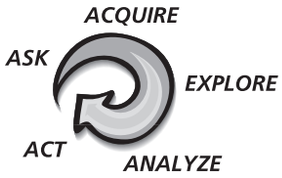
NAME _____ DATE _____

In the Eye of the Storm

A GIS investigation



Answer all questions on the student answer sheet handout

Part 1: The calm before the storm

October 21, 1998

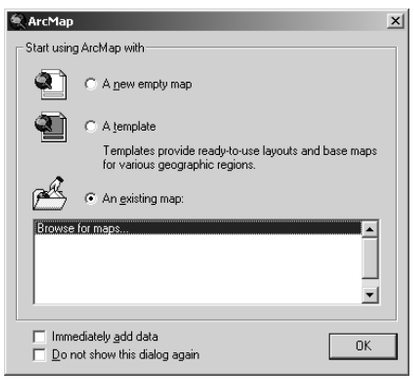
A tropical storm is brewing in the Atlantic Ocean. It began as a tropical wave a few weeks earlier, off the coast of western Africa. Today it is causing some rain and thunderstorms over the Caribbean. Later, the barometric pressure of the system will continue to drop and it will soon be identified as a tropical depression—the beginning of a hurricane. By the time Hurricane Mitch left the Central America region, 9,086 people were dead and 9,191 were declared missing.

Central America consists of the small chain of countries that link the North and South American continents. Explore these countries using ArcView and gather data to complete your chart titled Central America Prior to Hurricane Mitch. The data you are collecting will help you to gain an understanding of the complexity of this region's delicate infrastructure. The steps that follow will guide you in obtaining the information using GIS.

Step 1 Start ArcMap

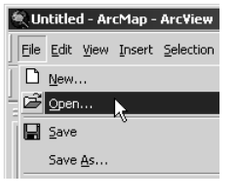
a **Double-click the ArcMap icon on your computer's desktop.**

b **If the ArcMap start-up dialog appears, click An existing map and click OK. Then go to step 2b.**

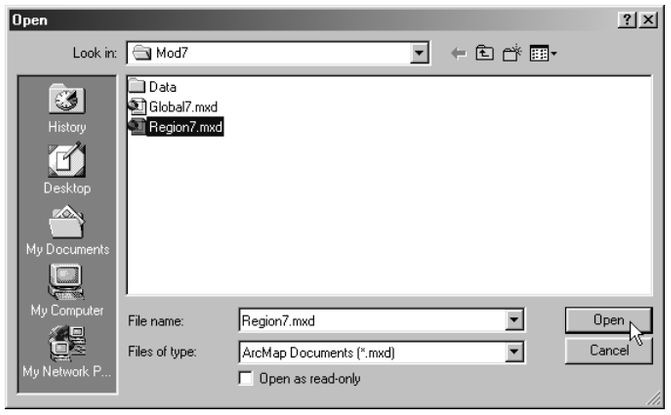


Step 2 Open the Region7.mxd file

a In this exercise, a map document has been created for you. To open it, go to the File menu and choose **Open**.

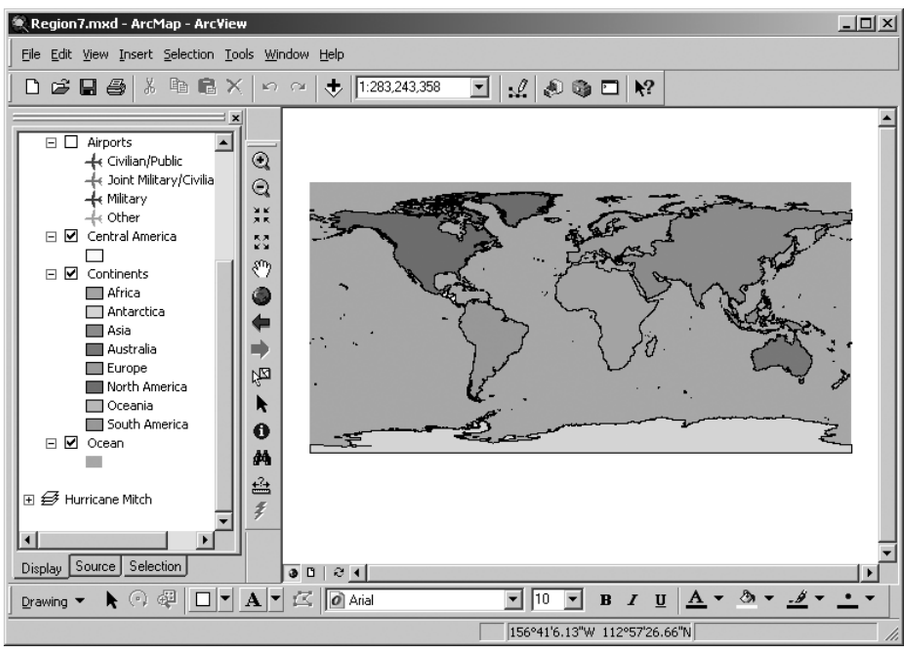


b Navigate to the module folder (**C:\MapWorld9\Mod7**) and choose **Region7.mxd** (or **Region7**) from the list.



c Click Open.

The map document opens and you see a world map. Scroll down in the table of contents. A check mark next to the following layers tells you they are displayed: Central America, Continents, and Ocean.



Step 3 Focus on the capital cities of Central America

a **Right-click on the Central America layer name and click Zoom to Layer. The map immediately centers around the countries of Central America.**

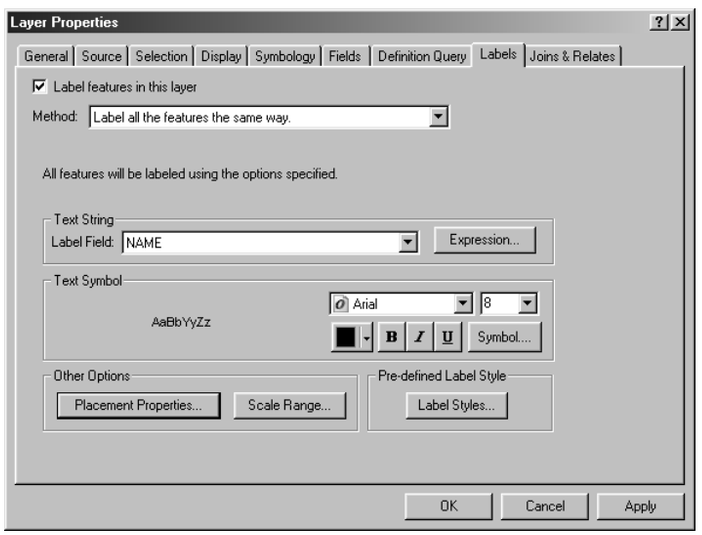
Before you look at the path and effect of Hurricane Mitch, you will collect data about Central America prior to Mitch. Record this information in the table titled "Central America Prior to Hurricane Mitch" on your student answer sheet. The information for the country of Belize has been completed for you as an example of the data you will need to find. First, you will record the country capitals.

b **Scroll to the top of the table of contents and turn on the Capitals layer by clicking the box next to the layer name.**

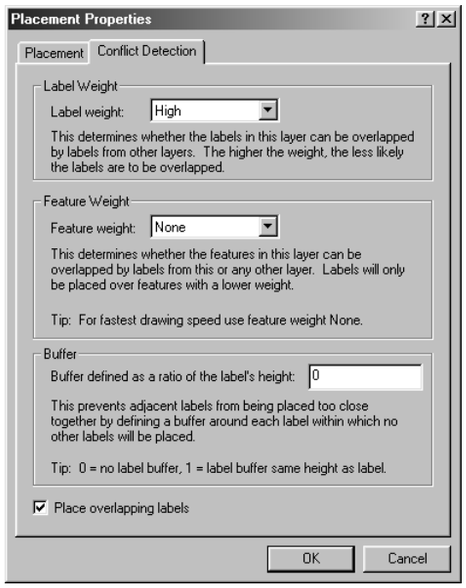
You can find the names of the capitals by using the Identify tool or by labeling features. Labeling features is a quick way to get information about a group of features.

c **In the table of contents, right-click Capitals and click Properties. Click the Labels tab.**

d **At the top of the Labels tab, click the small white box next to "Label features in this layer." Notice that Name is already chosen as the field to use for labeling.**



e **Near the bottom of the dialog under Other Options, click the Placement Properties button. Click the Conflict Detection tab. At the bottom of the tab, click the small white box next to "Place overlapping labels."**



f **Click OK on the Placement Properties dialog and the Layer Properties dialog. The name of each capital city displays on the map.**

g **Use this information to record the capital cities for each of the countries in Central America. Record them in the Populated Places column.**

Note: If you don't know the name of a country, use MapTips to identify it.

h **When you have finished recording the names of each capital, go to the table of contents, right-click Capitals, and click Label Features. The labels disappear from the map.**

Step 4 Focus on Central America prior to Hurricane Mitch

There are four layers in the table of contents that are not turned on. Each of these layers provides important data about the transportation network in Central America. This table is a summary of the layers.

Populated Places	Points showing major cities and populated areas of Central America
Roads	Lines representing Central American roads and trails
Railroads	Lines representing Central American railroads
Airports	Points showing airport location and type (civilian, military/civilian, military, other)

a **Turn these layers on one at a time to obtain important data for your handout.**

Remember: Layers that are at the top of the table of contents will cover up layers that are listed lower. Turn on each layer individually to see it clearly. When using the Identify tool, make sure the appropriate layer is selected in the Layers list in the Identify Results window.

b **Record this data in the Populated Places and Transportation Network columns on your answer sheet.**

Now you will add more data needed to complete your handout.

c **Click the Add Data button.**

d **Navigate to the module 7 layer files folder (C:\MapWorld9\Mod7\Data\LayerFiles).**

e **Hold down the Ctrl key and click the following four layer files:**

- **Agricultural Use.lyr**
- **Coastal Features.lyr**
- **Landforms.lyr**
- **Precipitation.lyr**

f **Click Add. The point layers (Coastal Features and Landforms) appear at the top of the table of contents; the polygon layers (Agricultural Use and Precipitation) appear lower down, below the Airports layer. All four layers are turned off.**

The table below summarizes the data in each layer:

Agricultural Use	Polygons showing agricultural use of land in Central America
Coastal Features	Points representing coastal features of Central America
Landforms	Points representing mountains, mountain chains, and volcanoes in Central America
Precipitation	Polygons showing annual precipitation in millimeters (mm) for Central America

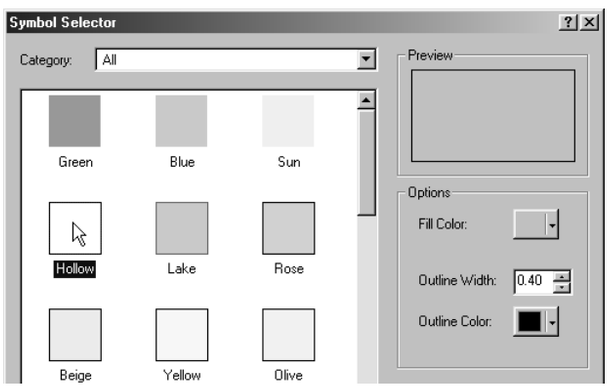
g **Scroll down and turn on Precipitation.**

The precipitation data appears in the map, but you cannot determine the average precipitation for each individual country. You will move the Central America layer and change its legend so you can view each country's average precipitation data.

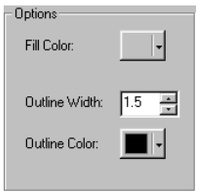
h **Click and drag the Central America layer above Agricultural Use in the table of contents. It covers up Precipitation.**

i **Click on the yellow symbol for the Central America layer to open the Symbol Selector.**

j **Click the Hollow symbol.**



k **In the Options panel on the right, increase the Outline Width to 1.5.**



l **Click OK.**

The map now displays Central American countries as outlines.

m **Analyze the precipitation for each country and record the precipitation data in the Average Precipitation column on your answer sheet.**

n **Turn off Precipitation.**

o **Turn on each of the remaining layers individually. Use the available data to complete the remaining columns in your table.**

p **After you complete the data table, scroll to the top of the table of contents and click the minus sign to the left of Snapshot of Central America to collapse the data frame.**

(1) Which country has the most area devoted to agriculture?

(2) Which country has the most area covered by mountains?

(3) Which country has the most extensive transportation network?

Step 5 Save the map document and exit ArcMap

In the first part of the GIS Investigation, you analyzed and recorded information about Central America from before Hurricane Mitch.

a **Ask your teacher for instructions on where to save this ArcMap map document and on how to rename the map document. If you are not going to save the map document, proceed to step 5b now. Otherwise, record the map document's new name and where you saved it on your answer sheet.**

b **From the File menu, click Exit.**

Part 2: The storm

October 24–26, 1998

In a span of less than two days, Tropical Storm Mitch develops into a category 5 hurricane with winds in excess of 155 mph. Category 5 is the deadliest rating on the Saffir-Simpson Hurricane Potential Damage Scale. Barometric pressure drops to 905 millibars, the lowest pressure ever observed in the Atlantic basin.

Step 1 Open the map document

a **Double-click the ArcMap icon on your computer's desktop.**

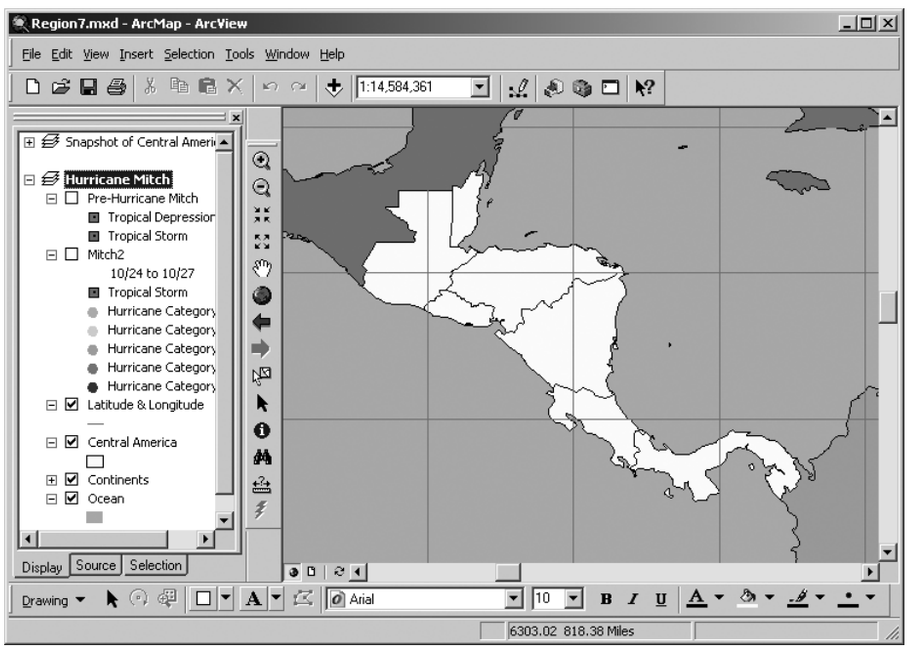
b **Refer to your answer sheet and determine where Region7.mxd (or Region7) is saved and how you renamed it.**

c **Navigate to the location of the saved map document and open it. If you didn't rename or save the map document in part 1, navigate to the module 7 folder (C:\MapWorld9\Mod7) and select Region7.mxd (or Region7).**

Step 2 Track Hurricane Mitch

a **In the table of contents, right-click the Hurricane Mitch data frame and click Activate. Click the plus sign to expand its contents.**

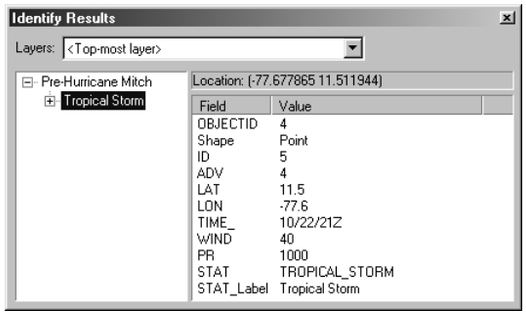
The Hurricane Mitch data frame displays with the following layers turned on: Latitude & Longitude, Central America, Continents, and Ocean.



b **Turn on Pre-Hurricane Mitch and Mitch2.**

Both of these layers, and similarly named ones to follow, will show the location of the center or eye of the storm. At locations where it was declared a hurricane, the legend reflects the category number. Placing your mouse pointer over a location displays the MapTip for that location. You will now explore the data that these layers represent.

c **Click the Identify tool. Click the most southeastern dark square that is a tropical storm. An Identify Results window displays with information about Tropical Storm Mitch, including: latitude and longitude, time (Zulu), wind velocity (miles per hour), pressure reading (millibars), and status in reference to the Saffir-Simpson scale. The time is written in this format: Month/Day/Hour (of 24).**



d **Answer the following questions:**

(1) At what time was Tropical Storm Mitch at this location?

(2) What does the "z" mean in the time?

(3) What was Mitch's wind speed at this location?

e **Click the location of Hurricane Mitch category 1 on the map. The Identify Results window updates.**

f **Answer the following questions:**

(1) What are the latitude and longitude coordinates for Hurricane Mitch at this location?

(2) At what time was Hurricane Mitch at this location?

(3) What was Mitch's wind speed at this location?

g **Click the last mapped location for Hurricane Mitch category 5 before it struck land. The Identify Results window updates.**

h **Answer the following questions:**

(1) At what time was Hurricane Mitch at this location?

(2) What was Mitch's wind speed at this location?

Now you will determine how much time it took Mitch to develop from a tropical storm to a category 5 hurricane.

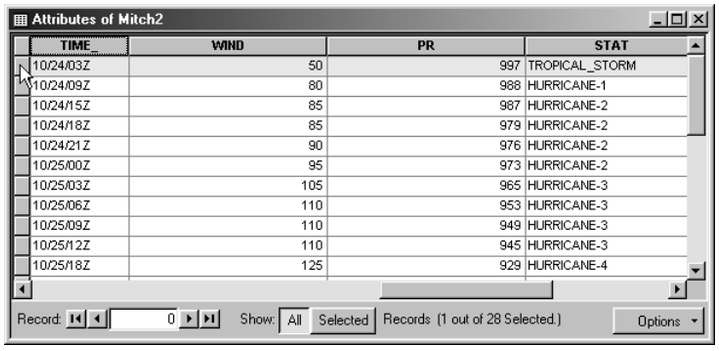
i **Close the Identify Results window.**

j **In the table of contents, right-click Mitch2 and click Open Attribute Table. The Attributes of Mitch2 table opens.**

k Scroll right in the table until you see a field named TIME_ and a field named STAT. Click the TIME_ column heading to select it. The heading depresses like a button and the column turns light blue.

l Right-click the TIME_ column heading and click Sort Ascending.

m Click the small gray box to the left of the first record to select it. The first record turns light blue to show it is selected. Notice that this record represents Hurricane Mitch when it was a tropical storm.



n Scroll down and locate the record representing the first time Hurricane Mitch became a category 5 hurricane. Hold the Ctrl key down and click the small gray box for the Hurricane-5 record. Both records are highlighted blue in the table and on the map.

Remember: You must click the small gray box to the left of a row in the table in order to select the entire row.

o Click the Selected button at the bottom of the attribute table. Now you see only the two selected records and they are easier to compare.

p Use the information in the attribute table to determine how long it took for Tropical Storm Mitch to become a category 5 hurricane. On the answer sheet, write down the times for each event and determine the time difference. Remember, the time is written in this format: Month/Day/Hour (of 24).

q Click the All button at the bottom of the attribute table to see all the records again.

r Examine the attribute table further and identify the maximum wind speed. Record this on your answer sheet.

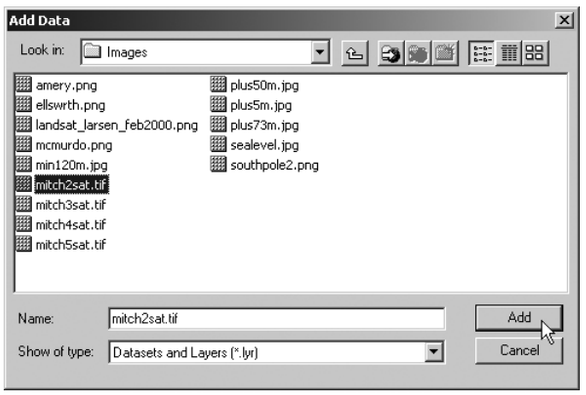
s Close the Attributes of Mitch2 table.

Step 3 Measure the size of the storm

The National Oceanic and Atmospheric Administration (NOAA), in partnership with the National Aeronautics and Space Administration (NASA), used special storm-tracking satellites to take several high-resolution photographs of Mitch from space. You will view these images and measure the massive size of this storm.

a Click the Add Data button and navigate to the module 7 images folder (**C:\MapWorld9\Mod7\Data\Images**).

b **Click mitch2sat.tif and click Add.**



The satellite image now sits underneath your basemap and you cannot see it. In order to see both the satellite image and the storm track, you will rearrange the layers in the table of contents.

c **Click and drag the mitch2sat.tif layer so it's just below Mitch2 in the table of contents.**

Now you can see the highlighted points of Tropical Storm and Hurricane Category 5. Hurricane Category 5 is almost directly over the eye of the storm. The eye is the center of the cloud mass that looks like a doughnut hole.

You will use the Measure tool to measure several parts of the storm.

d **Turn off Mitch2 so you have a better view of the eye of Hurricane Mitch.**

e **Use the Zoom In and Pan tools so the satellite image fills the map display. Do not zoom in too close or it will be difficult to view the image.**

f **Click the Measure tool. Your cursor turns into a right-angle ruler with cross hairs.**

g **Click the left edge of the eye once and move the cursor directly across the diameter of the eye. Double-click when your cursor is at the right edge of the eye.**

Note: If you accidentally clicked the wrong spot, you can double-click to end the line and simply start over.

A segment length appears on the bottom left of the ArcMap window.

What is the diameter of the eye of Hurricane Mitch?

h **Use the Measure tool to measure the total diameter of the storm at its widest point and the distance of the eye to the coastline of Honduras. Record your answers for Mitch2sat.tif in the table on the answer sheet.**

Note: You will need to use the Zoom and Pan tools to focus on the area of the storm you need to measure.

i **Turn off mitch2sat.tif.**

Now that you have recorded data for mitch2sat.tif, you will follow the same procedures for adding new layers and measuring the storm at other locations.

j **Click the Add Data button. Navigate to the module 7 images folder (C:\MapWorld9\Mod7\Data\Images).**

k **Hold down the Ctrl key and add the following images: mitch3sat.tif, mitch4sat.tif, and mitch5sat.tif.**

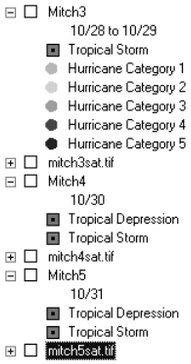
l **Turn off all three images. Click the minus sign in front of each image to collapse its legend.**

m **Click the Add Data button again. This time, navigate to the module 7 layer files folder (C:\MapWorld9\Mod7\Data\LayerFiles).**

n **Hold down the Ctrl key and add the following layer files: Mitch3.lyr, Mitch4.lyr, and Mitch5.lyr.**

With six new layers added, it's important to organize your table of contents so you can view the layers easily.

o **In the table of contents, click mitch3sat.tif and drag it directly below Mitch3. Do this for the other satellite images.**



p **Turn each set of layers on and off individually. Use the Zoom and Pan tools to see different parts of each layer. Use the Measure tool to collect data on the size of Hurricane Mitch at these different locations.**

Note: If you don't remember how to use the Measure tool, refer to steps 3f–3g.

q **Record your measurements and observations in the table on the answer sheet.**

Step 4 Analyze rainfall from Hurricane Mitch

Once Hurricane Mitch made landfall, the winds weakened to the point where it was downgraded to a tropical storm. Nonetheless, Mitch still had not shown its worst side. In the days that followed, Mitch poured more than 30 inches of rain in the region. You will take a closer look at the precipitation that fell in the region on October 30 and 31, 1998.

a **Turn off all layers except mitch3sat.tif, Central America, Continents, and Ocean.**

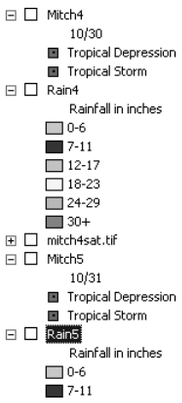
b **Click the Add Data button. Navigate to the module 7 layer files folder (C:\MapWorld9\Mod7\Data\LayerFiles). Add the following layer files to your map: Rain3.lyr, Rain4.lyr, and Rain5.lyr.**

c **Turn on Rain3. The rain pattern appears overlaid on top of mitch3sat.tif. Answer the following questions:**

(1) What pattern do you notice in the amount of rainfall within the storm?

(2) Is this a pattern you expected to find? Why or why not?

d **In the table of contents, click Rain4 and drag it above the corresponding satellite image, mitch4sat.tif. Do this for the other rain layers.**



e **While turning layers on and off, look at each set of rain and satellite layers. Answer the following questions:**

(1) At the Mitch4 location, what was the highest range of rainfall measured?

(2) Which country received the majority of this heavy rain?

(3) Describe the difference between the rainfall patterns on October 30 and October 31, 1998.

(4) What kind of damage do you expect to find with this type of storm? What aspects of the region will be most affected? Elaborate on your answer using your table, Central America Prior to Hurricane Mitch, as a resource.

Step 5 Save the map document and exit ArcMap

In this GIS investigation, you used ArcMap to analyze a large region of Central America and to track Hurricane Mitch as it approached and made landfall. You more than likely have many questions as to the extent of the damage Mitch caused. The assessment will have you take on the role of emergency management personnel. Your job will be to identify those areas where danger is still high as a result of the storm and to develop emergency action plans for affected Central American countries. You will use the data from this investigation to help you in the assessment.

a **Ask your teacher for instructions on where to save this ArcMap map document and on how to rename the map document. If you already renamed the map document in part 1, save it under that name.**

b **Record the new name of the map document and its location on your answer sheet.**

c **Choose Exit from the File menu.**