

# module 7

## Human/Environment Interaction

*Physical processes influence patterns of human activity, just as human activities have an effect on the environment.*



### **Water World: A global perspective**

Students will investigate and explore changes that might occur to the surface of the earth if the major ice sheets of Antarctica melted. They will begin their exploration at the South Pole by studying images and information relating to the physical geography of Antarctica. Proceeding according to the steps of the geographic inquiry method, they will consider the consequences of projected changes on human structures, both physical and political. The final assessment will call for students to create an action plan for a major city of the world that would be flooded in the event of catastrophic polar meltdown.



### **In the Eye of the Storm: A regional case study of Latin America and the impact of Hurricane Mitch**

Students will study the destructive force of Hurricane Mitch, the deadliest storm of the twentieth century, which devastated Central America. Students will analyze information about the storm itself, compare the region before, during, and after the storm, and reflect on the impact it had on the society it ravaged. The students will end their study by developing a hurricane relief/rebuilding plan for the region, and then compare their theories with the plans that were actually made.



### **Data Disaster: An advanced investigation**

Students will act as data detectives in this scenario-based investigation. Due to a recent storm, the main computer was flooded at the International Wildlife Conservancy (a fictitious organization). They lost all their metadata for their ecozones. The data and maps have survived, but they are unsure what each zone represents. They know that the zones represent areas that are critically challenged and are in danger. The students must analyze the data that is available to them and create new metadata for the data.





# Water World

## *A global perspective*

### Lesson overview

Students will investigate and explore changes that might occur to the surface of the earth if the major ice sheets of Antarctica melted. They will begin their exploration at the South Pole by studying images and information relating to the physical geography of Antarctica. Proceeding according to the steps of the geographic inquiry method, they will consider the consequences of projected changes on human structures, both physical and political. The final assessment will call for students to create an action plan for a major city of the world that would be flooded in the event of catastrophic polar meltdown.

**Estimated time** Two to three 45-minute class periods

- Materials**
- ✓ Student handouts from this lesson to be copied:
    - GIS Investigation sheets (pages 403 to 411)
    - Student answer sheets (pages 412 to 415)
    - Assessment(s) (pages 416 to 420)

**Standards and objectives** *National geography standards*

GEOGRAPHY STANDARD	MIDDLE SCHOOL	HIGH SCHOOL
1 How to use maps and other geographic representations, tools, and technologies to acquire, process, and report information from a spatial perspective	The student understands the relative advantages and disadvantages of using maps, globes, aerial and other photographs, satellite-produced images, and models to solve geographic problems.	The student understands how to use geographic representations and tools to analyze, explain, and solve geographic problems.
4 The physical and human characteristics of places	The student understands how different physical processes shape places.	The student understands the changing physical and human characteristics of places.
11 The patterns and networks of economic interdependence on Earth's surface	The student understands the basis for global interdependence and the reasons for the spatial patterns of economic activities.	The student understands the increasing economic interdependence of the world's countries.
18 How to apply geography to interpret the present and plan for the future	The student understands how the interaction of physical and human systems may shape present and future conditions on Earth.	The student understands how to use geographic knowledge, skills, and perspectives to analyze problems and make decisions.



Standards and objectives (continued)

**Objectives**

The student is able to:

- Manipulate map projections using GIS technology.
- Compare locations on a map to photos and satellite imagery using GIS.
- Analyze the impact on major human systems (such as transportation networks) if various parts of the Antarctic ice sheet melted causing a significant rise in sea level.
- Predict how such a catastrophe might change the nature of cities and societies around the world, and propose ways to minimize danger and hardship.

**GIS skills and tools**



Add layers to the map



View a hyperlink to a photograph or image

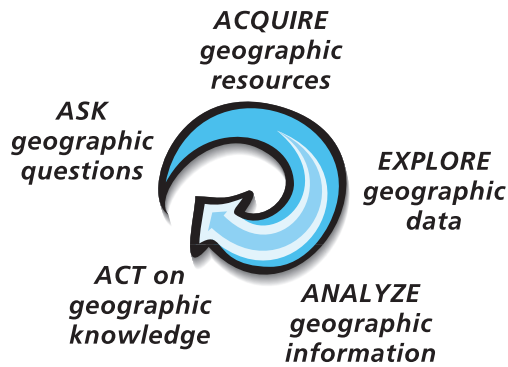


Zoom in and out of the map



Identify a feature to learn more about it

- Change the map projection for a data frame
- Activate a second data frame



For more on geographic inquiry and these steps, see Geographic Inquiry and GIS (pages xxiii to xxv).



## Teacher notes

### Lesson introduction

Begin the lesson with a discussion of Antarctica. Use these questions as a guide.

- What is the climate of Antarctica like?
- What does the place look like?
- Are there any human settlements there?

After a brief discussion introducing the subject, share with your students some of the work that scientists have been doing in the region. You may want to have them explore some of the Internet sites associated with this lesson on the book's Web site. These resources provide information on the latest research into snow and ice melt in Antarctica and its impact on mean sea level. In the GIS investigation, students will look at visual representations of the rising sea level and analyze current data about cities, transportation networks, and other important human structures. They will be challenged in the closing assessment to save a major city from the rising floodwaters by using the data they gather in the course of their investigation.

### Student activity



**Before completing this lesson with students, we recommend that you complete it as well. Doing so will allow you to modify the activity to accommodate the specific needs of your students.**

After the initial discussion, have your students work on the computer component of the lesson. Ideally, each student should be at an individual computer, but the lesson can be modified to accommodate a variety of instructional settings.

Distribute the GIS Investigation sheets to the students. This investigation has two main parts: observing Antarctica, and analyzing the earth at various sea levels. The investigation sheets will provide students with detailed instructions for their investigations. As they work through the steps, they will explore how the changes in sea level could affect important human structures. They will begin to make hypotheses that they will attempt to prove in their final assessment.

The investigation sheets include questions to help students focus on key concepts. Some questions will have specific answers; others require creative thought.

Things to look for while the students are working on this activity:

- Are the students using a variety of tools?
- Are the students answering the questions as they work through the procedure?
- Are the students beginning to ask their own questions of the data they are observing?

### Conclusion

Before beginning the assessment, briefly discuss the initial observations your students have made. Review their findings on the areas most affected by the changing sea level. How similar or different were these observations?

**Assessment** *Middle school: Highlights skills appropriate to grades 5 through 8*

The middle school assessment will provide students a list of cities that will be greatly affected by the 50-meter rise in sea level. Students will work in teams of three. They will select one city from the list (or you can assign each group a city) and create an action plan for relocating the city and its resources. They will focus on basic modes of transportation such as major roads and railways. Each group may also address how the change in sea level will affect industry and commerce.

Within each group, students should assign themselves to the following roles:

- Team leader—organizes the group and assists in creating the final product
- Cartographer—focuses on manipulating the GIS and printing of maps (if necessary) for the final product
- Data expert—focuses on research and determines which data is best to use

Each student group will work together as a team to create the final product. Team presentations can be made at your discretion. Some suggestions include oral presentation, a formal written report with printed maps, or a “science fair”-type poster presentation.

*High School: Highlights skills appropriate to grades 9 through 12*

The high school assessment will provide students a list of 10 major cities that will be greatly affected by the 50-meter rise in sea level. Students will work in teams of three. They will select one city from the list and create an action plan to relocate the city, shift the roles that city plays in the national and international scheme of things to another city, adapt the city to its new environment, or choose another option. They must take into account transportation, utilities, economics, and politics in their solutions.

Within each group, students should assign themselves to the following roles:

- Team leader—organizes the group and assists in creating the final product
- Cartographer—focuses on manipulating the GIS and printing of maps (if necessary) for the final product
- Data expert—focuses on research and determines which data is best to use

Each student group will work together as a team to create the final product. Team presentations are at your discretion. Some suggestions include oral presentation, a formal written report with printed maps, or a “science fair”-type poster presentation.

**Extensions**

- Have students research other details for the affected cities and countries by obtaining additional data from outside sources such as the Internet.
- Have students create action plans for an entire country by having small groups research specific details. For example, one group could focus on political boundary issues, another on transportation issues, another on export and trade. Each group would need to present its findings to the whole class (or country) and then the group must decide as a whole team how the different plans will work together.
- Identify a city along the Mississippi River that frequently floods. Research and analyze its flood disaster plans. How could those plans be improved?
- Check out the Resources by Module section of this book’s companion Web site ([www.esri.com/mappingourworld](http://www.esri.com/mappingourworld)) for print, media, and Internet resources on the topic of Antarctica.



NAME \_\_\_\_\_

DATE \_\_\_\_\_

# Water World

## *A global perspective*



### *Answer all questions on the student answer sheet handout*

Imagine that the year is 2100. Scientists have determined that the rapidly warming climate of the earth will cause the ice sheets of Antarctica to break apart and melt at a much faster rate than was predicted a hundred years earlier. You and your GIS investigation team are presented with the challenge of studying the impact this change will have on the planet.

In part 1 of this GIS investigation, you will explore and compare maps of Antarctica offering different views of the continent. You will also investigate specific Antarctic sites to learn more about the continent. In part 2, you will use world maps to investigate changes in ocean levels associated with melting of the Antarctic ice sheets.

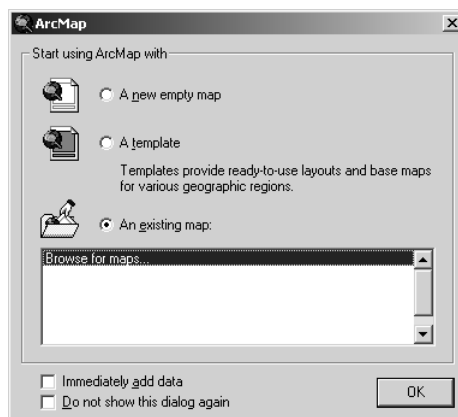
## Part 1: A South Pole point of view

### Step 1 Start ArcMap

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

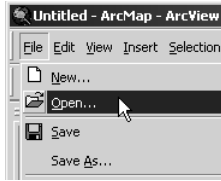


- b* If the ArcMap start-up dialog appears, click **An existing map** and click OK. Then go to step 2b.

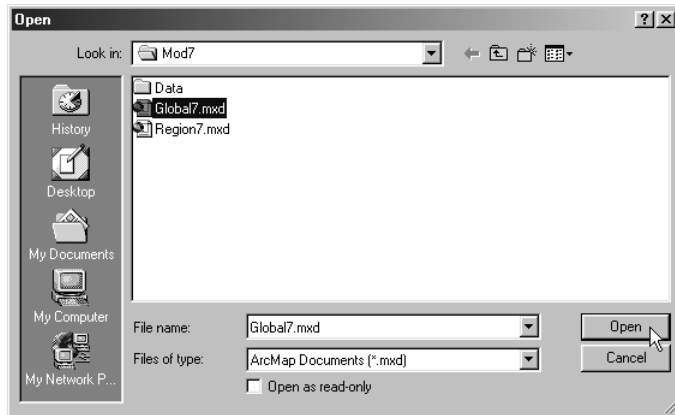


**Step 2 Open the Global7.mxd file**

- 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 **Global7.mxd** (or **Global7**) from the list.



- c* Click **Open**.

When the map document opens, you see a map with three layers turned on (Latitude & Longitude, Continents, Ocean). The check mark next to the layer name tells you the layer is turned on and visible in the map.

**Step 3 Look at Antarctica**

- a* Use the legend to locate the continent of Antarctica.

Take a look at where the melted water is coming from. Scientists believe that the first area to melt will be the Western Ice Shelf of Antarctica. The western part of Antarctica is considerably smaller than the eastern portion. It lies on the west of the Transantarctic Mountain Range, which is basically all the land to the west of the prime meridian. The prime meridian is the line that runs north-south on the map.

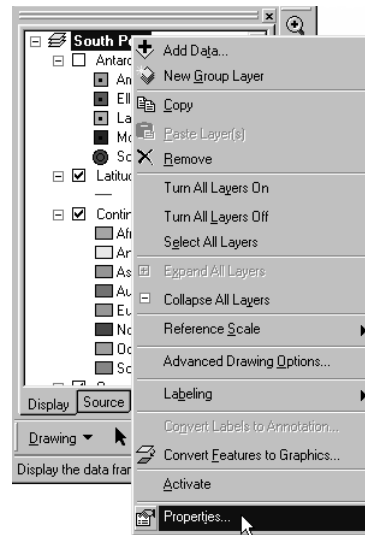
The map is now viewed in a geographic map projection. Because this is a flat projection of the spherical earth, some parts of the map are skewed (out of shape). This affects either size or shape of features (such as landforms), distance, direction, or all four.



*Do you think this map gives you a realistic representation of Antarctica? Explain.*



- b** At the top of the table of contents, right-click South Pole and click Properties.

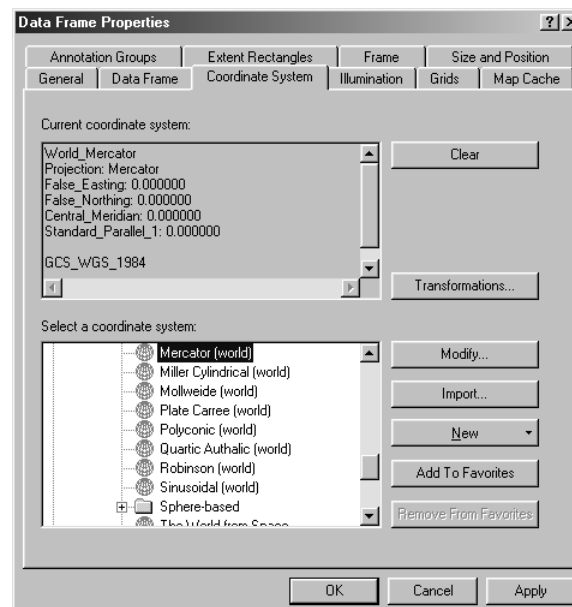


Data Frame Properties opens.

- c** Click the Coordinate System tab.

The current coordinate system is GCS\_WGS\_1984 (Geographic Coordinate System, World Geodetic System of 1984).

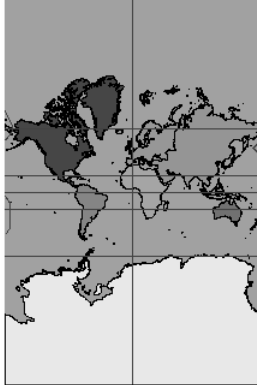
- d** Under Select a coordinate system, click the plus signs next to the following folders to expand them: Predefined, Projected Coordinate Systems, and World. Scroll down the list of world projections and click **Mercator (world)**.





- e Click OK, then click the Full Extent button to see all the continents.

The map looks rectangular.



*Does this projection give you a better view of the region around the South Pole? Why or why not?*

- f Repeat steps b through e to change the map projection to each one listed below:
- Aitoff (world)
  - Bonne (world)
  - Cylindrical equal area (world)
  - Equidistant conic (world)
  - Mollweide (world)
  - Polyconic (world)
  - Robinson (world)
  - Sinusoidal (world)
  - Van der Grinten I (world)



*Do any of these projections work well for viewing Antarctica?*

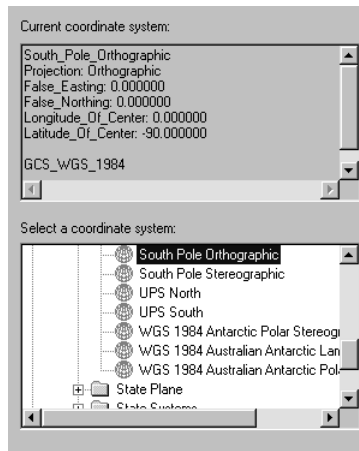
#### Step 4 View the South Pole

As you reviewed the various projections, you may have thought that none of them would give you a good perspective of the South Pole, or you may have wanted to flip the map upside down or change its center. The recommended projection to view either pole is the polar orthographic projection. This is a picture of the earth as though you were looking at it from space. In order to see the South Pole, you will choose a projection that centers the map on the South Pole.

- a Open Data Frame Properties. Make sure that the Coordinate Systems tab is selected.



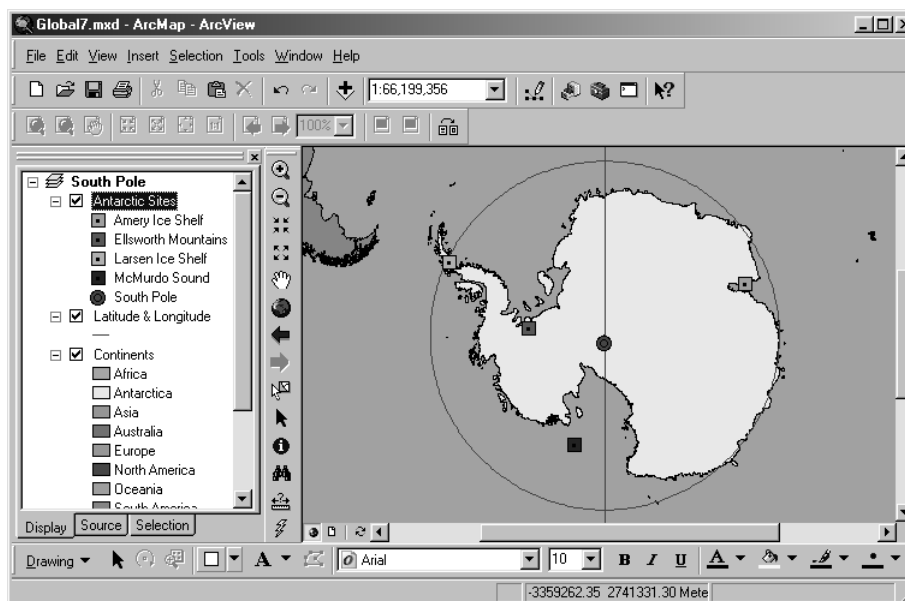
- b** Expand the following folders: Predefined, Projected Coordinate Systems, and Polar. Scroll down the list of polar projections and click **South Pole Orthographic**.



- c** Click OK, then click the Full Extent button.

### Step 5 Picture Antarctica

- a** In the table of contents, click the check box next to Antarctic Sites to display the point layer.
- b** In the table of contents, right-click Antarctic Sites and click Zoom To Layer to get a closer view of Antarctica.



Each point on the map is hyperlinked to an image. Like an Internet link, if you click on a hyperlink in ArcMap, you are taken to additional information.



- c** Click the Hyperlink tool. When you move the cursor over the map, it turns into a lightning bolt. Notice that when the Hyperlink tool is selected, a blue dot displays at the center of each Antarctic site, indicating that it has an active hyperlink.



- d* Move the tip of the lightning bolt over the South Pole until the cursor changes to a hand, then click. A photograph of the South Pole opens in the default Windows image viewer.
- e* If the photograph appears cut off you may need to resize the image or the image viewer.
- f* Read the caption at the bottom of the photograph to learn more about the picture.
- g* Minimize the image viewer.
- h* Find out more about what Antarctica looks like by clicking on the other points on the map. Read the caption at the bottom of each image. Hint: You can stretch or maximize the images and the image viewer to see the images and captions at a larger size.
- i* In the table of contents, click the check box next to Antarctic Sites to turn it off.
- j* Ask your teacher if you should stop here and save this ArcMap document. Follow your teacher's instructions on how to rename the map document and where to save it. Exit ArcMap by choosing Exit from the File menu.

If you do not need to save the map document and exit ArcMap, proceed to part 2.



*On the answer sheet, write the new name you gave the map document and where you saved it.*

## Part 2: Just add water

Antarctica has two major ice sheets: the western and the eastern. The western sheet is smaller than the eastern and covers Antarctica from the Transantarctic Mountains, which run from the South Pole westward. The eastern sheet is on the opposite side of the mountain range and includes the majority of the continent. Both of these enormous sheets of ice are moving from the continental center toward the ocean. For example, as the western ice sheet moves into the ocean it forms the Ross and Ronne Ice Shelves that float on top of the ocean. It is at this point where the ice begins to break apart and melt.

Now you will examine what might happen to the water levels of the oceans if part of these ice sheets were to melt.

### Step 1 Activate the Water World data frame

- a* Make sure the Global7.mxd (or Global7) map document is open. If you renamed this document in part 1, open it using the name you recorded. Otherwise, continue with step 1b.
- b* Click the minus sign next to the South Pole data frame to collapse it in the table of contents.
- c* Click the plus sign next to the Water World data frame to expand its contents.
- d* In the table of contents, right-click Water World and click Activate.

The Water World map displays on your screen. You see a world map in Robinson projection. This projection is commonly used for world maps.



You see the Country Outlines from the year 2004. You also see a layer named “20,000 Years Ago.” This layer shows an elevation map of the earth as scientists believe it looked 20,000 years ago. At that time, sea level was 400 feet lower than it is today.

*e* Stretch the ArcMap window by dragging the lower right corner with your mouse.



*f* What significant differences do you see between today’s country outlines and the elevation map of 20,000 years ago? List at least three.

## Step 2 Analyze global sea levels if Antarctic ice sheets melted

If the western ice sheet melted, scientists predict that the oceans would rise about 5 meters. If the eastern ice sheet melted, sea level would rise about 50 meters. If all the ice at the South Pole melted, including all the ice shelves and glaciers, sea level would increase by 73 meters.

One by one, you will turn on the layers: Today, Plus 5 Meters, Plus 50 Meters, and Antarctic Total Thaw and make observations in the table on your answer sheet. Remember: ArcMap draws the layers starting with the bottom of the table of contents and moves upward. Therefore, a layer that’s turned on at the top of the table of contents will “draw over” a layer below it.



*a* Turn the layers on and off and compare each change in sea level. Record your general observations of each layer in the table on the answer sheet.

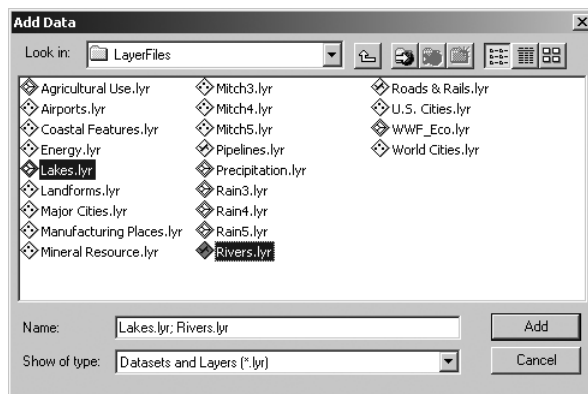
*b* Turn off all layers except Plus 50 Meters.

## Step 3 View changes in water levels



*a* Click the Add Data button.

*b* Navigate to the module 7 layers files folder (**C:\MapWorld9\Mod7\Data\LayerFiles**). Click **Lakes.lyr** and hold the Ctrl key down and click **Rivers.lyr**. Click Add.



Both layers appear in the table of contents.



- c Use the Zoom In tool to drag a box around South America.
- (1) *What kinds of changes do you see in the rivers and lakes? Provide a specific example.*
  - (2) *With a sea level increase of 50 meters, what kinds of consequences do you foresee for the major river ecosystems of South America? Provide a specific example.*
  - (3) *There are several locations around the globe that are on the interior of land-masses and are below sea level. One of them is in South America. Hypothesize how these low-lying areas were formed.*



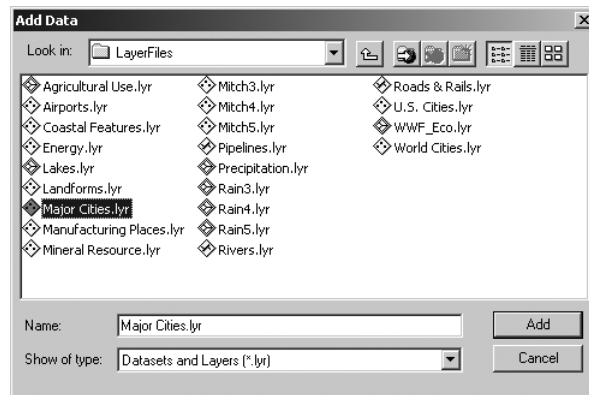
- d Click the Full Extent button to see the entire world on the map.
- e Turn off the Rivers and Lakes layers.

#### Step 4 View changes in political boundaries

The oceans of the world form the coastlines of many nations. In this step, you will focus on coastal boundaries and how the 50-meter rise would affect political boundaries.



- a Click the Add Data Button.
- b Navigate to the module 7 layer files folder (**C:\MapWorld9\Mod7\Data\LayerFiles**) and double-click **Major Cities.lyr**.



- c Click the Zoom In tool. Zoom to focus on the Middle East.
- d Turn on the Major Cities layer.




The dark blue dots that represent city locations appear on the map. Note how some of them are now in the ocean or on the edge of the ocean.

- e Turn on Country Outlines so you can view current country boundaries.
- f Take note of significant changes in the amount of land now remaining in the countries of that region. Predict possible consequences to the societies that live in those areas (political disputes, trade and economic issues, transportation problems, and so on) and record them in the table on your answer sheet. Use the Zoom, Pan, and Identify tools to help you complete the table.



**Note:** Refer to the ArcMap Toolbar Quick Reference for a brief explanation of the Zoom and Pan tools.



-  *g* Click the Full Extent button. Repeat the process of zooming and identifying potential consequences of the rising sea level for the other major regions of the world.
-  *Record your results in the table on the answer sheet.*
-  *h* Click the Full Extent button.

#### Step 5 Look for additional data to explore

You have now only begun to scratch the surface of understanding a world with a significant rise in sea level.

-  *Based on your previous observations, list other possible layers of data you would like to analyze to study the impact of this phenomenon. In your final assessment, you will have the opportunity to explore many other datasets; this list will help to guide you in further explorations.*

#### Step 6 Exit ArcMap

In this exercise, you used ArcMap to investigate the continent of Antarctica. You also explored and analyzed the potential effect of thawing the Antarctic ice sheets on the global environment.

- a* Ask your teacher for instructions on where to save this ArcMap map document and on how to rename the map document.
- b* If you are not going to save the map document, exit ArcMap by choosing Exit from the File menu. When asked if you want to save changes to Global7.mxd (or Global7), click No.



NAME \_\_\_\_\_

DATE \_\_\_\_\_

# Student answer sheet

## Module 7

### Human/Environment Interaction

#### Global perspective: Water World

#### Part 1: A South Pole point of view

##### Step 3 Look at Antarctica

a Do you think this map gives you a realistic representation of Antarctica? Explain your answer.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

e Does this projection give you a better view of the region around the South Pole? Why or why not?

\_\_\_\_\_

f Do any of these projections work well for viewing Antarctica? \_\_\_\_\_

##### Step 5 Picture Antarctica

j Write the new name you gave the map document and where you saved it.

\_\_\_\_\_  
(Name of map document.  
For example: ABC\_Global7.mxd)

\_\_\_\_\_  
(Navigation path to where map document is saved.  
For example: C:\Student\ABC)



## Part 2: Just add water

### Step 1 Activate the Water World data frame

- f What significant differences do you see between today's country outlines and the elevation map of 20,000 years ago? List at least three.

---



---



---



---



---

### Step 2 Analyze global sea levels if Antarctic ice sheets melted

- a Record your general observations of each layer in the table below.

SEA LEVEL	OBSERVATIONS
Today	
Plus 5 meters	
Plus 50 meters	
Total Thaw (plus 73 meters)	



**Step 3 View changes in water levels**

c-1 What kinds of changes do you see in the rivers and lakes? Provide a specific example.

---

---

---

---

---

c-2 With a sea level increase of 50 meters, what kinds of consequences do you foresee for the major river ecosystems of South America? Provide a specific example.

---

---

---

---

---

c-3 There are several locations around the globe that are on the interior of landmasses and are below sea level. One of them is in South America. Hypothesize how these low-lying areas were formed.

---

---

---

---

---

---

---

---

---

---


**Step 4 View changes in political boundaries**

f, g Record your results in the table below.

REGION	COUNTRIES/AREAS AFFECTED	POSSIBLE CONSEQUENCES
Middle East		
Asia		
Europe		
Africa		
Oceania		
North America		
Latin America		

**Step 5 Look for additional data to explore**

Based on your previous observations, list other possible layers of data you would like to analyze to study the impact of this phenomenon. In your final assessment, you will have the opportunity to explore many other datasets; this list will help to guide you in further explorations.

---



---



---



---



---



---



---



---



---



---



NAME \_\_\_\_\_

DATE \_\_\_\_\_

# Water World

## *Middle school assessment*

You and your teammates have been selected to be part of an elite team of GIS experts who will determine the fate of one of the following six world cities. Over the next 50 years, the rise in sea level up to 50 meters will affect these cities.

List of world cities affected by 50-meter rise in sea level:

San Francisco, USA	Miami, USA
London, England	Calcutta, India
Tokyo, Japan	Houston, USA

As part of your task, select a city and develop an action plan for relocating the city and its resources. The plan must take into account the following factors:

Major roads	Ocean ports
Railroads	Utilities
Airports	Relocation of people

Your Project Director (teacher) will provide you with a detailed listing of the available data you can use. You will add this data to the Water World data frame in the Global7 map document you used in the GIS Investigation.

Your action plan must include each of the following:

- **Time line**—It describes the various phases of your plan. For example, one five-year phase might include relocating people, while another includes relocating specific businesses.
- **Map**—It displays proposed changes and could be a series of maps generated in ArcMap or on paper.
- **Data**—It will support your suggested changes. This data will come from the GIS Investigation and can be displayed through maps, charts, or tables.
- **Written report**—This is a written explanation of your plan and can include the time line.

Your Project Director (teacher) will provide you with instructions on how you will present your action plan to the class.

# Water World

## Assessment rubric

### Middle school

STANDARD	EXEMPLARY	MASTERY	INTRODUCTORY	DOES NOT MEET REQUIREMENTS
<b>The student knows and understands the relative advantages and disadvantages of using maps, globes, aerial and other photographs, satellite-produced images, and models to solve geographic problems.</b>	Uses GIS to create a map in an appropriate projection (Orthographic) to display information on the region of the South Pole. Uses GIS to create a digital map illustrating the effects of a 50-meter rise in sea level for the selected city.	Uses GIS to create a map in an appropriate projection (Orthographic) to display information on the region of the South Pole. Uses a GIS to create a paper map illustrating the effects of a 50-meter rise in sea level for the selected city.	Uses GIS to create a map in an appropriate projection (Orthographic) to display information on the region of the South Pole. Creates a map of the selected city, but it does not adequately illustrate the effects of the 50-meter rise in sea level.	Does not select an appropriate projection for view data on the South Pole, and cannot make distinctions between various projections. Does not include a map of the selected city.
<b>The student knows and understands how different physical processes shape places.</b>	Creates a clear and concise hypothesis on the impact of a 50-meter rise in sea level on a city. Provides data and maps that support ideas.	Creates a clear and concise hypothesis on the impact of a 50-meter rise in sea level on a city. Provides a map that supports ideas, but does not highlight supporting data.	Identifies some factors that will affect a city with a significant rise in sea level, but does not create a formal hypothesis. Provides some data or a basic map.	Identifies some places that will be affected by a rise in sea level, but does not identify what changes could take place.
<b>The student knows and understands the basis for global interdependence and the reasons for the spatial patterns of economic activities.</b>	Analyzes the effect on trade and transportation routes for a flooded city. Develops an action plan that relocates the city and provides details on plan implementation. The plan uses data and maps to support ideas and includes a time line.	Analyzes the impact on trade and transportation routes for a flooded city. Develops an action plan on how to deal with this change that includes a time line.	Attempts to analyze appropriate data and creates an outline for a plan, but does not provide detail on implementation. Time line is incomplete.	Does not select appropriate datasets (such as transportation) to analyze the issue of spatial patterns of economic activities, and therefore has difficulty creating a plan. The plan lacks a time line.
<b>The student knows and understands how the interaction of physical and human systems may shape present and future conditions on Earth.</b>	Develops a coherent argument that supports the relocation plan. Uses a variety of data to support the findings and creates additional data and maps that illustrate changes to the human infrastructure.	Develops a coherent argument that supports the relocation plan. Uses a variety of data to support the findings.	Creates a relocation plan for the selected city, but does not offer a variety of data to support ideas.	Relocates a selected city, but does not formalize a plan on how the change will take place. Uses little or no data to support ideas.

This is a four-point rubric based on the National Standards for Geographic Education. The “Mastery” level meets the target objective for grades 5–8.





NAME \_\_\_\_\_

DATE \_\_\_\_\_

# Water World

## *High school assessment*

You and your teammates have been selected to be part of an elite team of GIS experts who will determine the fate of one of the following 10 world cities. Over the next 50 years, the rise in sea level up to 50 meters will affect these cities.

List of World Cities affected by 50-meter rise in sea level:

San Francisco, USA	Houston, USA
London, England	Odessa, Ukraine
Tokyo, Japan	Rome, Italy
Miami, USA	Sydney, Australia
Calcutta, India	Buenos Aires, Argentina

As part of your task, select a city and develop an action plan that relocates the city, relocates the roles of the city to another city, adapts the city to its new environment, or chooses another option. The plan must take into account the following factors:

Major roads	Utilities
Railroads	Relocation of people
Airports	Economics and trade relations
Ocean ports and shipping lanes	Agriculture and manufacturing

Your Project Director (teacher) will provide you with a detailed listing of the available data you can use. You will add this data to the Water World data frame in the Global7 map document you used in the GIS Investigation. You may need to consult an atlas or the Internet to research some factors.

Your action plan must include each of the following:

- **Time line**—It describes the various phases of your plan. For example, one five-year phase might include relocating people, while another includes relocating specific businesses.
- **Map**—It displays proposed changes and could be a series of maps generated in ArcMap or on paper.
- **Data**—It will support your suggested changes. This data will come from the GIS Investigation and can be displayed through maps, graphs, or tables.
- **Written report**—This is a written explanation of your plan and can include the time line.

Your Project Director (teacher) will provide you with instructions on how you will present your action plan to the class.

# Water World

## Assessment rubric

### High school

STANDARD	EXEMPLARY	MASTERY	INTRODUCTORY	DOES NOT MEET REQUIREMENTS
<b>The student knows and understands how to use geographic representations and tools to analyze, explain, and solve geographic problems.</b>	Uses GIS to create a map in an appropriate projection (Orthographic) to display information on the region of the South Pole. Uses GIS to create a digital map illustrating the effects of a 50-meter rise in sea level for the selected city.	Uses GIS to create a map in an appropriate projection (Orthographic) to display information on the region of the South Pole. Uses a GIS to create a paper map illustrating the effects of a 50-meter rise in sea level for the selected city.	Uses GIS to create a map in an appropriate projection (Orthographic) to display information on the region of the South Pole. Creates a map of the selected city, but it does not adequately illustrate the effects of the 50-meter rise in sea level.	Has difficulty projecting maps using GIS, and does not show an understanding of variations in projections. Does not include a map of the selected city.
<b>The student knows and understands the changing physical and human characteristics of places.</b>	Clearly defines how the characteristics of a city could change, should a 50-meter rise in sea level occur. Includes data from the GIS Investigation to create an original map to illustrate the changes.	Clearly defines how the characteristics of a city could change, should a 50-meter rise in sea level occur. Includes data from the GIS Investigation.	Defines how some characteristics of a city change, should a 50-meter rise in sea level occur. Provides little evidence from the data.	Attempts to define how some characteristics of a city change with a 50-meter rise in sea level. Does not provide any evidence from the data.
<b>The student knows and understands the increasing economic interdependence of the world's countries.</b>	Provides specific examples of how the loss of the selected city would affect the global marketplace. Provides an economic action plan to prevent this loss from occurring.	Identifies how the global economic infrastructure will be altered with a 50-meter rise in sea level, using the perspective of the selected city.	Identifies how the selected city will be affected economically, but does not make a connection to the global marketplace.	Attempts to identify how the selected city will be affected economically, but does not make a connection to the global marketplace.
<b>The student knows and understands how to use geographic knowledge, skills, and perspectives to analyze problems and make decisions.</b>	Develops a detailed action plan to sustain the selected city in the event of a 50-meter rise in sea level. Creates original maps with a GIS that uses a variety of data sources to support the ideas in the plan.	Develops a detailed action plan to sustain the selected city in the event of a 50-meter rise in sea level. Uses a variety of data sources to support the ideas in their plan.	Develops a plan to sustain the selected city in the event of a 50-meter rise in sea level. Provides little or no data to support ideas.	Creates an outline of a plan to sustain the selected city in the event of a 50-meter rise in sea level. Provides little or no data to support ideas.

This is a four-point rubric based on the National Standards for Geographic Education. The “Mastery” level meets the target objective for grades 9–12.





## Student assessment handouts data sheet

The layers below can be found in the World7.mdb geodatabase in your module 7 Data folder (C:\MapWorld9\Mod7\Data\World7.mdb).

FEATURE CLASS NAME	DESCRIPTION OF DATA
roads_rail	Lines that represent main and smaller roads and railroads for the world.
w_cities	Points that represent cities that are major population centers of the world and includes whether a city is a shipping port.
us_cities	Points that represent a detailed listing of U.S. cities.
airports	Points representing the world's airports.
energy	Points that represent major power plants for the world and includes type of energy source (atomic, thermal, and so on).
pipelines	Lines that represent major oil and gas pipelines throughout the world.
manufact_plc	Points that list major manufacturing places around the world.
mineral_res	Points of mineral resource mining sites around the world.
rivers	Lines that represent the major rivers of the world.
lakes	Polygons that represent the major lakes of the world.



# In the Eye of the Storm

## *A regional case study of Latin America and the impact of Hurricane Mitch*

### Lesson overview

Students will study Hurricane Mitch, the deadliest storm of the twentieth century, and the havoc it wreaked on several Central American countries. They will analyze information about the storm itself, compare the region before, during, and after the storm, and consider the consequences of such a disaster for the society it ravaged. The lesson will conclude with the development of a hurricane relief and rebuilding plan for the region, and comparison of student ideas with the plans that were actually made.

**Estimated time** Three 45-minute class periods

- Materials** ✓ Student handouts from this lesson to be photocopied:
- GIS Investigation sheets (pages 425 to 436)
  - Student answer sheets (pages 437 to 442)
  - Assessment(s) (pages 443 to 448)

**Standards and objectives** *National geography standards*

GEOGRAPHY STANDARD	MIDDLE SCHOOL	HIGH SCHOOL
1 How to use maps and other geographic representations, tools, and technologies to acquire, process, and report information from a spatial perspective	The student understands the characteristics, functions, and applications of maps, globes, aerial and other photographs, satellite-produced images, and models to solve geographic problems.	The student understands how to use technologies to represent and interpret Earth's physical and human systems.
7 The physical processes that shape the patterns of Earth's surface	The student understands how to predict the consequences of physical processes on Earth's surface.	The student understands the spatial variation in the consequences of physical processes across Earth's surface.
15 How physical systems affect human systems	The student understands how natural hazards affect human activities.	The student understands strategies of response to constraints and stresses placed on human systems by the physical environment, and how humans perceive and react to natural hazards.
18 How to apply geography to interpret the present and plan for the future	The student understands how to apply the geographic point of view to solve social and environmental problems by making geographically informed decisions.	The student understands how to use geographic knowledge, skills, and perspectives to analyze problems and make decisions.



Standards and objectives (continued)

**Objectives**

The student is able to:

- Analyze human and physical characteristics of the region of Central America.
- Follow the development and impact of Hurricane Mitch on Central American countries.
- Compare satellite imagery of Hurricane Mitch to ground tracking observations.
- Develop a disaster relief plan for the areas most heavily affected by Hurricane Mitch.

**GIS skills and tools**



Add layer files and images to a map



Zoom in or out on the map



Pan the map

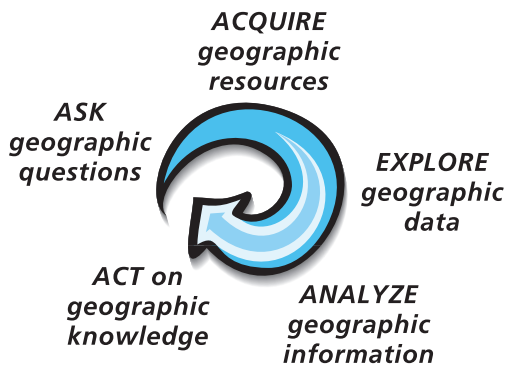


Identify the attributes of a feature



Measure distance on a map

- Zoom to the geographic extent of a layer
- Label features including overlapping labels
- Turn labels on and off
- Change a layer's symbol
- Activate and expand a second data frame
- Open an attribute table
- Sort a field in a table in ascending order
- Show only selected records in a table
- Show all records in a table
- Rearrange layers in the table of contents
- Hide or show a layer's legend in the table of contents



For more on geographic inquiry and these steps, see Geographic Inquiry and GIS (pages xxiii to xxv).



## Teacher notes

### Lesson introduction

First, discuss the weather hazards of your own region. Use the following questions as a guide:

- What weather hazards are specific to our hometown or region?
- When do they typically occur? (Year-round, or in a particular season?)
- What are some characteristics of these phenomena?
- How do you prepare for one? (You may want to review school procedures, or have the students share plans they have from home.)

After the discussion, tell your class that in this GIS Investigation, they will be studying the impact of Hurricane Mitch on a large part of Central America. They will explore characteristics of the storm, including how it developed, and how it changed the physical and human characteristics of the region. In the final assessment, they will be part of a special team developing an action plan for dealing with the devastation the storm caused.

### Student activity



**Before completing this lesson with students, we recommend that you complete it yourself. Doing so will allow you to modify the activity to suit the specific needs of your students.**

After the initial discussion, have the students work on the computer component of the lesson. Ideally, each student should be at an individual computer, but the lesson can be modified to accommodate a variety of instructional settings.

Distribute the GIS Investigation sheets to the students and the “Central America Prior to Hurricane Mitch” handout. This project has two parts: a general investigation of the region, then tracking of the storm and consideration of its impact. The GIS Investigation will provide them with detailed instructions for their ArcMap exploration.



**Teacher Tip: This GIS Investigation is divided into two parts, each appropriate for a 45-minute class period. At the end of part 1, students are instructed to ask you how to rename the map document and where to save it. Because this data will be valuable to the students during the assessment, be sure they record the new name and location on their answer sheet.**

In part 2, the students will add image data on Hurricane Mitch and track its path over Central America. Because these image files are large, you may not want students to have individual copies of the module 7 folder. You can have students access the same copy of the data but save individual map documents (e.g., ABC\_Region7 where ABC are a student’s initials). If students save their map documents periodically during the activity, they will be able to use them to complete the assessment.

In addition to instructions, the handout includes questions to help students focus on key concepts. Some questions will have specific answers, while others require creative thought.

Things to look for while the students are working on this activity:

- Are the students using a variety of tools?
- Are the students answering the questions as they work through the procedure?
- Are the students beginning to ask their own questions of the data they are observing?



- Conclusion** Once students have completed the GIS Investigation, have them share their findings, either in small groups or as a class. They should have a basic understanding of the region and the effect of the storm in terms of rainfall amounts, wind speeds, and so forth. Ask your students which parts of the region suffered the most damage and why. To find out more about the storm and its impact on Central America, refer to this book's companion Web site ([www.esri.com/mappingourworld](http://www.esri.com/mappingourworld)) for print, media, and Internet resources on Hurricane Mitch. The USGS has an enormous amount of data on the impact of Hurricane Mitch and disaster recovery efforts in the affected countries (<http://mitchnts1.cr.usgs.gov>). Encourage students to research this topic while completing their assessment. Allow class time for each team to meet and plan how they will complete the assessment.
- Assessment** The middle school and high school assessments vary in the specific tasks the students undertake, but the basic design of the assessments is the same.
- Assign students to small groups of three to four students per team. Each team will have the following (some roles may be combined):
- Within each group, students should assign themselves to the following roles:
- Team leader—organizes the group and takes the lead in creating the final product/presentation.
  - Cartographer—creates the maps using GIS.
  - Data expert—gathers data sources and determines which data is best to use.
  - Multimedia specialist—responsible for creating the multimedia presentation of your choice.
- Assign each team to a particular job focus: flood hazards or volcano and landslide hazards. The choices are detailed in the assessment handouts. There is a different assessment handout created for each team type. Also assign each team a particular country to focus on. That way, they will have more depth to their research. The goal for each team is to assess the possible damage and then to develop a disaster relief plan based on their findings. You may modify this assessment into a longer research project or shorten it to a two-night homework assignment.
- Extensions**
- Have students create a disaster relief plan for your city using a local natural hazard as the springboard. Research disasters in your city or region's past to find out how they have changed the local area.
  - Watch excerpts from films such as *The Perfect Storm* or *Twister* and discuss how these fictional storms relate to those in real life.
  - Conduct a book study on *Isaac's Storm*, by Erik Larson. Compare the Galveston storm of 1900 to Hurricane Mitch.
  - Check out the Resources by Module section of this book's companion Web site ([www.esri.com/mappingourworld](http://www.esri.com/mappingourworld)) for print, media, and Internet resources on the topics of Hurricane Mitch, Central America, and tropical storms.



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.

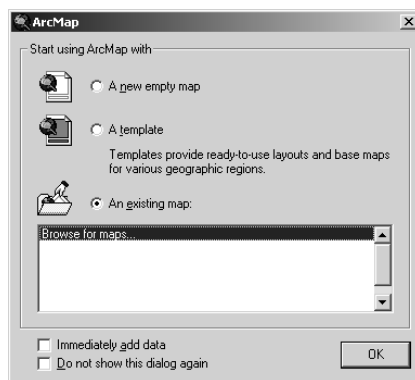
Central America consists of the small chain of countries that link the North and South American continents. Explore these countries using ArcView and gather data to complete your chart titled Central America Prior to Hurricane Mitch. The data you are collecting will help you to gain an understanding 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.

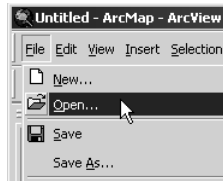


- b* If the ArcMap start-up dialog appears, click **An existing map** and click OK. Then go to step 2b.

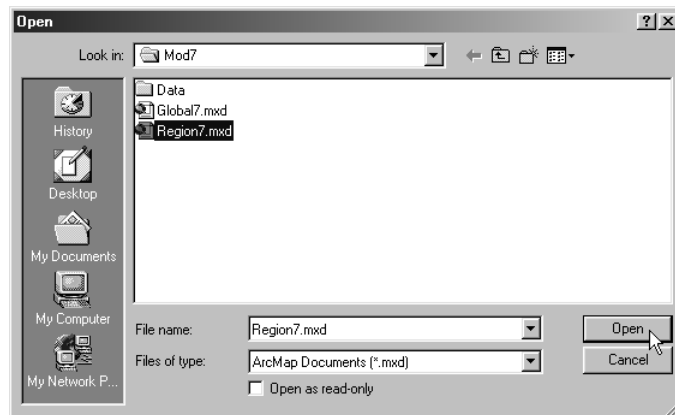


**Step 2 Open the Region7.mxd file**

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

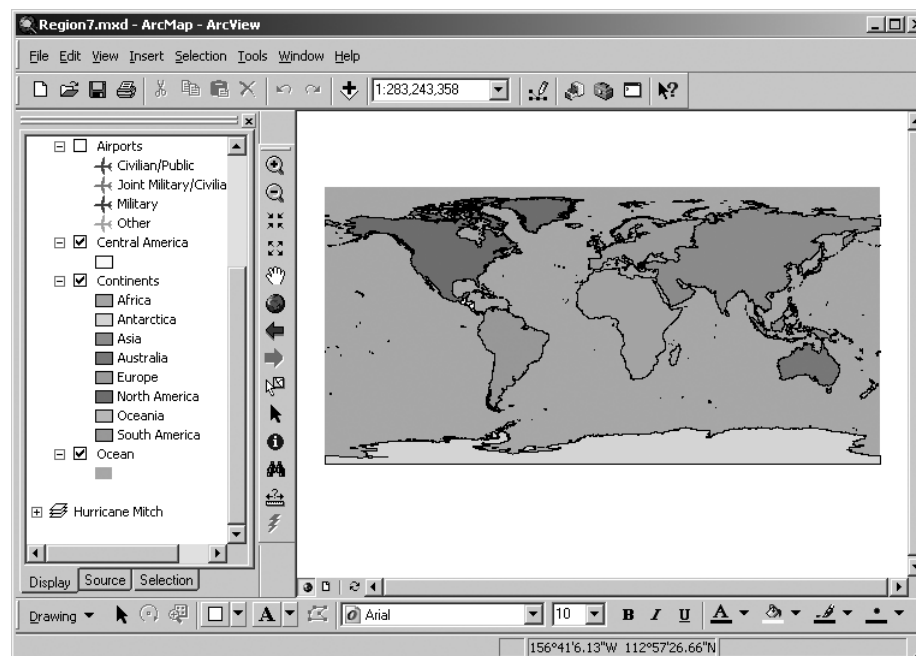


- b Navigate to the module folder (**C:\MapWorld9\Mod7**) and choose **Region7.mxd** (or **Region7**) from the list.



- 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

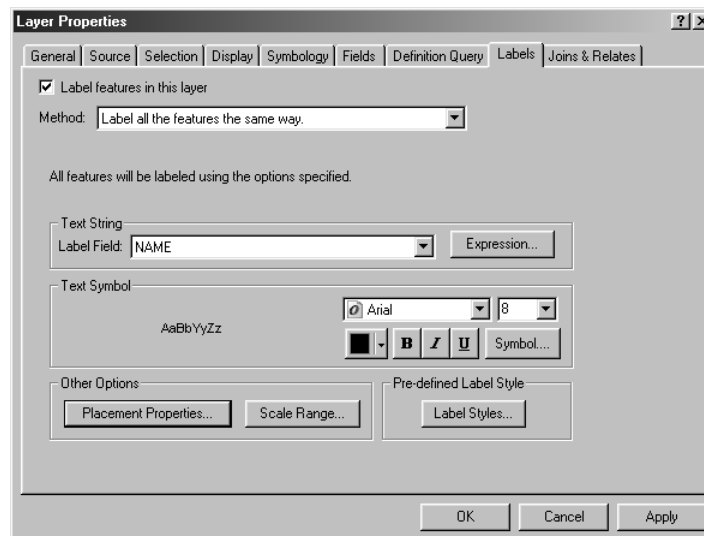
- a** Right-click on the Central America layer name and click Zoom to Layer. The map immediately centers around the countries of Central America.

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.

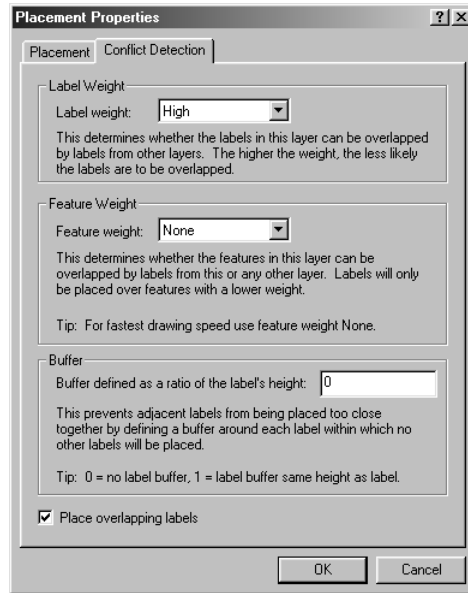
You can find the names of the capitals by using the Identify tool or by labeling features. Labeling features is a quick way to get information about a group of features.

- 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.

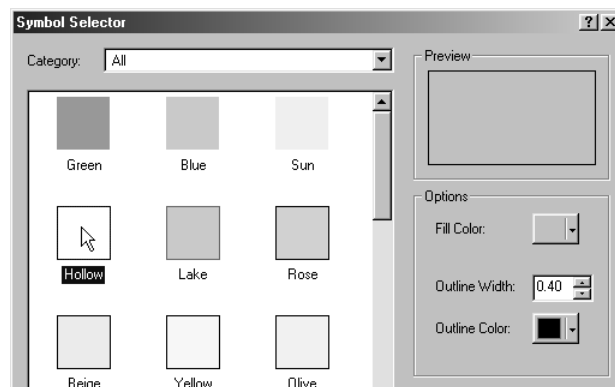
The table below summarizes the data in each layer:

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.

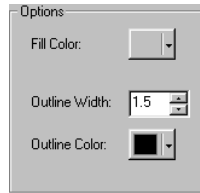
The precipitation data appears in the map, but you cannot determine the average precipitation for each individual country. You will move the Central America layer and change its legend so you can view each country's average precipitation data.

- 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.



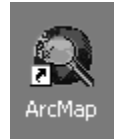
## Part 2: The storm

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.

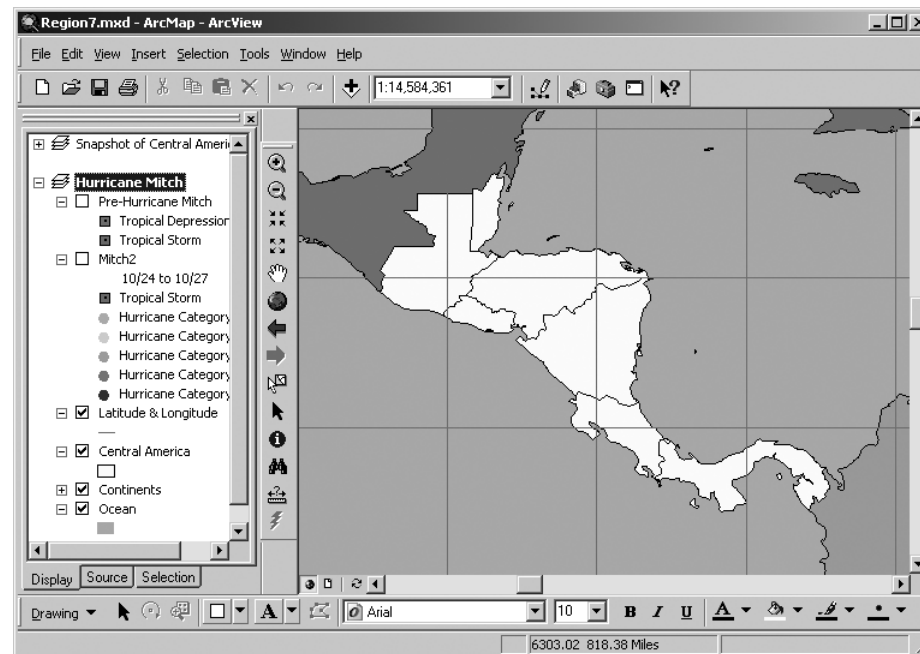


- b Refer to your answer sheet and determine where Region7.mxd (or Region7) is saved and how you renamed it.
- c Navigate to the location of the saved map document and open it. If you didn't rename or save the map document in part 1, navigate to the module 7 folder (C:\MapWorld9\Mod7) and select **Region7.mxd** (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).

Field	Value
OBJECTID	4
Shape	Point
ID	5
ADV	4
LAT	11.5
LON	-77.6
TIME_	10/22/21Z
WIND	40
PR	1000
STAT	TROPICAL_STORM
STAT_Label	Tropical Storm

- 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.


TIME_	WIND	PR	STAT
10/24/03Z	50	997	TROPICAL_STORM
10/24/09Z	80	988	HURRICANE-1
10/24/15Z	85	987	HURRICANE-2
10/24/18Z	85	979	HURRICANE-2
10/24/21Z	90	976	HURRICANE-2
10/25/00Z	95	973	HURRICANE-2
10/25/03Z	105	965	HURRICANE-3
10/25/06Z	110	953	HURRICANE-3
10/25/09Z	110	949	HURRICANE-3
10/25/12Z	110	945	HURRICANE-3
10/25/18Z	125	929	HURRICANE-4

Record: 0 Show: All Selected Records (1 out of 28 Selected.) Options


- 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.

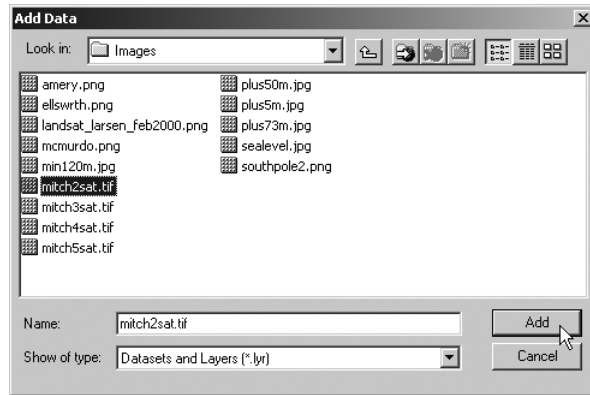
### Step 3 Measure the size of the storm

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.

Segment: 24.901145 Total: 24.901145 Miles



*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*.

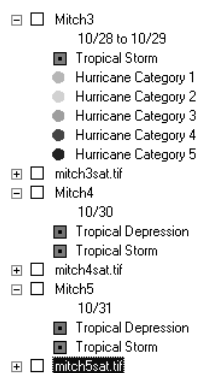
Now that you have recorded data for *mitch2sat.tif*, you will follow the same procedures for adding new layers and measuring the storm at other locations.




-  *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.

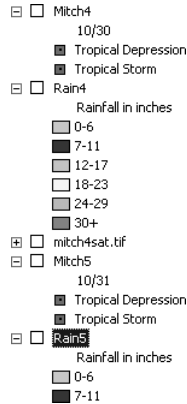


- c Turn on Rain3. The rain pattern appears overlaid on top of mitch3sat.tif. Answer the following questions:



- (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.



NAME \_\_\_\_\_

DATE \_\_\_\_\_

# Student answer sheet

## Module 7

### Human/Environment Interaction

#### Regional case study: In the Eye of the Storm

##### Part 1: The calm before the storm

###### Step 3 Focus on the capital cities of Central America

- g Record the capital cities for each of the countries in Central America in the Populated Places column in the table on the next two pages.

###### Step 4 Focus on Central America prior to Hurricane Mitch

- b Record this data in the Populated Places and Transportation Network columns in the table on the next two pages.
- m Analyze the precipitation for each country and record the precipitation data in the Average Precipitation column in the table on the next two pages.

p-1 Which country has the most area devoted to agriculture? \_\_\_\_\_

p-2 Which country has the most area covered by mountains? \_\_\_\_\_

p-3 Which country has the most extensive transportation network? \_\_\_\_\_

###### Step 5 Save the map document and exit ArcMap

- a Write the new name you gave the map document and where you saved it.

\_\_\_\_\_  
 (Name of map document.  
 For example: ABC\_Region7.mxd)

\_\_\_\_\_  
 (Navigation path to where map document is saved.  
 For example: C:\Student\ABC)

**Central America Prior to Hurricane Mitch**

COUNTRY	POPULATED PLACES	TRANSPORTATION NETWORK	MAJOR EXPORTS
Belize	Capital: Belmopan Distribution: Throughout the country, but concentrated around the capital	Roads: Sparse road network Railways: none Airports: 1 civilian	Bananas
Guatemala	Capital: Distribution:	Roads: Railways: Airports:	Coffee
Honduras	Capital: Distribution:	Roads: Railways: Airports:	Coffee
El Salvador	Capital: Distribution:	Roads: Railways: Airports:	Coffee
Nicaragua	Capital: Distribution:	Roads: Railways: Airports:	Coffee
Costa Rica	Capital: Distribution:	Roads: Railways: Airports:	Garments
Panama	Capital: Distribution:	Roads: Railways: Airports:	Bananas



## Central America Prior to Hurricane Mitch (continued)

COUNTRY	AGRICULTURAL LAND USE	AVERAGE PRECIPITATION	PHYSICAL LANDMARKS
Belize	Primarily forest with some irrigated land and little cropland	Primarily 1,401–2,800 mm	Maya Mountains
Guatemala			
Honduras			
El Salvador			
Nicaragua			
Costa Rica			
Panama			



## Part 2: The storm

### Step 2 Track Hurricane Mitch

d-1 At what time was Tropical Storm Mitch at this location? \_\_\_\_\_

d-2 What does the "z" mean in the time? \_\_\_\_\_

d-3 What was Mitch's wind speed at this location? \_\_\_\_\_

f-1 What are the latitude and longitude coordinates for Hurricane Mitch at this location?  
\_\_\_\_\_

f-2 At what time was Hurricane Mitch at this location? \_\_\_\_\_

f-3 What was Mitch's wind speed at this location? \_\_\_\_\_

h-1 At what time was Hurricane Mitch at this location? \_\_\_\_\_

h-2 What was Mitch's wind speed at this location? \_\_\_\_\_

p Write down the times for each event and determine the difference. The time is written in this format:  
Month/Day/Hour (of 24).

Hurricane - 5: \_\_\_\_\_

Tropical\_Storm: \_\_\_\_\_

Time Difference: \_\_\_\_\_

r Examine the attribute table further and identify the maximum wind speed. \_\_\_\_\_



### Step 3 Measure the size of the storm

g What is the diameter of the eye of Hurricane Mitch? \_\_\_\_\_

h–q Record your measurements and observations in the table below.

	DIAMETER OF EYE	DIAMETER OF STORM	DISTANCE OF EYE TO COASTLINE OF HONDURAS	HOW HAS THE STORM CHANGED FROM THE PREVIOUS IMAGE?
Mitch2sat.tif				
Mitch3sat.tif				
Mitch4sat.tif				
Mitch5sat.tif				



**Step 4 Analyze rainfall from Hurricane Mitch**

c-1 What pattern do you notice in the amount of rainfall within the storm?

---

c-2 Is this a pattern you expected to find? Why or why not?

---

e-1 At the Mitch4 location, what was the highest range of rainfall measured?

---

e-2 Which country received the majority of this heavy rain?

---

e-3 Describe the difference between the rainfall patterns on October 30 and October 31, 1998.

---

---

---

e-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**

a Write the new name you gave the map document and where you saved it.

---

(Name of map document.  
For example: ABC\_Region7.mxd)

---

(Navigation path to where map document is saved.  
For example: C:\Student\ABC)



NAME \_\_\_\_\_

DATE \_\_\_\_\_

# Volcano and Landslide Hazard Team

## *Middle school assessment*

Your assigned country is: \_\_\_\_\_

The focus of this team is potential hazards of landslides and debris flows from volcanoes in the region devastated by the intense rainfall of Hurricane Mitch. Begin by studying the volcanoes in your assigned country and the amounts of rainfall they received from the storm. Compare this rainfall to the typical precipitation received in that area. Use the ArcMap map document and add data from the module 7 data folder (CentralAmerica.mdb\ca\_utility) to help you with your presentation. This additional data provides information on utility lines in Central America.

In your report/presentation, you need to do the following:

- Predict which towns are in the most danger from flooding.
- Create an emergency action plan for these towns, including:
  - An evacuation plan in case of major landslides/debris flows
  - Ways to reroute power
  - A plan to provide medical and humanitarian aid to the affected areas
  - Alternative routes to transportation networks that will be affected
- Identify agricultural areas that will be damaged (if any).



NAME \_\_\_\_\_

DATE \_\_\_\_\_

# Flood Hazard Team

## *Middle school assessment*

Your assigned country is: \_\_\_\_\_

The focus of this team is damage from rising floodwaters caused by Hurricane Mitch. It will be helpful to look at the rainfall layers from Hurricane Mitch, typical precipitation patterns for the region, and data from the module 7 data folder (CentralAmerica.mdb\ca\_drain and ca\_utility). This additional data provides information on drainage features and utility lines in Central America.

In your report/presentation, you need to do the following:

- Predict which towns are in the most danger from flooding.
- Create an emergency action plan for these towns, including:
  - An evacuation plan in case of major landslides/debris flows
  - Ways to reroute power
  - A plan to provide medical and humanitarian aid to the affected areas
  - Alternative routes to transportation networks that will be affected
- Identify agricultural areas that will be damaged (if any).

# In the Eye of the Storm

## Assessment rubric

### Middle school

STANDARD	EXEMPLARY	MASTERY	INTRODUCTORY	DOES NOT MEET REQUIREMENTS
<b>The student knows and understands the relative advantages and disadvantages of using maps, globes, aerial and other photographs, satellite-produced images, and models to solve geographic problems.</b>	Uses GIS to gather a variety of data about Hurricane Mitch including new data from outside sources. Analyzes this information to determine cities at greatest risk for particular hazards.	Uses GIS to gather a variety of data about Hurricane Mitch and analyzes this information to determine cities at greatest risk for particular hazards.	Uses GIS to gather data about Hurricane Mitch and attempts to determine cities at risk for particular hazards. Because their selection of data is limited, some predictions may not be accurate.	Only uses data provided from the original GIS project and does not make accurate predictions.
<b>The student knows and understands how to predict the consequences of physical processes on Earth's surface.</b>	Accurately predicts the impact of Hurricane Mitch on the physical environment of their assigned Central American country. Creates a map of the affected areas using a variety of data.	Accurately predicts the impact of Hurricane Mitch on the physical environment of their assigned Central American country. Provides ample data to support their predictions.	Attempts to predict the impact of Hurricane Mitch on the physical environment of their assigned Central American country. Provides some data to support their predictions.	Is not able to identify major effects of Hurricane Mitch on the physical environment of their assigned Central American country.
<b>The student knows and understands how natural hazards affect human activities.</b>	Accurately predicts the impact of Hurricane Mitch on human activities in their assigned Central American country. Creates a map of the affected areas using a variety of data.	Accurately predicts the impact of Hurricane Mitch on human activities in their assigned Central American country. Provides ample data to support their predictions.	Attempts to predict the impact of Hurricane Mitch on human activities in their assigned Central American country. Provides some data to support their predictions.	Is not able to identify the effects of Hurricane Mitch on human activities in their assigned Central American country.
<b>The student knows and understands how to apply the geographic point of view to solve social and environmental problems by making geographically informed decisions.</b>	Creates an emergency action plan for their country that takes into account infrastructure and environmental changes. Uses a variety of data to support the ideas in their plan. Creates a map with evacuation routes and other important factors.	Creates an emergency action plan for their country that takes into account infrastructure and environmental changes. Uses a variety of data to support the ideas in their plan, including an evacuation route.	Creates an emergency action plan, but does not take into account both infrastructure and environment changes—focuses only on one. Uses data to support the ideas in their plan, but is missing some important factors.	Creates an outline for an emergency action plan, but does not take into account both infrastructure and environmental changes—focuses only on one. Provides little or no data to support their plan.

This is a four-point rubric based on the National Standards for Geographic Education. The “Mastery” level meets the target objective for grades 5–8.





NAME \_\_\_\_\_

DATE \_\_\_\_\_

# Volcano and Landslide Hazard Team

## *High school assessment*

Your assigned country is: \_\_\_\_\_

The focus of this team is potential hazards of landslides and debris flows from volcanoes in the region devastated by the intense rainfall of Hurricane Mitch. Begin by studying the volcanoes in your assigned country and the amounts of rainfall they received from the storm. Compare this rainfall to the typical precipitation received in that area. Use the ArcMap map document and add data from the module 7 data folder (CentralAmerica.mdb\ca\_utility) to help you with your presentation. This additional data provides information on utility lines in Central America.

In your report/presentation, you need to do the following:

- Predict which towns are in the most danger from debris flow and landslide threat.
- Create an emergency action plan for these towns, including:
  - An evacuation plan in case of major landslides/debris flows
  - Ways to reroute power
  - A plan to provide medical and humanitarian aid to the affected areas
  - Alternative routes to transportation networks that will be affected
- Identify agricultural areas that will be damaged (if any) and discuss how this would hinder the economy of the country.



NAME \_\_\_\_\_

DATE \_\_\_\_\_

# Flood Hazard Team

## *High school assessment*

Your assigned country is: \_\_\_\_\_

The focus of this team is damage from rising floodwaters caused by Hurricane Mitch. It will be helpful to look at the rainfall layers from Hurricane Mitch, typical precipitation patterns for the region, and data from the module 7 data folder (CentralAmerica.mdb\ca\_drain and ca\_utility). This additional data provides information on drainage features and utility lines in Central America.

In your report/presentation, you need to do the following:

- Predict which towns are in the most danger from flooding.
- Create an emergency action plan for these towns, including:
  - An evacuation plan in case of major landslides/debris flows
  - Ways to reroute power
  - A plan to provide medical and humanitarian aid to the affected areas
  - Alternative routes to transportation networks that will be affected
- Identify agricultural areas that will be damaged (if any) and discuss how this would hinder the economy of the country.



# In the Eye of the Storm

## Assessment rubric

### High school

STANDARD	EXEMPLARY	MASTERY	INTRODUCTORY	DOES NOT MEET REQUIREMENTS
<b>The student knows and understands how to use technologies to represent and interpret Earth's physical and human systems.</b>	Uses GIS to analyze a variety of data from satellite imagery to social infrastructure themes to determine what areas are at greatest risk from Hurricane Mitch. In addition, the students import data from outside sources.	Uses GIS to analyze a variety of data from satellite imagery to social infrastructure themes to determine what areas are at greatest risk from Hurricane Mitch.	Uses GIS to analyze data to determine what areas are at greatest risk from Hurricane Mitch. Because their selection of data is limited, some predictions may not be accurate.	Only uses data provided from the original GIS project and does not make accurate predictions.
<b>The student knows and understands the spatial variation in the consequences of physical processes across Earth's surface.</b>	Analyzes and makes accurate predictions on the impact of Hurricane Mitch on the physical environment of their assigned country. Uses GIS to create a map that details how the storm affects the region.	Analyzes and makes accurate predictions on the impact of Hurricane Mitch on the physical environment of their assigned country. Provides details on how the storm affects the region.	Reviews data and attempts to make predictions about the storm impact on the physical environment of their assigned country.	Makes inaccurate predictions on the storm impact on the physical environment of their assigned country.
<b>The student knows and understands strategies to respond to constraints placed on human systems by the physical environment and how humans perceive and react to natural hazards.</b>	Analyzes and makes accurate predictions on the impact of Hurricane Mitch on human systems of their assigned country. Uses GIS to create a map that details how the storm affects the region.	Analyzes and makes accurate predictions on the impact of Hurricane Mitch on human systems of their assigned country. Provides details on how the storm affects the region.	Reviews data and attempts to make predictions about the storm impact on human systems of their assigned country.	Makes inaccurate predictions on the storm impact on human systems of their assigned country.
<b>The student knows and understands how to use geographic knowledge, skills, and perspectives to analyze problems and make decisions.</b>	Creates an emergency action plan for their country that takes into account infrastructure and environmental changes. Uses a variety of data to support the ideas in their plan. Creates a map with evacuation routes and other important factors.	Creates an emergency action plan for their country that takes into account infrastructure and environmental changes. Uses a variety of data to support the ideas in their plan, including an evacuation route.	Creates an emergency action plan, but does not take into account both infrastructure and environment changes—focuses only on one. Uses data to support the ideas in their plan, but is missing some important factors.	Creates an outline for an emergency action plan, but does not take into account both infrastructure and environmental changes—focuses only on one. Provides little or no data to support their plan.

This is a four-point rubric based on the National Standards for Geographic Education. The "Mastery" level meets the target objective for grades 9–12.



# Data Disaster

## *An advanced investigation*

### Lesson overview

Students will act as data detectives in this scenario-based investigation. Due to a recent storm, the main computer was flooded at the International Wildlife Conservancy (a fictitious organization). All documentation for their ecozone maps was lost. The data and maps have survived, but staff members are unsure what each field in the database represents. What they do know is that the maps show areas in critical situations, and even in some cases in outright danger. The students must analyze the data that is available to them and create metadata for the data.

**Estimated time** Two 45-minute class periods

- Materials** ✓ Student handouts from this lesson to be copied:
- GIS Investigation sheets (pages 453 to 462)
  - Student answer sheet (pages 463 to 466)

### Standards and objectives

#### *National geography standards*

GEOGRAPHY STANDARD	MIDDLE SCHOOL	HIGH SCHOOL
1 How to use maps and other geographic representations, tools, and technologies to acquire, process, and report information from a spatial perspective	The student understands how to make and use maps, globes, graphs, charts, models, and databases to analyze spatial distributions and patterns.	The student understands how to use maps and other graphic representations to depict geographic problems.
5 That people create regions to interpret Earth's complexity	The student understands the connections among regions.	The student understands how multiple criteria can be used to define a region.
8 The characteristics and spatial distribution of ecosystems on Earth's surface	The student understands the local and global patterns of ecosystems.	The student understands the distribution and characteristics of ecosystems.

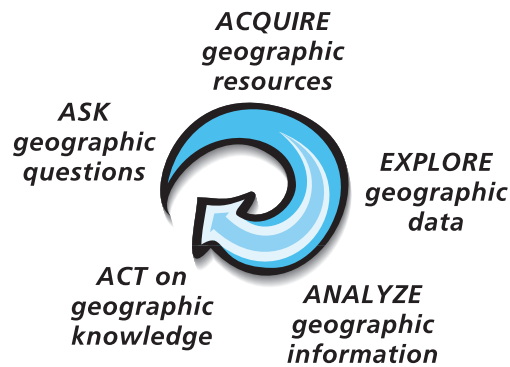
#### *Objectives*

The student is able to:

- Analyze and interpret various kinds of ecoregion data.
- Understand the importance of metadata in using spatial data.
- Create metadata for a dataset to make it more useful.

**GIS skills and tools**

- Create a new map document
- Change map symbols using the Symbol Selector
- Copy a layer and symbolize it based on different attributes
- Determine the best color scheme for depicting spatial information
- Start ArcCatalog and create a new folder connection
- View metadata for a feature class and change the metadata stylesheet
- Update metadata using the metadata editor




For more on geographic inquiry and these steps, see *Geographic Inquiry and GIS* (pages xxiii to xxv).

**Teacher notes****Lesson introduction**


Begin the lesson with a discussion of what metadata is. Metadata is data about data—it is information that describes the content and quality of GIS data. Metadata includes information about who created the data, when it was created, what resources were used, how it was made, and also defines various fields in an attribute table. Without metadata, tables can end up as meaningless sets of numbers and words.

**Student activity**

 **Before completing this lesson with students, we recommend that you complete it as well. Doing so will allow you to modify the activity to accommodate the specific needs of your students. The lesson is designed for students working individually at the computer, but it can be modified to accommodate a variety of instructional settings.**

After the initial discussion, distribute and explain the Data Disaster GIS Investigation. In the GIS Investigation, students will act as data detectives. They will create an ArcMap map document from the ground up, beginning with a new data frame. They will also create metadata for an ecoregions layer using ArcCatalog.

 **Teacher Tip: Make sure you advise students on how to name and where to save their map document. Be sure to have instructions ready for the students if you would like them to save their work.**

 **Teacher Tip: In step 6, students are asked to update metadata for the WWF\_Eco layer. This action results in permanent changes to the WWF\_Eco feature class in the World7.mdb geodatabase (C:\MapWorld9\Mod7\Data\World7.mdb). In order for this to work properly, each student must have their own copy of the Mod7 folder.**



Steps 5–7 can be done as part of the assessment. They include instructions on how to look at a sample metadata document and how to write some metadata.

Things to look for while the students are working on this activity:

- Are students selecting appropriate colors for the data they are trying to map?
- Are they documenting their hypotheses about the data as they create the various maps?
- When creating metadata, are they referring back to the sample metadata and their answer sheet for guidance?

**Conclusion** Each student will have completed the holes in the data definition tables provided in the student answer sheet handout. The GIS Investigation reviews sample metadata documentation. You should be present to answer any questions students might have. Show them how to access the metadata for the data included with this book through ArcCatalog. Visit [www.esri.com/mappingourworld](http://www.esri.com/mappingourworld) to access the Federal Geographic Data Committee (FGDC) Web site.

**Assessment** *Middle school: Highlights skills appropriate to grades 5 through 8*

In the middle school assessment, students will create a metadata set based on their findings in the GIS Investigation. Items that they should include are:

- Identification—identifies what the data represents.
- Attribute information—defines each of the fields in the attribute table.
- Metadata reference—identifies who created the metadata and contact information.

*High school: Highlights skills appropriate to grades 9 through 12*

In the high school assessment, students will create metadata based on their findings in the GIS Investigation. Items that they should include are:

- Identification—identifies what the data represents.
- Attribute information—defines each of the fields in the attribute table.
- Metadata reference—identifies who created the metadata and contact information.
- Attribute information—defines each of the values for the THREAT and FINAL attributes.

**Extensions**

- Have students create their own attribute tables and corresponding metadata using school information or by conducting a local survey, and so forth.
- Students can create their own data disasters and try to stump the class in trying to define other mystery datasets.
- View metadata documents for other data included in this book. Have students determine basic information about the data.
- Check out the Resources by Module section of this book's companion Web site ([www.esri.com/mappingourworld](http://www.esri.com/mappingourworld)) for print, media, and Internet resources on the topic of metadata.



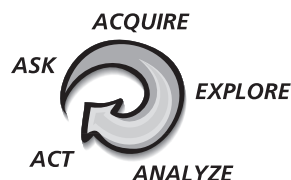


NAME \_\_\_\_\_

DATE \_\_\_\_\_

# Data Disaster

## *An advanced investigation*



### ***Answer all questions on the student answer sheet handout***

International Wildlife Conservatory (a fictitious organization) headquarters have been flooded. All of the metadata for their ecosystems data has been destroyed. This metadata contained detailed information describing the ecosystems database. It included definitions of the fields of the database, the names of types of data, and definitions for the data.

The IWC has created a list of endangered spaces known as Earth 200. According to the IWC, Earth 200 represents a list of the world's most unique and diverse environments. If any of these areas were lost or destroyed, the impact on the planet's ecosystem would be felt at a global level.

The dataset that you must investigate contains important information about these regions and identifies which are most threatened. The problem is that without the metadata, no one knows which areas are under the greatest threat. Your job is to review and map the data, rebuild the metadata, and use it to determine which regions are at a critical stage.

#### **Step 1 Start ArcMap**

- a Double-click the ArcMap icon on your computer's desktop.
- b If the ArcMap start-up dialog appears, click **A new empty map** and click OK. Then go to step 1d.

In this exercise, you will create your own map document from scratch.



- c Click the New Map File button. A new blank map document opens.



- d Click the Add Data button.

- e Navigate to the World7.mdb geodatabase in the module 7 Data folder (**C:\MapWorld9\Mod7Data\World.mdb**) and add the following feature classes:

*world30—ocean background with 30-degree grid*

*continents—continents of the world*



**Note: A feature class is a collection of features with the same type of shape and the same attributes.**

- f Stretch your ArcMap window to make it larger.



ArcMap randomly assigns a symbol color to each added layer. You will change these colors using the symbol selector and then change the layer names.


- g* In the table of contents, click the symbol below world30 to open the Symbol Selector.
- h* In the Options panel on the right, change the Fill Color to a light shade of blue and change the Outline Color to Gray 30%.
- i* In the table of contents, click the world30 layer name once, then click it again slowly. Change the layer name to **Ocean**.
- j* Move continents to the top of the table of contents.
- k* Click the symbol below continents to open the Symbol Selector. Change the symbol for continents to a Hollow symbol.
- l* Change the layer name to **Continents**.
- m* At the top of the table of contents, change the name of the data frame from Layers to **Data Disaster**.

## Step 2 Add the mystery data






- a* Click the Add Data button and navigate to the module 7 layer files folder (**C:\MapWorld9\Mod7\Data\LayerFiles**). Add WWF\_Eco.lyr to the map.

The layer file loads with a complex legend with many colors.

 **Remember:** A layer file contains the complete definition of a layer including its name, data source, symbology, and other properties. By saving a layer outside a map document as a layer file, you can reuse it in other maps.

Next you will determine the data source for the layer file so you can use this information later when you rebuild the metadata.

- b* In the table of contents, right-click WWF\_Eco and choose Properties. Click the Source tab.
  -  (1) What is the name of the feature class that the layer is based on?
  -  (2) What is the name of the geodatabase that contains the feature class?
- c* Close the Layer Properties dialog.
- d* Widen the table of contents so you can read the legend or pause the cursor over a long legend label to view the complete text.
  -  What do you think this map is showing?



### Step 3 Evaluate the attribute table and map two layers

The layer file's complex legend is created from the attribute table that is associated with the WWF\_Eco features. Take a closer look at the information in the table to begin to solve the mystery of the data.

*a* In the table of contents, right-click WWF\_Eco and select Open Attribute Table. The Attributes of WWF\_Eco table displays.

*b* Use the scroll bar at the bottom of the attribute table to see all the fields in the table.



(1) *There are nine fields in the table. Three of these fields, OBJECTID, Shape\_Length, and Shape\_Area won't help you identify the mystery data. You will concentrate on the other six fields. Record the names of the other six fields and the types of data they contain (numeric or text) in the table on the answer sheet.*



(2) *Write a hypothesis on what you think the data in this table represents.*

*c* Compare the data in the table to the WWF\_Eco layer legend.



*Which field does this layer map?*

In order to evaluate all of the data, you will map each of the six fields you recorded on the answer sheet. You will also name each legend heading to match the field being mapped and compare each layer to the others.

*d* Close the attribute table.

*e* In the table of contents, click the LEGEND label below the WWF\_Eco layer name, then click it again slowly. Type **MHT\_NAME** in the text box and press Enter.

Now you will remember that the data mapped in this layer matches the field MHT\_NAME in the attribute table.

*f* Rename the WWF\_Eco layer to WWF\_Eco1.

In order to map the other five fields, you will make copies of this layer and change the legend and layer names appropriately.

*g* Turn off the WWF\_Eco1 layer. Right-click WWF\_Eco1 and click Copy.



*h* Click the Paste button. A duplicate of the WWF\_Eco1 layer is now added to the top of the table of contents.

*i* Right-click WWF\_Eco1 and click Properties. Click the General tab.

*j* Change the layer name to WWF\_Eco2.

*k* Click the Symbology tab.



*l* In the Value Field drop-down list, choose Ecoregion. Notice that all the fields from the attribute table, except OBJECTID and SHAPE, can be mapped.

*m* Click the Add All Values button. Click Yes to generate the list of more than 500 unique values. Notice that Ecoregion is the heading for the legend.

*n* Keep the default color scheme or change it by using the Color Scheme drop-down list.





*o* Click OK to close the Layer Properties and apply the new layer name and legend.



- p* Turn on WWF\_Eco2. Look at the map and observe the similarities and differences between WWF\_Eco2 (ECOREGION) and WWF\_Eco 1 (MHT\_NAME).
-  *Record the similarities and differences between the two layers.*
- q* Click the minus sign to the left of WWF\_Eco2 to hide its legend.
-  *r* Ask your teacher where to save this map document and how to rename it. Save the map document. Record the new name and location on your answer sheet.


#### Step 4 Map the data and analyze it

In order to get a good look at all the data, you will need to map each of the three remaining fields the same way you mapped the ECOREGION field.

- a* In the table of contents, right-click WWF\_Eco1 (MHT\_NAME) and click Copy.
-  *b* Click the Paste button three times.
- c* Rename the layers WWF\_Eco3, WWF\_Eco4, and WWF\_Eco5.
- d* Use these layers to map the three remaining fields: BDI, Threat, and Final. Even though BDI, Threat, and Final are numeric fields, map them using unique values.
-  *e* Save the Map document, then examine these layers.
-  (1) *After mapping out all the data fields, what additional conclusions can you make about the data?*
-  (2) *Use this new information to revise your hypothesis about what the data represents.*

#### ★★★ NEWS FLASH ★★★


A cleanup volunteer has just discovered a document that appears to have some information about the data you are researching. The document has been heavily damaged by floodwater and is difficult to interpret. The table on your answer sheet has the information that could be deciphered.

-  *f* Read the table on the answer sheet and use the mapped data to complete the missing pieces. The definitions in the table belong to the six fields you mapped. Fill in the table on the answer sheet with the appropriate field name from the attribute table.

With this information, you are very close to being able to create a simple metadata document. You know what the data looks like because you've mapped it, and you have made educated guesses as to the definitions for each field. An important piece of information still missing is how to interpret the legend for the numeric fields.

Each of the numeric fields represents a scale. The question is what order does the scale follow? Is 1 the lowest or the highest value in the scale? The ranking definitions without their numeric values are found on the answer sheet for each of the numeric fields. The title for each table is its field name.



-  *g* Complete the tables on your answer sheet by filling in the numeric values for each description. Keep in mind that the definitions may not be listed in numeric order and don't forget about zero. The first table has been filled in for you.

Congratulations! All of the details that you have discovered will go in the attribute information section of a metadata document. That section defines each of the fields in the database or attribute table, identifies what type of data it is, and provides the user with details on how types of data are ranked or identified.

### Step 5 View metadata documentation

Now that you have had the opportunity to fill in the blanks in the definitions of the data, you will create a formal metadata document. Metadata means data about data. Metadata for each GIS data source is viewed and created in ArcCatalog. You will start ArcCatalog from ArcMap.

Before you create your own metadata, you will look at a sample metadata document.



- a* Save your ArcMap map document.



- b* Click the ArcCatalog button on the Standard toolbar. ArcCatalog opens in a separate window.

- c* Minimize the ArcMap window.

On the left side of the ArcCatalog window you see the Catalog tree. The Catalog tree is where you expand and contract folders to navigate to data stored on your computer.

On the right side of the ArcCatalog window is the preview pane. This pane has three tabs that show you different views of the item that is selected in the Catalog tree.

In ArcCatalog, you can create direct connections to folders to speed up the process of navigating to data. You will create a connection to the Mod7 folder so you can get to the module data more quickly.



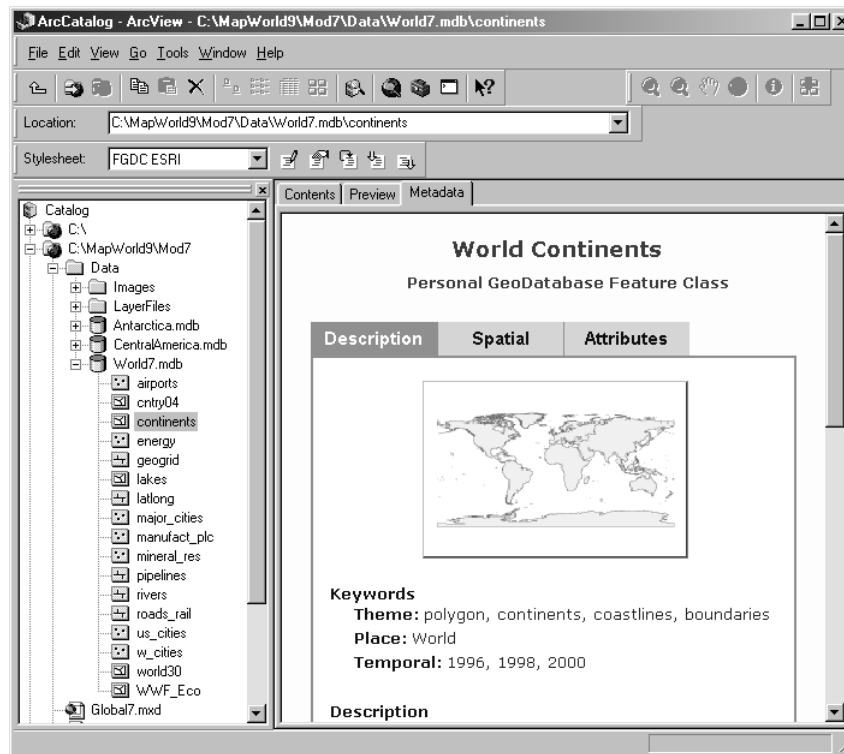
- d* Click the Connect To Folder button on the Standard toolbar. In the Connect to Folder dialog, navigate to the Mod7 folder (**C:\MapWorld9\Mod7**) and click on it, then click OK. The new folder connection displays in the Catalog tree.



- e* Expand the Mod7 and Data folders. Expand the World7.mdb geodatabase.




- f Click on the continents feature class, then click the Metadata tab.



You see the metadata for World Continents presented in FGDC ESRI style. This style reflects the metadata standard developed by the Federal Geographic Data Committee with some additional information from ESRI. You will change the style to a question-and-answer format.

- g Make sure the Metadata toolbar is visible. (In the graphic above, the Metadata toolbar is docked above the Catalog tree.)

 **Note:** If you don't see the Metadata toolbar, right-click in the gray area near the top of the ArcCatalog window and click Metadata on the menu that appears.

- h Click the Stylesheet down arrow and choose FGDC FAQ from the list.
- i Stretch the ArcCatalog window so you can view more of the metadata.
- j Explore the links in the World Continents metadata and answer the questions below. (Hint: After you click a link, you can go back to the original display by scrolling to the top of the page or by right-clicking on the page and choosing Back on the menu that appears.)



- (1) How would you describe this dataset?
- (2) Who made this data?
- (3) When was this data published?
- (4) Which section explains whether or not you can reuse the data for a project or publish a work that uses the data?

Now that you have viewed sample metadata, you will write a description (abstract) of the WWF\_Eco data that you will add to a metadata document in step 6.



- k* Look at the hypothesis you wrote on your answer sheet in steps 3b-2 and 4e-2. Use the World Continents metadata abstract as a sample and answer the following question:



*How would you describe the data in the WWF\_Eco layer that you investigated?*

### Step 6 Create metadata documentation

Now you will create your own metadata for WWF\_Eco. For simplicity, you will create metadata in only a few key areas.

In step 2, you added the WWF\_Eco.lyr layer file to the map and determined that the data source for the layer file is the WWF\_Eco feature class located in the World7.mdb geodatabase. You want to create metadata for the feature class rather than the layer file that references it.

- a* In the Catalog tree, look through the list of feature classes in the World7 geodatabase and click on WWF\_Eco. Its metadata displays in the metadata tab on the right.
- b* Scroll down through the metadata page. Some information is filled in automatically by ArcCatalog, but other information is missing.

**What does this data set describe?**

*Title:*  
WWF\_Eco

*Abstract:*  
REQUIRED: A brief narrative summary of the data set.

1. **How should this data set be cited?**

REQUIRED: The name of an organization or individual that developed the data set.,  
REQUIRED: The date when the data set is published or otherwise made available for release., WWF\_Eco.

You see the word “REQUIRED,” followed by a description of the required information, in many places. This indicates missing information that is required to comply with FGDC metadata standards. You will fill in some, but not all, of the missing information.



- c* Click the Edit Metadata button on the Metadata toolbar. This opens the metadata editing window.

The information is divided into seven main sections. The seven section titles, beginning with Identification, appear across the top of the window. Each section also contains multiple tabs.

- d* In the Identification section, make sure the General tab is selected.



You will begin by filling in general description information.

- e In the Description area, in the Abstract text box, highlight the red text and replace it with the description of the WWF\_Eco data that you wrote on your answer sheet in step 5k.
- f In the Supplemental Information text box, type a statement explaining that the original metadata was destroyed in a flood and that this metadata is reconstructed information.

Next you will define each of the fields in the attribute table.

- g Click on the Entity Attribute section, then click on the Attribute tab.

You see the first attribute, OBJECTID, in the WWF\_Eco attribute table. Notice that a definition and definition source are already entered for this attribute. Also notice that this is attribute 1 of 9. You will advance through the other eight attributes and add definitions for five of them.

- h Click the Move Next button near the bottom of the Attribute tab to display the next attribute in the WWF\_Eco attribute table.

You see the definition for the SHAPE attribute.

- i Click the Move Next button again to advance to the third attribute, ECOREGION. In the Definition text box, type the definition from step 4f on your answer sheet.
- j Use the Move Next button to advance to the next four attributes (MHT\_NAME, BDI, THREAT, and FINAL). Fill in the definitions based on your answers in step 4f.

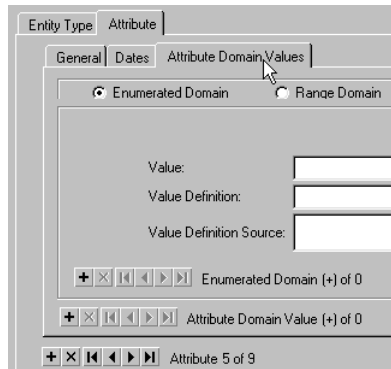


- k** Use the Move Previous button to navigate back to the fifth attribute, BDI.



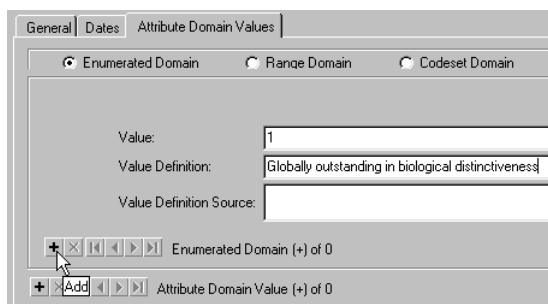
Now you will define each of the values in the BDI attribute field.

- l** Under the Attribute tab, click the Attribute Domain Values tab.



Notice that Enumerated Domain is already selected. An enumerated domain is used to describe a list of values. Each value should be listed in the metadata along with a definition of the value and, if known, the source of that definition. For the BDI attribute, you will enter each attribute value and its definition.

- m** In the Value text box, Type **1**.
- n** In the Value Definition box, type the description of the value listed in the BDI table in step 4g on your answer sheet.
- o** Click the Add button to add this value to the metadata document.



- p** Continue adding values and their definitions for the BDI attribute as listed in the BDI table on your answer sheet. Don't forget to add the "0" value and its definition.

Now you will add information about who created the metadata.



- q* Click the Metadata Reference section at the top of the dialog, then click the Details button next to Contact.

The screenshot shows the 'Editing WWF\_Eco' dialog box with the 'Metadata Reference' tab selected. The 'Contact' field is highlighted, and a 'Details...' button is visible next to it. A tooltip 'View or Edit the Contact Information' is shown over the button.

- r* Select Person as the Primary Contact. Fill in your name for the Person, your school for the Organization, and your grade for the Position. Click OK.
- s* Click Save on the bottom of the editing window to exit and save your changes to the metadata document.
- t* Look for your updates in the metadata document.
- u* Ask your teacher if there are other items that you should add to the metadata document.

Two additional items could include:

- Values and definitions for the THREAT attribute
- Values and definitions for the FINAL attribute

- v* Click the File menu and click Print to print your metadata document.

### Step 7 Exit ArcCatalog and ArcMap

Congratulations on a job well done! Your efforts will help the IWC get their data records back on track.

- a* In ArcCatalog, click the File menu and click Exit.
- b* In ArcMap, click the File menu and click Exit.



NAME \_\_\_\_\_

DATE \_\_\_\_\_

# Student answer sheet

## Module 7

### Human/Environment Interaction

#### Advanced investigation: Data Disaster

##### Step 2 Add the mystery data

b-1 What is the name of the feature class that the layer is based on?

\_\_\_\_\_

b-2 What is the name of the geodatabase that contains the feature class?

\_\_\_\_\_

d What do you think this map is showing?

\_\_\_\_\_

\_\_\_\_\_

##### Step 3 Evaluate the attribute table and map two layers

b-1 Write each field name and the type of data it contains (numeric or text) in the table below.

FIELD NUMBER	FIELD NAME	FIELD TYPE
1		
2		
3		
4		
5		
6		

b-2 Write a hypothesis on what you think the data represents.

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

c Which field does this layer map?

\_\_\_\_\_



p Record the similarities and differences between these two layers.

Four horizontal lines for writing.

r Write the new name you gave the map document and where you saved it.

Two horizontal lines with labels: (Name of map document. For example: ABC\_Adv7.mxd) and (Navigation path to where map document is saved. For example: C:\Student\ABC)

Step 4 Map the data and analyze it

e-1 After mapping out all the data fields, what additional conclusions can you make about the data?

Four horizontal lines for writing.

e-2 Use this new information to revise your hypothesis about what the data represents.

Four horizontal lines for writing.

f Read the table below and use the mapped data to complete the missing pieces. The definitions in the table belong to the six fields you identified in step 3b-1. Fill in the table with the appropriate field name from the attribute table.

Table with 2 columns: FIELD NAME, DEFINITION. Contains 6 rows of definitions for field names to be identified.



- g Complete the following tables by filling in the numeric values for each description. Keep in mind that the definitions may not be listed in numeric order and don't forget about zero. The first table has been filled in for you.

BDI	
1	Globally outstanding in biological distinctiveness
2	Regionally outstanding in biological distinctiveness
3	Bioregionally outstanding in biological distinctiveness
4	Locally important in biological distinctiveness
0	Not assessed or unknown

THREAT	
	Relatively stable in degree of threat
	Relatively intact in degree of threat
	Vulnerable in degree of threat
	Not assessed or unknown
	Endangered in degree of threat
	Critical in degree of threat

FINAL	
	Not assessed or unknown
	Critical in estimated threat over the next 20 years
	Endangered in estimated threat over the next 20 years
	Relatively intact in estimated threat over the next 20 years
	Vulnerable in estimated threat over the next 20 years
	Relatively stable in estimated threat over the next 20 years

### Step 5 View metadata documentation

j-1 How would you describe this dataset?

---

j-2 Who made this data?

---

j-3 When was this data published?

---



j-4 Which section explains whether or not you can reuse the data for a project or publish a work that uses the data?

---

k How would you describe the data in the WWF\_Eco layer that you investigated?

---

---

---

---