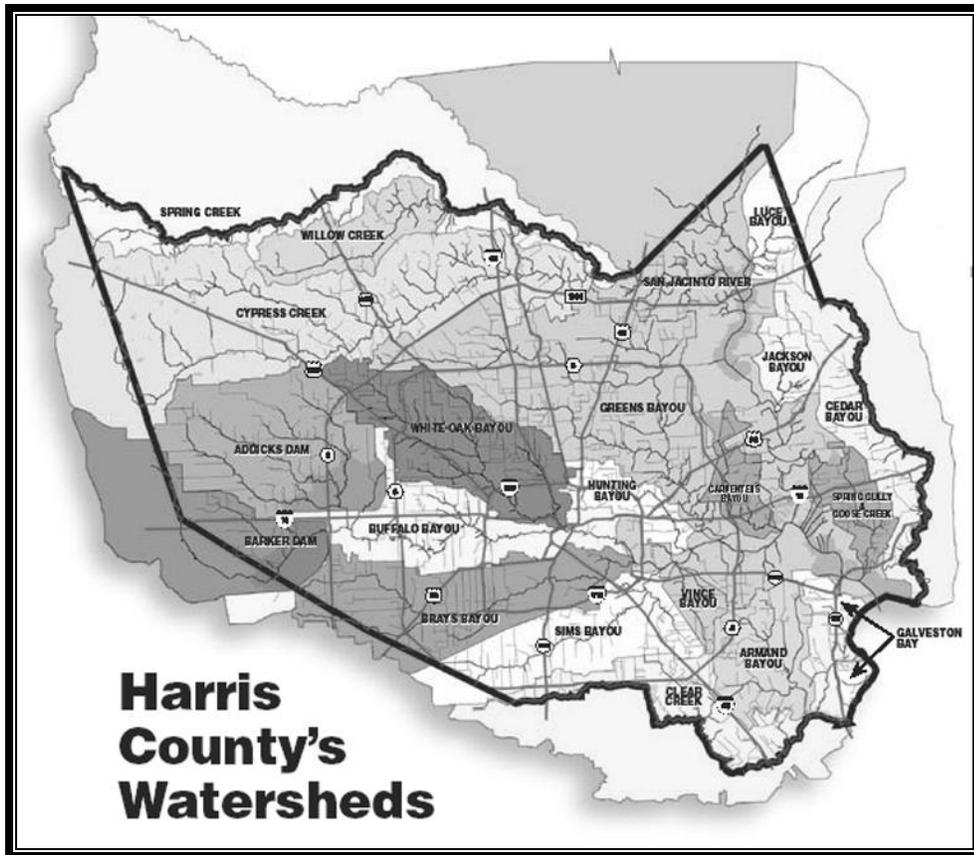


Figure 1: Harris County's Watersheds (TSARP 14)

The students will learn that runoff from storms is the most common way water gets from where we live down to the stream or bayou that drains their watershed(s). People who reside in the countryside can easily follow the path the water follows—through a few ditches (if they exist) until it reaches the first creek. City dwellers (like themselves) will not see the path so readily. They might see the water for the last time after it leaves their homes. After water goes down the storm drains, it goes through a series of pipes right into the ditches, bayous, or creeks just as it does in the country. Whatever goes into the storm drains directly, or what is put on the lawn,

(fertilizers, etc.), or thrown on the ground goes right into the rivers or bays (“Texas Coastal Watershed Program”).

The following paragraphs are based on a discussion about Brays and Buffalo Bayou watersheds are taken from the Harris County Flood District’s website.

T. H. Rogers School (the school my students attend) is located within the Buffalo Bayou watershed. This watershed is located in West-Central Harris County and drains an area mostly within the city of Houston and to a lesser degree, Memorial Villages. Buffalo Bayou is the primary stream within the watershed and the sole outlet for the Addicks and Barker reservoirs. The bayou flows into the Houston Ship Channel after combining with White Oak Bayou and passing through downtown Houston. Buffalo Bayou becomes the Houston Ship Channel at the Turning Basin. The watershed covers approximately 103 square miles and has about 47 miles of open streams within the watershed, including the primary stream and tributary channels (“Buffalo Bayou Watershed,” Harris County Flood Control District).

Brays Bayou is another of Houston’s main watersheds. “The Brays Bayou watershed, which drains approximately 128 square miles is located in southwest Harris County, and runs through the cities of Houston, Missouri City, Stafford, Bellaire, West University, and Southside Place. Brays Bayou flows eastward for 31 miles from its headwaters in Fort Bend County to its confluence with the Houston Ship Channel. Except for the western regions, underdeveloped areas of significant size are rare” (“Brays Bayou Watershed,” Harris County Flood Control District).

Included in the Brays Bayou watershed are critical developments such as the Texas Medical Center, the Houston Zoo, Houston Baptist University, Rice University and the intensely developed commercial corridor along the Loop 610 and the U. S. 59 interchange...

The watershed contains forty-six sub basins. The portion of the watershed upstream of Main Street, located in the Medical Center, has an area of about 95 square miles and contains thirty-nine of the sub basins. The Harris County Office of Emergency Management (HCOEM) currently has eight operating gages along the bayou recording water levels during rainfall events. Harris Gully is a smaller tributary that flows underneath the Medical Center and is important due to its close proximity to the Medical Center...

In spite of flooding that caused severe damage in the early 20th century, no action was taken to prevent this until 1937, when the Harris County Flood Control District was created. This was not activated until 1939, when a flood control master plan was developed. In 1945, the 13,000-acre Barker was completed and later during that same decade, the 11,600-acre Addicks-Reservoir was completed to serve the Buffalo Bayou watershed. Eleven independent drainage districts in the Harris County area were merged under the HCFDC so that drainage issues would be resolved.” (“Flooding and Flood Policies”)

This explanation and discussion of watersheds, their history and functions will aid in enabling the students to draw the conclusion of why Houston floods because of a heavy downpour.

“Houston was established at the point of juncture of Buffalo and White Oaks Buffalo Bayou. Very shortly after the settlers established their homes, every new structure in the settlement flooded. The settlers began to keep records of having to walk through knee-deep waters for days during their wagon trips west through the prairie” (“Harris County Flooding History,” Harris County Flood Control District).

As a solution, they set out to “drain the land by building channels to flow downhill. They also wanted to clear it of as much of its natural habitat to continue their agricultural and constructional projects. They wanted the water to go away in what they considered a reasonable amount of time, so they drained without any specific purpose of awareness of rainfall. As the channels they built got deeper, they got wider” (Harris County Flood Control District).

Sixteen major floods occurred in Harris County from 1836 to 1936. Some crested at more than 40 feet, turning downtown streets into raging rivers. This caused extensive property damage, loss of lives, and crippled the Port of Houston for months. During the 1920’s and ‘30’s, the federal government was financing huge water infrastructure projects, so Houston tapped into this engineering endeavor, but they needed a local agency to serve as a sponsor. Thus, the Harris County Flood Control District was born on April 23, 1937. There have been 30 damaging floods in the Houston area since the formation of the Flood Control District, in spite of all the efforts they have made. None, however, caused widespread regional flooding until Tropical Storm Allison in 2001.

Hurricanes and Floods that have affected Houston and the Gulf Coast Area

This part of my unit will focus on the major hurricanes that occurred from 1961-2004 in the Houston area and other counties and states of the Gulf Coast Area (states that border the Gulf of Mexico). The student Research Teams will choose a specific storm to research and write about. Table 2 below will serve as an aid for the students to choose a hurricane for in-depth study. Collaboration with the Computer Lab teacher will be used here for the students to complete a PowerPoint presentation on their storm. Flooding caused by this storm will also be analyzed, as flooding is one of the main impacts of hurricanes.

Name and Date of Occurrence	Areas Affected	Approximate Wind Speeds	Category
Carla/1961	Texas	140 mph	4
Hilda/1964	Louisiana	115 mph	3
Buelah/1967	Texas	120 mph	3
Camille/1969	Mississippi	190 mph	5
Celia/1970	Texas	125 mph	3
Carmen/1974	Louisiana	120 mph	3
Eloise/1975	Florida Panhandle	125 mph	3
Frederick/1979	Alabama	130 mph	3
Allen/1980	Texas	115 mph	3
Alicia/1983	Texas	115 mph	3
Elena/1985	Alabama Mississippi	115 mph	3
Andrew/1992	Louisiana	115 mph	3
Opal/1995	Florida Panhandle	115 mph	3
Bret/1999	Texas	115 mph	3
Ivan/2004	Alabama/Florida Panhandle	120 mph	3

Table 2: Selected Gulf Coast Hurricanes from 1961-2004

We will begin our research with the busy hurricane season of 2004, which some say may be the costliest on record. This was clearly one of the most devastating hurricane season for Florida, which experienced four hurricanes back to back: Charley (August 15), Frances (September 5), Ivan (September 15), and Jeanne (September 26).

The following dialogue will summarize information about the most destructive and powerful hurricanes. Students can choose their storm for research from those listed in table 2, or others they read about during research sessions in the computer lab or at home.

Hurricane Ivan was the third most devastating hurricane in the United States. It caused major flooding and brought rivers and streams near Atlanta Georgia to or near 100-year records. Ivan was formed on September 2, 2004, about 555 miles southwest off the coast of Cape Verde Islands. It started out as a tropical depression, strengthened to a tropical storm and was given the name Ivan on September 3rd. Winds strengthened to hurricane category 3 status on September 5th. The path of Ivan started west and weakened to a category 2, but after passing through Grenada (northern South America) strengthened to a category 4 with winds at 135 miles per hour. Ivan continued northwest and retained category 5 intensity with 165 miles per hour winds on September 13th. The storm continued toward Alabama, and by the time it made landfall, wind speeds were 120 miles per hour. After the eye passed through Alabama, Ivan weakened to a tropical depression. (“Hurricane Ivan”).

Another storm of interest is **Hurricane Andrew**, which smashed onto the Miami-Dade County Coast August 24, 1992. It was a deadly hurricane that caused \$22 billion in damage and took 52 lives. It was a small but ferocious system whose path caused economic devastation through the northwestern Bahamas, the southern Florida peninsula, and south-central Louisiana (Rappaport).

These are but two of the hurricanes from the chart (Table 2) the students will study. As we progress in our unit, they will choose and research more storms on their own. These research sessions will be held on the day the students go to the computer lab so that they will each have their own computers. Each computer session for the duration of the unit will focus on research or an interactive website.

Flooding is one of the major occurrences during hurricanes. The students will create their own flood using Internet resources. They will be allowed to alter the planned activities to fit their own curiosity needs. They will show comprehension of how a flood is created by writing summaries and presenting them to the class. They can use photo essays, poster board displays, dioramas, poetry, skits and demonstrations.

For historical research, the students will study the **Galveston Storm of 1900**. During the spring semester, we will visit the Galveston harbor, tour the city and see the film of the storm from Galveston’s archives.

For local hurricane study, we will choose **Hurricane Alicia**, which formed over the Gulf of Mexico in August 1983. Alicia made landfall on August 8th in Galveston. The storm’s eye passed over Houston as it continued its northbound path toward Oklahoma. It was the first hurricane the National Hurricane center predicted landfall probability. The students will be challenged to find as much information as they possibly can about the storm. It should be enlightening for them to see the technological advancements that have been refined since that time in history.

Tropical Storm Allison, June 6, 2001 was the most dangerous tropical storm in Houston’s records (TSARP). We will use this weather event as our flood study. This storm will be most memorable to those students who experienced it as kindergarteners. When the students conduct their own study, they can choose this storm or another they find interesting while conducting research. Individually created tropical storms will be part of the study. The students will create their own tropical storms using resource activities from the Internet.

Allison was the first named tropical storm of 2001. She formed in the northwest Gulf of Mexico, on June 5th, only five days into the 2001 hurricane season. Houston’s Metro Area,

surrounding communities, and portions of Southeast and East Texas were hit and devastated by the storm. Severe flooding was caused by record amounts of rainfall. The severe flooding was caused by three distinct heavy rain events. The first rainfall event occurred when Allison made landfall on June 5th, affecting northern Galveston and southern and eastern Harris counties. June 7th, the second event stretched from Liberty County southwestward into the Houston area and northern Fort Bend County. The third and most devastating event on the 8th and 9th stretched from Conroe to the Woodlands, to Houston and on into northern Galveston County again. Nearly 37 inches of rain was recorded at the Port of Houston during this five-day event (“Flood Safety”).

This storm was the costliest natural disaster in Houston’s history. Damage in Harris County alone has surpassed \$4.88 billion (“Flood Safety”). These costs have risen as damaged areas outside the city of Houston were still pending as of this article’s publication (“Tropical Storm Allison Floods”).

PREPARATION FOR STUDY

Before the unit is introduced officially, contact your local television station to set up a visit from the meteorologist (weather reporter). In Houston, I will contact KHOU (channel 11), KPRC (channel 2), and KTRK (channel 13). It is also very important to gather and assemble the “storm” library. More resources should be added as the study progresses. This library should stay in place during the entire school year, as it could serve as the focal point of the designated science center area in the classroom.

The students and I will discuss the current hurricane season in the Gulf Coast Area during the first week of school. We will talk about the hurricanes that developed and made landfall (if any) during our summer vacation. At the end of the discussion, we will familiarize ourselves with the hurricane-tracking chart (these can be picked up from any grocery store) and design our own weather journals. We will follow the progress of storms by monitoring weather reports on television, and radio, and by reading newspaper articles on the current storm(s). The journal and hurricane tracking chart activities may take two class sessions to complete. Hurricane and tropical storm monitoring should continue throughout the season. Approximately 10 minutes of daily class time should be set aside for storm monitoring discussions.

Hurricane Preparedness will be included in our study. We will make charts as a class of preparations that are necessary for surviving a hurricane and the weather events that happen as a result. This document will be a work in progress as we work through our research and observations. A contest for the best-designed chart will motivate the students’ creativity and prepare them subtly for competition in our annual science fair.

Objective

To design and complete a weather journal

Materials Needed

Construction paper

Unlined copy paper

Notebook paper

Crayons or map pencils

(These are only suggested materials. You may choose others)

Procedure

Begin a discussion about recording observations in a journal, since hurricane studies require careful study. After deciding the contents of the journal, the students can start to put them together. Record the students’ suggestions and models on chart paper so that the students can have examples if they need them.

Parts of a Weather Journal

Cover
Title Page
Observation Page

(These are just suggestions to get started. Once the discussion with the students begins, their input should be considered before the actual activity is implemented.)

INTERNET LIBRARY

The research articles I have collected from the Internet will be made available to the students. They will be organized in a binder so that the students can use them in their projects. Any research the students gather will be placed in binders and made available to the class.

LESSON PLANS

Lesson I: Unit Introduction

Objective

To introduce the unit, and assess students' prior knowledge and experience of hurricanes.

Materials Needed

The Weather Watcher's Library Hurricanes by Dean Galiano
Chart Tablet
Markers for writing
Bulletin Board

Procedure

Upon completion of the book, the students and I will discuss its contents and make a LKW (Learned, Know, and Want to Know) chart about hurricanes. I will record the responses on chart paper that will remain posted during the unit of study. We will add responses to the chart weekly. A bulletin board will be delegated for Comments and Questions where the students who desire to respond more than once, and are not given the chance during the class time because of time restraints, can post them for future discussions.

The second computer lab session for the year will involve the students using the "how stuff works" website to further understand the workings of a hurricane. When we come back to our classroom, the students will design their own hurricane. During the study of our unit, they can use the computer to enhance their designs.

Lesson II

Objective

To discuss other weather events brought about by hurricanes.

Materials Needed

Chart paper
Markers

Brainstorming Session

Procedure

Students will respond to the question, what are other weather events caused by hurricanes? (The students will discuss this question in groups of 4 before they record their responses on chart

paper.) After 10 minutes of discussion, the students will write their responses and each group will present to the class.

(It is important that rules for working in groups are discussed before the activity begins. Each group should select one person to respond for the group when they are ready to present. The teacher should monitor the groups while they work.)

Lesson III: Hurricanes, Floods, and Tropical Storms from A-Z

Objective

To keep a record of vocabulary words introduced during the unit.

Materials Needed

Construction paper
Dictionaries
Pencils
Copier paper
Storm library
Internet
Crayons or map pencils

The students will make dictionaries of storm vocabulary words. They will define and illustrate the terms. This will be an ongoing assignment as we study and will be due at the end of the unit. The students and teacher will design a rubric for assessment.

Lesson IV: Hurricane Treasure Hunt

Objective

To research Gulf Coast Hurricanes

Materials Needed

Internet Resources
Printer

Students will research for the names of hurricanes in the Gulf Coast area during the last ten years. They will print the information so that they can summarize it in their own words. They can also use the information to guide them to other resources to use for their power point presentations.

Exposing the students and guiding them through the research will empower them to establish rules and safety tips with their families during hurricane season. We will track and study the hurricanes of this season during our unit.

*After several blasts of thunder had shaken the trembling earth,
The rain from the very clouds burst though in torrential showers!
Again there was a sudden breaking of the angry elements!
A stillness, seemed to reign on every hand and shadow!
The sun, in magnificent glory shone radiantly once more;
Everything was refreshed, from the green grass to the rosy flowers!
It was as if Nature had served here elemental sacraments,
To give new life to the ancient hill, dale, mountain and meadow!*

~ Marcus Garvey

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