

# Chapter 11: Dealing with Extreme Weather – Hurricanes in the Caribbean



## 1. Introduction

On September 7, 2004, Hurricane Ivan slammed into the Caribbean island of Grenada. “It was absolutely terrifying,” one resident said. “The winds were gusting over 145 miles per hour and just tearing off roofs.” Ivan damaged just about every home on the island and destroyed almost half of them, and more than 30 people lost their lives in the storm. One woman whose roof was torn off spent the storm huddled under a mattress with her family. “I stared death in the face,” she said. “What could be more scary than that?”

Hurricanes such as Ivan are an example of **extreme weather**, a term that refers to severe or unusual weather conditions. In addition to hurricanes, extreme weather includes **tornadoes**, blizzards, and even severe heat waves or cold spells.

Since extreme weather is often destructive, people may try to make preparations for these natural events. However, such preparations are not always possible, because extreme weather can be difficult to predict or guard against. When great damage or loss of life occurs, an extreme weather event is called a **natural disaster**. Hurricanes often produce natural disasters.

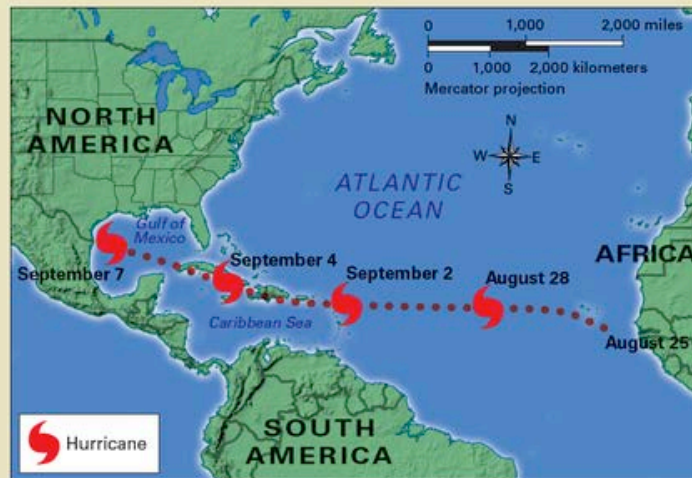
In this chapter, you will learn about the hurricanes that strike the Caribbean **region**. You will examine the causes and effects of hurricanes, and you will discover the ways in which people in the region deal with this form of extreme weather.

### Essential Question

**What causes extreme weather, and how do people deal with it?**

This map shows the course of a hurricane from the coast of Africa to the Caribbean Sea. Notice that the storm passes through several locations on its journey. At each location, people must deal with the hurricane as a dangerous form of extreme weather. Keep this map in mind as you try to answer the Essential Question.

### Graphic Organizer



## 2. The Geographic Setting

The Caribbean islands stretch in a gentle arc that extends from the tip of Florida to the northern coast of South America. Also known as the West Indies, these islands divide the Atlantic Ocean from the Caribbean Sea and the Gulf of Mexico. Thousands of islands make up this chain, with many being so tiny that only a few people live on them. However, some islands, such as Cuba and Hispaniola, are large enough to be home to millions of people.

**Islands in the Sun** The Caribbean islands lie within one of Earth's **tropical zones**. They have a warm to hot **climate** year-round, but regular sea breezes cool the islands and make the days pleasant.

These islands were first settled by small groups of Native Americans. The word *hurricane* comes from the language of one of these groups, the Taino, who believed that a storm god called Huracan controlled extreme weather events.

## ► Geoterms

**El Niño** a warm ocean current that flows off the west coast of South America every few years. An El Niño event changes weather patterns around the world. It may also cause extreme weather in some regions.

**extreme weather** severe or unusual weather conditions, such as hurricanes, tornadoes, and blizzards

**meteorology** the scientific study of climate and weather patterns

**natural disaster** great destruction or loss of life caused by natural forces rather than by human actions

**tropical cyclone** a severe storm with high winds that spiral around a calm center. Depending on where they form, tropical cyclones are called *hurricanes*, *typhoons*, or *cyclones*.

During the 1600s, European countries claimed the islands as colonies. The colonists set up **plantations**, or large farms, where they planted warm-weather crops such as tobacco and sugar. The planters tried to make native peoples work on their land, but in a short time the native peoples died out. Most of them were killed by diseases that were brought by Europeans to the Caribbean. After that, the European colonists brought large numbers of Africans to the Caribbean islands to work on their farms as slaves.

During the 1800s, almost all the Caribbean islands gained their independence. Slavery was also ended. However, independence brought new challenges, including the creation of stable governments and dealing with widespread poverty.

Today many Caribbean islands still base their economies on agriculture. Sugar remains a major **cash crop**, and bananas, coffee, and spices are also important. In recent years, **tourism** has become a key industry on many islands, and tourists flock to the Caribbean to enjoy the region's warm weather, beautiful beaches, and clear blue waters.

**Extreme Weather Is a Part of Island Life** Despite its pleasant climate, the Caribbean does get hit by extreme weather. Severe thunderstorms sometimes strike the islands, and heat waves and dry spells also occur.

The most extreme form of weather in the region is the **tropical cyclone**. In the Caribbean, tropical cyclones are called *hurricanes*. This is a powerful storm with winds of 74 miles per hour or more. From above, the storm looks like a giant pinwheel as it forms over warm water, and it produces heavy rain and high waves as it grows.

Our knowledge of tropical cyclones comes from **meteorology**, which is the scientific study of climate and weather. Meteorologists are scientists who study Earth's **atmosphere** and climate in an effort to understand weather patterns and the forces that cause them. The size and power of tropical cyclones make these storms especially challenging for meteorologists, who have nevertheless made progress in understanding these severe storms. Through their work, meteorologists are acquiring knowledge that can help to limit the damage and loss of life caused by these extreme weather events.



## 3. Understanding the Weather Machine

Weather doesn't just happen by itself. Instead, it is the product of natural forces working together like a machine. This “weather machine” takes energy from the sun, Earth, and the atmosphere and transforms it into rain, wind, and other types of weather.

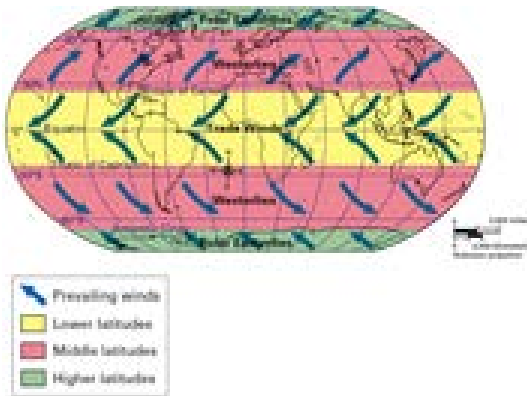
Weather affects us every day, in large and small ways—and extreme weather, such as hurricanes, can have extreme effects. Storms with powerful winds can pick things up and drop them miles away. In 1997, toads rained down on the town of Villa Angel Flores in Mexico. A whirlwind had picked up the amphibians from a nearby body of water and then dropped them over the town.

### The Sun Starts It All

Weather is caused by interactions among heat, air, and water, with the sun acting as the “engine” that drives the weather machine. As you read in Chapters 1 and 2, the sun warms Earth's surface unevenly. Its rays fall most directly between the Tropic of Cancer and the Tropic of Capricorn, whereas higher latitudes receive less direct sunlight. That is why temperatures are generally warmer near the equator and cooler near the poles.

The sun's heat is distributed around Earth through a process known as **convection**, or heat transfer. This transfer of heat occurs in both gases and liquids, such as air and water. Warm air and warm water are less dense than cooler air and water. As a consequence, warm air has a tendency to rise in the atmosphere while, meanwhile, warm water rises in the oceans.

When warm air or water rises out of an area, cool air or water flows in to take its place. The steady movement of air or water due to convection is called a **current**.



**Air and Water Move in Predictable Patterns** The movement of air and water around the globe occurs in regular patterns. In general, warm air and water currents flow from the equator toward the poles. At the same time, cool air and water currents flow from the poles toward the equator.

This predictable weather pattern creates **prevailing winds**, which are winds that predominantly blow in one direction for most of the year. If Earth didn't rotate, the prevailing winds would move in straight lines between the equator and the poles. Instead, Earth's rotation causes the wind currents to move in a curving pattern that is known as the **Coriolis effect**. You can examine the curvature of the paths of the prevailing winds on the map above. You can also see the names given to prevailing winds, depending on their locations.



### Small Changes Can Cause Extreme Weather

Wind and ocean currents have an important influence on weather because they distribute heat and cold throughout the world. Even relatively minor changes in prevailing winds or ocean currents can result in significant changes in the weather.

A good example of this effect is the impact of an **El Niño**, which is a warm ocean current that sometimes flows along the west coast of South America. This warm current does not appear every year, but when it does develop, it usually shows up during the Christmas season. That is why the current is called El Niño, which is a nickname for “the Christ child” in Spanish.

In an El Niño year, the weather on the Pacific coast of North and South America gets warmer. As a result, rainfall increases and flooding is common. At the same time, weather on the other side of the Pacific becomes drier. During these dry spells, severe forest fires sometimes occur in Southeast Asia and Australia. The effects of an El Niño's appearance can be felt as far away as India and Africa.

### Tropical Cyclones: The Most Violent Weather Events

Throughout the tropics, the weather machine can be extremely powerful because in these regions there is more energy from the sun to warm the air and water. This solar energy produces tropical cyclones, which are the most violent storms on Earth.

Tropical cyclones occur only in areas where the ocean temperature reaches at least 80°F. A large amount of warm, moist air is needed to start these storms. That is why tropical cyclones usually occur during the warmer months of the year.

Tropical cyclones form in three oceans. In the Atlantic Ocean and the eastern Pacific, they are called *hurricanes*. In the western Pacific, they are usually called *typhoons*. In the Indian Ocean, these storms are called *cyclones*.

## 4. Extreme Weather: A Hurricane Is Born

Have you ever witnessed a thunderstorm approaching? The wind picks up and the temperature drops. As clouds roll in and the sky grows dark, a bolt of lightning pierces the sky, followed by a crack of thunder. Suddenly it's pouring rain. In some regions of the world, such a storm might be the first stage of a hurricane.

### Tropical Thunderstorms Begin the Process

Hurricanes in the Atlantic Ocean usually start out off the coast of Africa. In the summer, water temperatures in that part of the ocean rise to 80°F or more. The ocean releases warm, moist air into the atmosphere, and as the warm air rises, the moisture **condenses** to form clouds and rain. The result is a tropical thunderstorm.

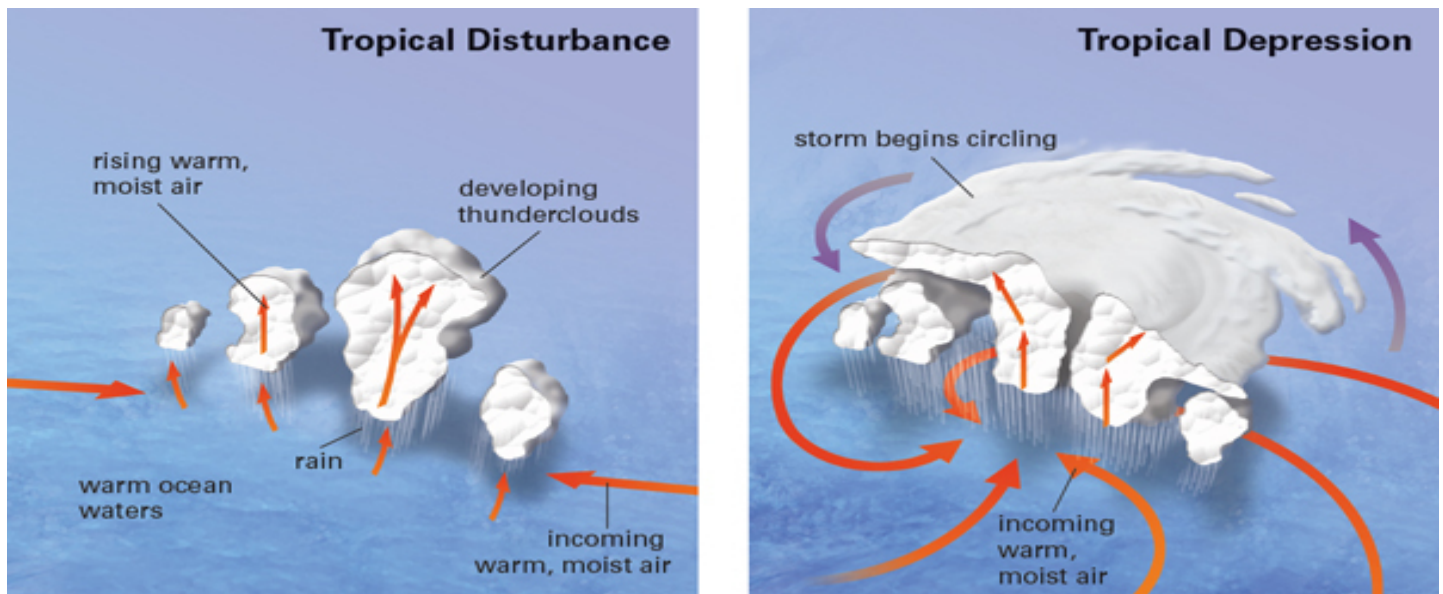
Sometimes several thunderstorms come together to create a **tropical disturbance**. This is a cluster of thunderstorms that move together with the prevailing winds.

### From a Tropical Disturbance to a Hurricane

As a tropical disturbance grows, more warm, moist air rises from the ocean. In the Northern Hemisphere, this rising air begins to circle in a counterclockwise direction as a consequence of the Coriolis effect, which you read about earlier. When wind starts circling inside a tropical disturbance, the storm becomes a **tropical depression**.

When the weather conditions are right, a tropical depression will suck up even more warm air and moisture. When the wind speeds inside the storm reach 39 miles per hour, a tropical depression is known as a **tropical storm**.

Most tropical storms die out in time, but a few storms will continue to grow in size and wind speed. When the wind speeds reach 74 miles per hour, the storm becomes a tropical cyclone. A hurricane is born!



## 5. Inside a Monster Storm

A hurricane is a massive, whirling storm, and it packs an extremely powerful punch. In just a single day, a hurricane releases more energy than 500,000 atomic bombs. If you could transform that amount of energy into electricity, it would be sufficient to satisfy the electrical needs of the United States for six months.

### The Parts of a Hurricane

A hurricane is made up of three key parts. The first part is the [eye](#), which is a calm spot at the center of the storm. The winds of the hurricane swirl around the calm eye, which might be 20 to 40 miles across.

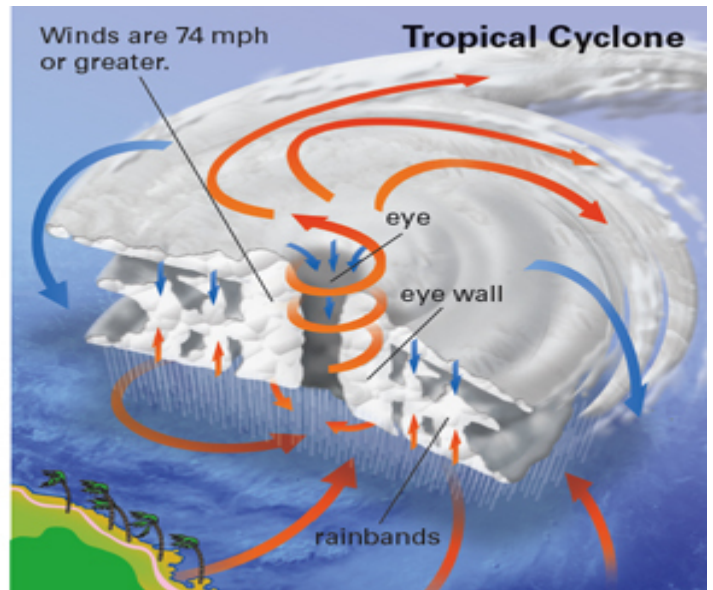
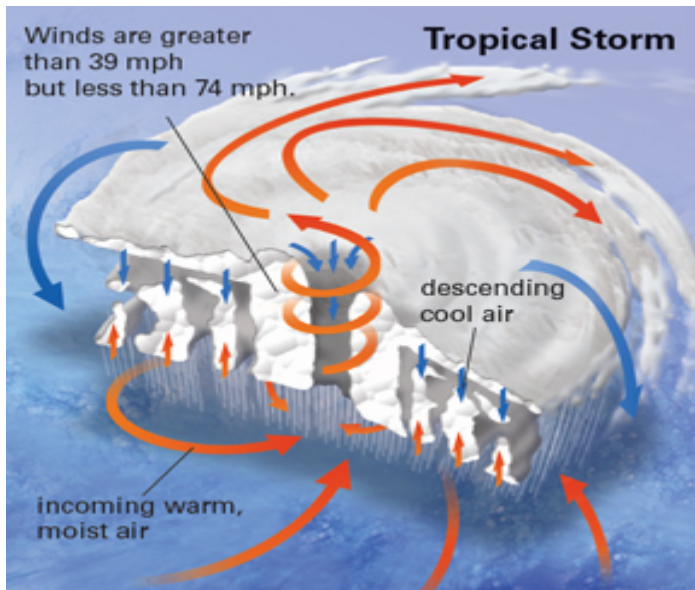
The second part of a hurricane is known as the [eye wall](#), which is made up of thunderstorms that surround the eye. The eye wall, which can be anywhere from 5 to 30 miles thick, looks like a huge curtain of clouds when it is viewed from the center of the storm.

The third key part of a hurricane consists of [rainbands](#), which are bands of dense clouds that swirl around the eye wall. Spiraling toward the center of the hurricane, the rainbands drop large amounts of rain as the storm travels across the ocean.

### The Path of Hurricanes

As you read, Atlantic hurricanes are born off the coast of Africa. When a monster storm develops, trade winds blow it from east to west across the Atlantic. The hurricane spins rapidly as it moves, like a giant top.

The exact track, or path, of a hurricane is unpredictable. A hurricane may change course with a shift in wind direction, and it may also speed up, slow down, or even stop for a while and build up strength. As long as a hurricane stays over warm water, it can continue to grow in both size and power. Severe storms can swell to 1,000 miles across in size while registering wind speeds of up to 200 miles per hour.



## 6. Tracking and Preparing for a Hurricane

“Hold on,” the pilot says to his flight crew. “We’re going in!” The plane shakes violently as it enters the storm’s eye wall, but soon the shaking stops. The plane has reached the calm eye of the hurricane.

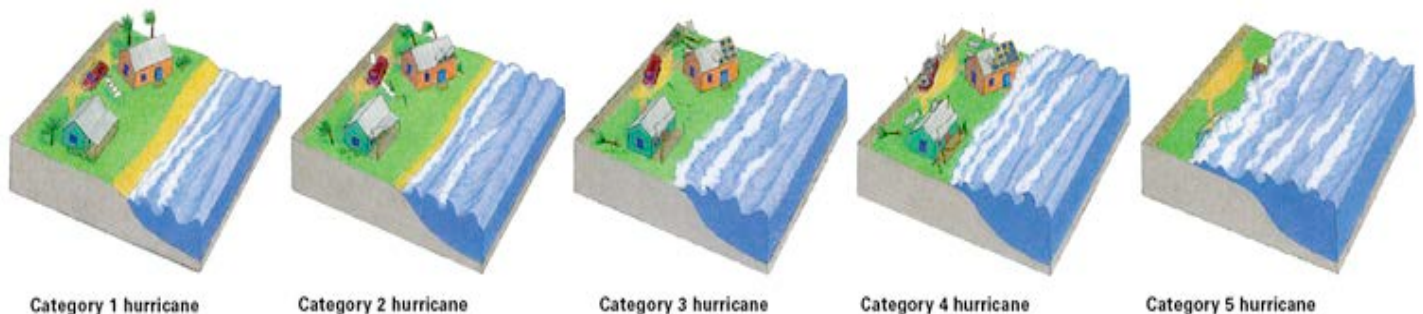
This plane and its crew are part of a special Air Force unit that is known as the Hurricane Hunters. The Hurricane Hunters fly into tropical storms in order to record weather data such as wind speed, wind direction, pressure, and temperature. The work is extremely dangerous, but the crews believe that what they are learning is well worth taking such risks. “The bottom line for all of us,” says one of the pilots, “is that we do save lives.”

### Meteorologists Track and Name Hurricanes

The Hurricane Hunters work with meteorologists to track the paths of tropical storms. The meteorologists use satellite images and data from the flight crews to predict a storm’s movement and to decide when a storm has become a hurricane. At that point, they give the hurricane a name.



Meteorologists have alphabetical lists of male and female names to use in naming hurricanes each year. The name of the year’s first hurricane always begins with the letter A. When a very destructive hurricane hits land, its name is retired and never used again. Since 1954, at least 70 hurricane names have been retired.



### Preparing for a Hurricane

When meteorologists have determined the track of a storm, they warn people who are in the storm’s path. When a storm might hit land within 24 to 36 hours, they issue a *hurricane watch*. When the storm is less than 24 hours away, they issue a *hurricane warning*. These predictions are not always perfect, but they do give people a chance to prepare for the storm.

Meteorologists use the Saffir-Simpson scale to rate the strength of a hurricane. This scale rates hurricanes from 1 to 5; the higher the number, the more damage the storm can potentially cause. This hurricane-rating information helps people decide whether to board up their windows and stay home or to seek a safer shelter away from the coast. Storms often change ratings as they travel. In 2003, Hurricane Isabel stayed at level 5 for over 30 hours, which made it one of the longest-lasting Category 5 storms on record.

## 7. Landfall: A Natural Disaster Begins

When a hurricane hits land, its power is truly awesome. "The wind is at a ferocious roar and coming in powerful bursts," wrote a reporter who witnessed Hurricane Ivan's landfall in Jamaica in 2004. "Even stepping outside for a minute would mean serious injury or worse. Hurricane Ivan has arrived in all its fury and it's terrible indeed."



### The Power of Wind and Rain

When a hurricane strikes, it lashes everything in its path with wind and rain. The most powerful hurricanes carry winds with speeds as great as 200 miles per hour. Such fierce winds can uproot trees or snap them in half. The winds are also powerful enough to shatter windows, blow off roofs, flip over cars, and hurl boats through the air.

Heavy hurricane rains often cause terrible flooding. They can also loosen rocks and soil on hillsides. The result may be deadly mudslides that crush everything in their path. In 1998, a Category 5 hurricane called Mitch dropped more than 75 inches of rain on Honduras, a small Central American country bordering the Caribbean Sea. The rain caused floods and mudslides that killed about 11,000 people.

### Storm Surge: The Most Dangerous Force of All

The most destructive feature of a hurricane is the [storm surge](#), which is a wall of water that is pushed ashore by a storm. A storm surge can rise as much as 33 feet above sea level, which is as high as a three-story building. When this wall of water hits land, it is capable of destroying everything in its path. Storm surges cause about 9 out of every 10 deaths that result from hurricanes.

The more powerful the hurricane, the higher the storm surge is likely to be. In 1999, a Category 4 storm named Lenny hit several Caribbean islands. In St. Croix, Lenny's 15-foot storm surge knocked over power poles, threw boats up on shore, and destroyed a ballpark. On the island of St. Lucia, dozens of people were left homeless when their homes were washed away. A Category 5 storm named Katrina tore through the Caribbean region in 2005. Katrina's storm surge flattened levees that protected the U.S. city of New Orleans from flooding. When the storm ended, much of New Orleans was under water. The storm damage was so widespread and serious that Katrina became the costliest Atlantic hurricane of all time.

## 8. Cleaning Up After a Natural Disaster

A hurricane can have a very powerful impact, but the problems do not end when the storm moves on. Although the hurricane itself may be over, the effects of the natural disaster continue.



### Hurricanes Lose Strength over Land

Fortunately, hurricanes do not last forever. Hurricane John, which was the world's longest-running storm, lasted nearly a month and crossed approximately 5,000 miles of ocean. However, most hurricanes die out sooner than that, mainly as a result of encountering land.

Hurricanes die when they lose their main source of energy. Remember that these storms need warm ocean water to keep them going. When the storms hit land or cross over cool water, they begin to weaken. In the Caribbean region, hurricanes can cross an island and then pick up force on the other side. However, they lose steam when they encounter a large [landmass](#) such as the United States or Mexico, usually dying out within a few days.

### Rebuilding After a Natural Disaster

After a hurricane has passed, the people living in its path face the task of rebuilding, which is often an enormous challenge. A hurricane may destroy many of the homes on a hard-hit island. It may damage schools, hospitals, roads, bridges, and power lines. Many people may be left homeless, and hunger and disease may become serious problems.

The first task after a storm passes is to rescue the people who were caught in the wreckage. Relief agencies are set up to find and treat the injured, and relief workers supply food, water, shelter, and clothing to people in need.

The next task is cleaning up after the storm. The floodwaters have to be drained from the low-lying areas. The water and **sewage** lines have to be repaired in order to provide clean water and **sanitation**. The roads need to be cleared. Electrical power has to be restored. Damaged buildings must be knocked down. All of this work requires time and money, and it can take months or even years for a Caribbean island to fully recover from a severe hurricane.

## Summary - Beginning to Think Globally

In this chapter, you learned about extreme weather in the Caribbean region. You learned how tropical cyclones get started and how they develop into deadly storms. You read about the methods meteorologists use to analyze and track tropical cyclones. You also learned how natural disasters caused by these storms affect people and communities throughout the Caribbean.

### Few Places Escape Extreme Weather

Tropical cyclones are tremendously destructive, but they are not the only example of extreme weather. Tornadoes, blizzards, and heavy rains can all do great harm as well.

Most parts of the world experience some form of extreme weather. In the United States, primarily in the midwestern and southern states, tornadoes rip through towns and destroy property every spring. During the winter months, blizzards can block roads, knock out power lines, and interrupt air travel.

The story is much the same on other continents. For instance, heavy rains often cause flooding in South Asia (see Chapter 27 for information on the **monsoon** season in this part of the world). Sandstorms in parts of Africa can destroy crops, fill wells with sand, and force people from their homes.

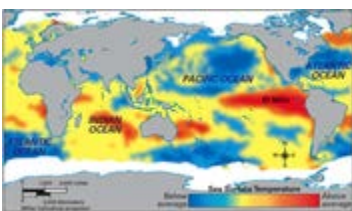
### El Niño's Impact on Weather

El Niño plays a key role in extreme weather. As you have learned, El Niño is a warm ocean current that flows from time to time along the Pacific coast of South America. When an El Niño occurs, it can trigger extreme weather in the Pacific region and in other parts of the world.

A major El Niño appeared off the coast of South America in 1997 and 1998. This warming of the ocean caused heavy rains and flooding in South America and produced tornadoes in Florida. At the same time, it caused dry spells that led to wildfires in Southeast Asia, Australia, and Central America.

Scientists are still trying to understand the role El Niño plays in extreme weather, but the effects are clear. You will look at El Niño's impact around the world in the next section.

| Hurricane | Year | Major Areas Affected   | Estimated Deaths | Estimated Damage |
|-----------|------|--|------------------|------------------|
| Ike       | 2008 | Turks and Caicos, Bahamas, Haiti, Dominican Republic, Cuba, Florida Keys, Mississippi, Louisiana, Texas, Mississippi Valley, Ohio Valley, Great Lakes region | 195              | \$28 billion     |
| Katrina   | 2005 | Bahamas, South Florida, Cuba, Mississippi, Alabama, Louisiana (especially Greater New Orleans), Florida  | 1,836            | \$81 billion     |
| Jeanne    | 2004 | U.S. Virgin Islands, Puerto Rico, Dominican Republic, Haiti, Bahamas, Florida  | 3,005            | \$7 billion      |
| Ivan      | 2004 | Grenada, Jamaica, Grand Cayman, Cuba, Alabama, Florida, Texas, Louisiana   | 92               | \$18 billion     |
| Mitch     | 1998 | Honduras, Nicaragua, El Salvador, Guatemala  | 11,000           | \$5 billion      |



## Global Connections

The small map shows the warmer-than-usual ocean currents that develop during an El Niño year. Notice that the warmest ocean area is located off the west coast of South America. The large map shows how different areas of the world are affected during a major El Niño year. The table includes data on some extreme weather events that occurred in the United States between 1997 and 2007.

**What parts of the world are most affected by an El Niño?**

As you might expect, the lands that are bordering the Pacific Ocean show the greatest effects from an El Niño. The west coasts of North and South America experience weather that is wetter than usual. The areas on the other side of the Pacific suffer from extremely dry weather.

| El Niño Year               | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 |
|----------------------------|------|------|------|------|------|------|------|------|------|------|------|
| Atlantic Hurricanes        | 3    | 10   | 8    | 8    | 9    | 4    | 7    | 9    | 15   | 5    | 6    |
| Violent Tornadoes          | 10   | 14   | 18   | 3    | 8    | 6    | 13   | 8    | 1    | 2    | 5    |
| Extreme Hail Events        | 65   | 100  | 73   | 71   | 69   | 75   | 95   | 99   | 72   | 116  | 67   |
| Extreme Temperature Events | 238  | 344  | 395  | 418  | 285  | 251  | 126  | 165  | 153  | 214  | 360  |

Source: National Oceanic and Atmospheric Administration, Sea, Ice, and Land Data Team, 4 Corners Ltd., 2004, Global Data Weather Service, Weather Underground, "Historical Archives," www.weatherground.com.

**What relationship do you see between an El Niño and extreme weather?**

An El Niño can affect weather in ways that you might not expect. The years 1997 and 2002 to 2007 were all considered to be El Niño years. As shown in the table of extreme weather events, there were fewer hurricanes in the Atlantic region during those years. Meanwhile, there were also fewer extreme temperature events in the United States than in an average year.

**How can understanding an El Niño's effects help meteorologists to predict extreme weather?**

Just how an El Niño shapes climate is not yet fully understood. But the more meteorologists learn about the factors that shape our climate, the better they will become at predicting extreme weather. This improvement in weather prediction, in turn, could help people to prepare for natural disasters that are caused by weather.

