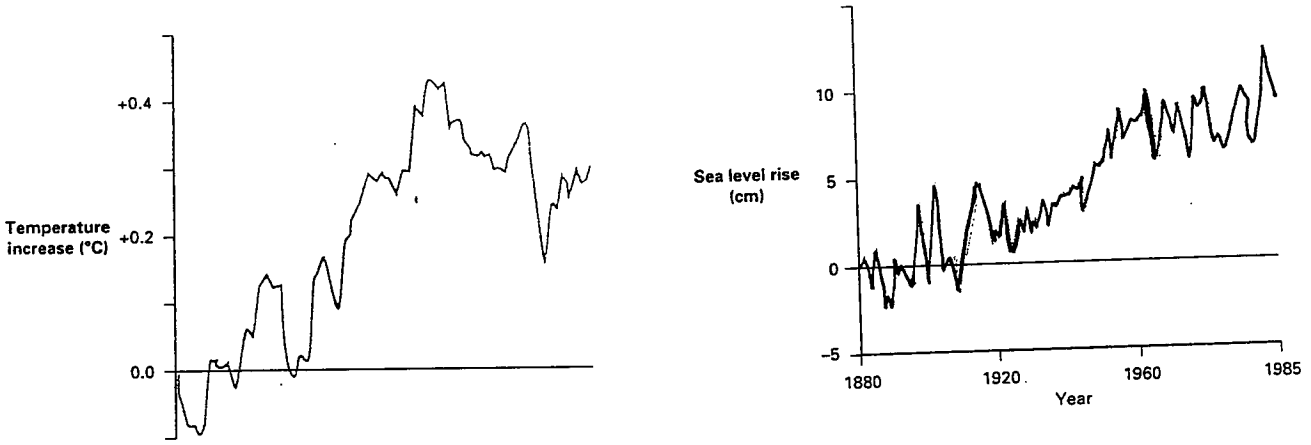
Teaching Activity: Climate Predictions and Sea Level Change

Introduction:. Most scientists agree that there has been a rise in global sea level of 10-25 cm over the last century and that this rise is likely due to the rise in global temperature (0.3-0.6 *C) over the same time period. The two main climate- related factors contributing to this rise are thermal (heat-induced) expansion of the oceans and the melting of glaciers, ice caps and ice sheets. The average global sea level rise for the next century has been calculated based on an average global temperature increase of 2.5*C, plus mid-value ice melting. The sea level rise for 2100 is expected to be about 50 cm higher than today, with a range of uncertainty between 20 and 86 cm.



Global Temperatures and Sea Levels Have Both Risen in the Last Century

When forecasting potential sea level rise, two types of climate models are generally used: *Ocean General Circulation models (OCGMs)* and *Coupled Atmosphere-Ocean General Circulation models (AOGCMs).* Both deal with the interactions within the ocean system caused by increasing levels of atmospheric CO2, as well as 3 dimensional atmosphere- ocean feedbacks which occur as the climate evolves. There is no certainty that the scenarios created by these modeling programs will actually happen. Because of the complex physics affecting each system, there are regional variations and response time lags which cannot be evaluated on a global scale.

The important thing to remember is that changes in sea level will not be uniform around the globe. There are many conditions, both geological and geophysical, that could affect the sea level changes on both local and regional levels. Overall, our basic knowledge of climate-sea level relationships has not improved much over the past 5-10 years. The present lower estimates of sea level rise are the result of lower estimates of temperature increases. If global warming were to occur more rapidly and at a greater magnitude than expected, the rate of sea level rise would consequently be higher. Either way, a rise in sea level of any magnitude will impact coastal areas and the people that inhabit them in a variety of ways.

Predictions of future sea level rise are generally global in scale and cannot be more specific because of differences in local and regional conditions. Each location around the globe presents unique situations which would inevitably determine the degree of increase in sea level. For example, some models predict a 55 cm (1.8 ft.) rise in sea level for the U.S. Gulf Coast. This would submerge almost all of the Mississippi Delta in the state of Louisiana. Most of the city of New Orleans already lies below sea level and is only protected from flooding by levees . If this degree of sea level rise did occur, the area would be more vulnerable to hurricanes and floods, despite its massive levee system. Other models predict a one meter (39.37 inches) rise in sea level; this would flood about 30% of the Gulf's coastal wetlands, up to 4600 square miles of dry land and about half of the total wetlands loss would be in Louisiana. A third scenario suggests a 2 meter rise. In this case, Louisiana would lose 80% of its wetlands and over 10,000 square miles of dry land.

How much is actually flooded will depend on how many new levees are built, which of course is dependent on the of availability of funds. At present, most of the Gulf Coast is protected by levees that are 10-15 feet high and over 300 feet wide at their base. Building levees of this size is very costly- over $3 million per mile. In addition, more money must be allocated for maintenance to keep them effective. The government, both state and federal would have to spend huge amounts of money to cope with sea level rise along the Gulf Coast alone.

Objectives:

- To understand how difficult it is for climate models to predict seal level increases in the future;
- To examine the possible impact of sea level rise on the U.S. Gulf Coast;

Important Terms: Thermal expansion, sea level rise, levee, wetlands, projection;

Materials: Copy of Student Activity Sheet, copies of maps of U.S. Gulf Coast area, colored pencils, calculator, ruler, paper/pencil;

Procedure:

Part I: What effect will seal level rise have on the U.S. Gulf Coast?

1. Read and discuss the **Introduction**.
   - Have students answer related questions on their own in writing.

2. Divide the class into groups of 3-4 students.
   - Hand out the **Student Activity Sheet #1** and the map of Morgan City, LA (Map #1).
   - Review the map and the map key.

3. Using a rule, each group should get an approximate measurement of the amount of coastline protected by levees in the Morgan City area. (2 Inches = 3 miles)

4. Each group should then be given a paper copy of the overhead transparency of the Morgan City area showing the results of sea level rise (Map #2).

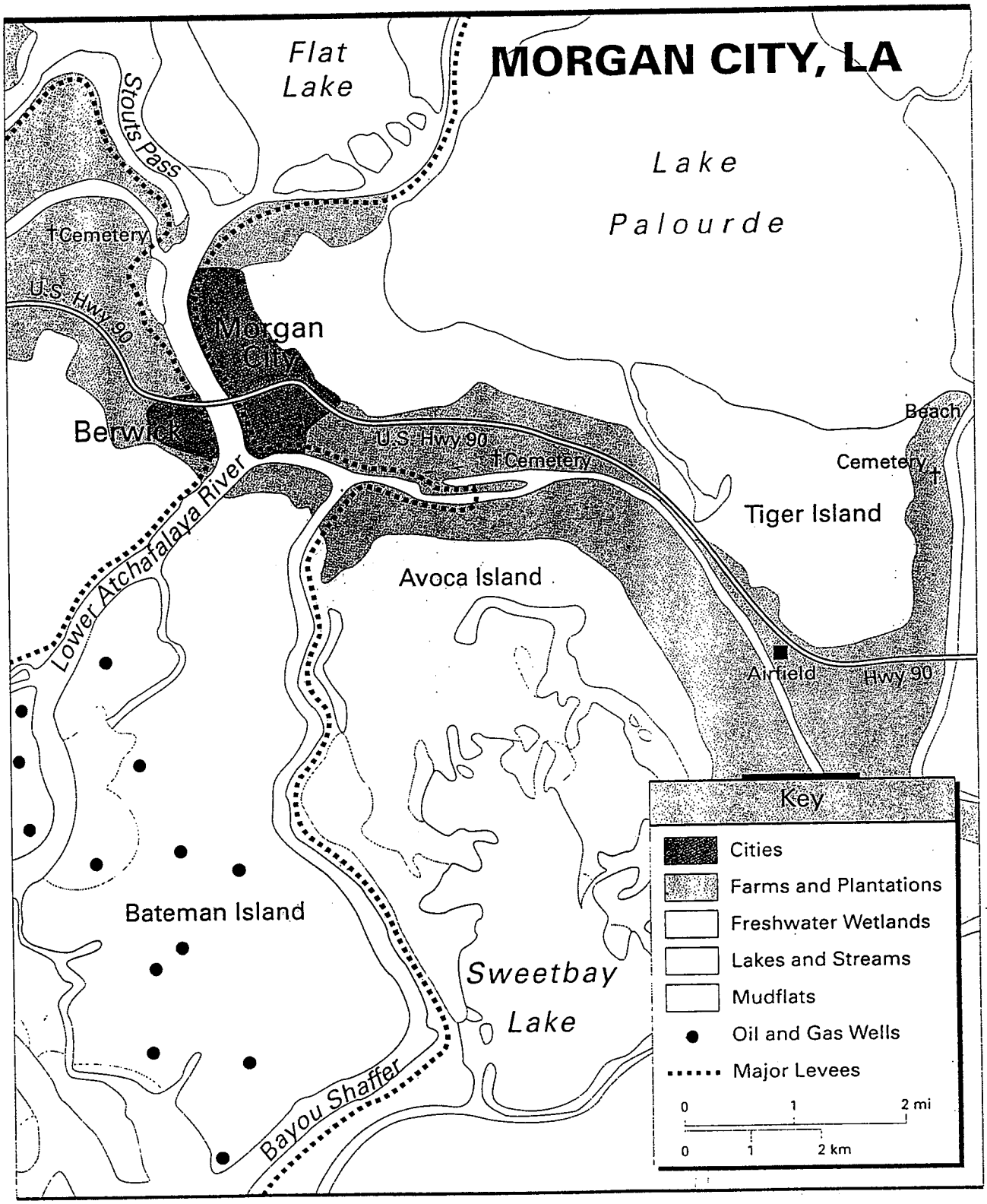
- Students should copy the contour lines onto their maps.
- Students should then color in all the areas that will be inundated by a 5 foot sea level rise, as well as those that will remain above the water line.
- Students should create a key for their map.

5. Student should attempt to calculate the total cost of levees to protect the Morgan City area.
   - Each group will probably have a different answer, depending upon the number of levees they choose to build. Ex: 40 miles = $120 Million
   - Students should show their computations on the **Computation Sheet**.

9. Refer to the map of the Louisiana delta area (Map # 3).
   - Students should use their rulers to measure the approximate total shoreline of Louisiana.
   - They should then calculate the cost for protecting the entire coastline of the state and write their computations on the **Computations Sheet**.

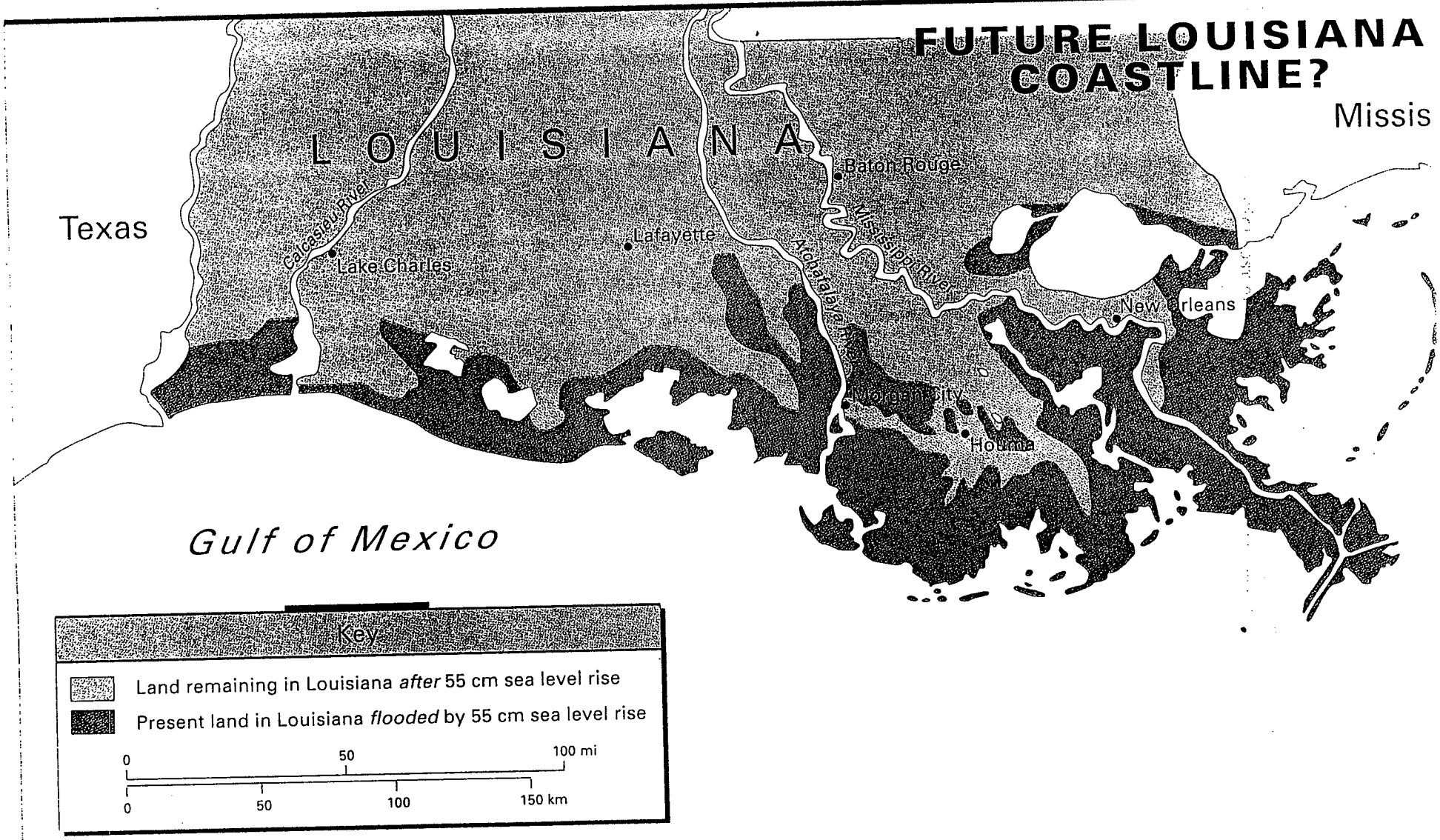
10. Students should then answer the questions in the **Analysis and Comprehension** section.

MAP # 1



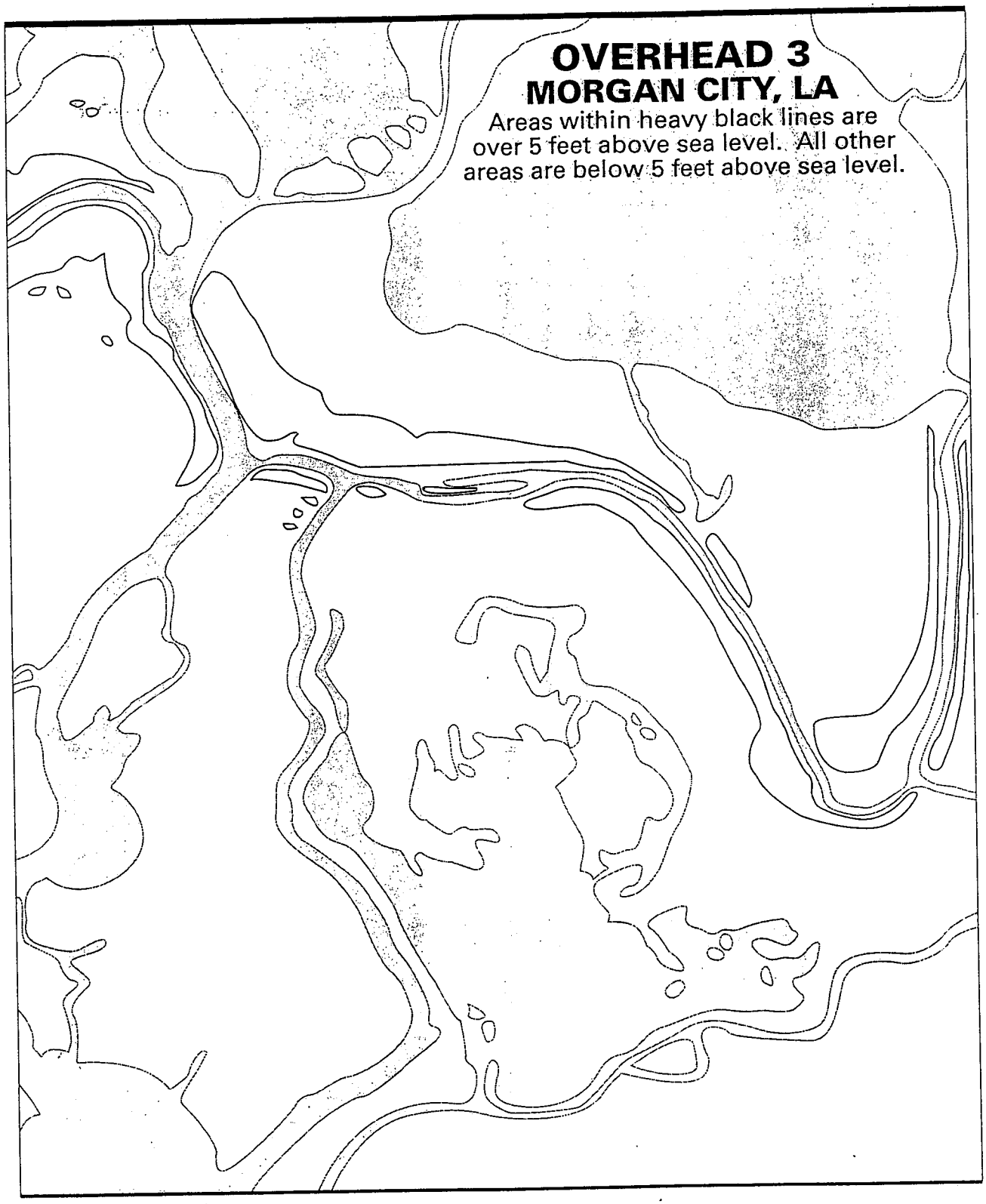
Selected land uses around Morgan City, LA

MAP #2



Map of the projected future coastline of Louisiana for the year 2050, given a rise in sea level of 55 cm (1.8 ft.) Coastlines of Texas and Mississippi would also change, but these changes are not shown.

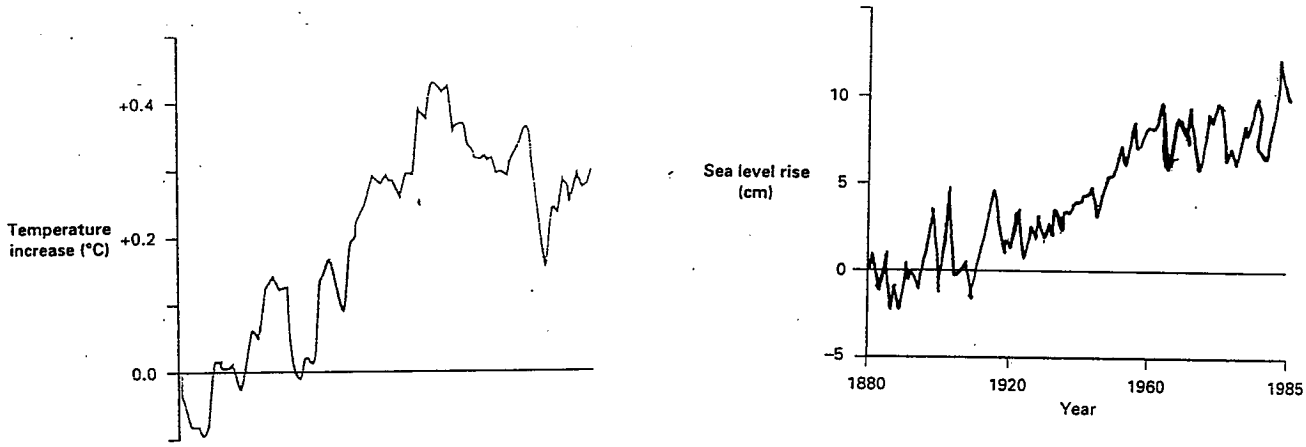
MAP # 3



Map of Morgan City, LA corresponding to area shown in Map #1. Heavy lines define areas with elevation between 5-10 ft. Light lines show position of present sea level (elevatioOn = zero). All areas outside heavy lines would be submerged by a 5 foot sea level rise.

Student Activity Sheet: Climate Predictions and Sea Level Change

Introduction:. Most scientists agree that there has been a rise in global sea level of 10-25 cm over the last century and that this rise is likely due to the rise in global temperature (0.3-0.6 *C) over the same time period. The two main climate- related factors contributing to this rise are thermal (heat-induced) expansion of the oceans and the melting of glaciers, ice caps and ice sheets. The average global sea level rise for the next century has been calculated based on an average global temperature increase of 2.5*C, plus mid-value ice melting. The sea level rise for 2100 is expected to be about 50 cm higher than today, with a range of uncertainty between 20 and 86 cm.



Global Temperatures and Sea Levels Have Both Risen in the Last Century

When forecasting potential sea level rise, two types of climate models are generally used: *Ocean General Circulation models (OCGMs)* and *Coupled Atmosphere-Ocean General Circulation models (AOGCMs).* Both deal with the interactions within the ocean system caused by increasing levels of atmospheric CO2, as well as 3 dimensional atmosphere- ocean feedbacks which occur as the climate evolves. There is no certainty that the scenarios created by these modeling programs will actually happen. Because of the complex physics affecting each system, there are regional variations and response time lags which cannot be evaluated on a global scale.

The important thing to remember is that changes in sea level will not be uniform around the globe. There are many conditions, both geological and geophysical, that could affect the sea level changes on both local and regional levels. Overall, our basic knowledge of climate-sea level relationships has not improved much over the past 5-10 years. The present lower estimates of sea level rise are the result of lower estimates of temperature increases. If global warming were to occur more rapidly and at a greater magnitude than expected, the rate of sea level rise would consequently be higher. Either way, a rise in sea level of any magnitude will impact coastal areas and the people that inhabit them in a variety of ways.

Student Activity Sheet

Predictions of future sea level rise are generally global in scale and cannot be more specific because of differences in local and regional conditions. Each location around the globe presents unique situations which would inevitably determine the degree of increase in sea level. For example, some models predict a 55 cm (1.8 ft.) rise in sea level for the U.S. Gulf Coast. This would submerge almost all of the Mississippi Delta in the state of Louisiana. Most of the city of New Orleans already lies below sea level and is only protected from flooding by levees . If this degree of sea level rise did occur, the area would be more vulnerable to hurricanes and floods, despite its massive levee system. Other models predict a one meter (39.37 inches) rise in sea level; this would flood about 30% of the Gulf's coastal wetlands, up to 4600 square miles of dry land and about half of the total wetlands loss would be in Louisiana. A third scenario suggests a 2 meter rise. In this case, Louisiana would lose 80% of its wetlands and over 10,000 square miles of dry land.

How much is actually flooded will depend on how many new levees are built, which of course is dependent on the of availability of funds. At present, most of the Gulf Coast is protected by levees that are 10-15 feet high and over 300 feet wide at their base. Building levees of this size is very costly- over $3 million per mile. In addition, more money must be allocated for maintenance to keep them effective. The government, both state and federal would have to spend huge amounts of money to cope with sea level rise along the Gulf Coast alone.

Objectives:

- To understand how difficult it is for climate models to predict seal level increases in the future;
- To examine the possible impact of sea level rise on the U.S. Gulf Coast;

Procedure:

Part I: What effect will seal level rise have on the U.S. Gulf Coast?

1. Read and discuss the **Introduction**.
   - Answer related questions on your own in writing.

2. Review the **Student Activity Sheet Introduction** and the map of Morgan City, LA (Map #1).

3. Using a rule, get an approximate measurement of the amount of coastline protected levees in the Morgan City area. (2 Inches = 3 miles)

4. Get a paper copy of the overhead transparency of the Morgan City area showing the results of sea level rise (Map #2).
   - Copy the contour lines onto their maps.
   - Color in all the areas that will be inundated by a 5 foot sea level rise, as well as those that will remain above the water line.
   - Create a key for their map.

5. Calculate the total cost of levees to protect the Morgan City area.
    - You will probably all have a different answer, depending upon the number of levees you choose to build. Ex: 40 miles = $120 Million
    - Show your computations on the **Computation Sheet**.

6. Refer to the map of the Louisiana delta area (Map # 3).
    - Use your rulers to measure the approximate total shoreline of Louisiana.
    - Calculate the cost for protecting the entire coastline of the state and write your computations on the **Computations Sheet**.

7. Answer the questions in the **Analysis and Comprehension** section.

Student Activity Sheet #1

Analysis and Comprehension

1. What do most scientists agree will probably happen by the year 2100?

_____

2. What has happened in conjunction with the sea level rise? _____

_____

3. What are thought to be the 2 climate related factors contributing to this rise?

_____

_____

4. Name the two types of climate models used for these investigations._____

_____

5. What would be the reasons for differences in sea level rise around the world?

_____

_____

_____

6. Would all regions of the world be able to cope in the same way? _____

_____

_____

7. How many different scenarios have been suggested for the U. S. Gulf Coast? What are they? _____

_____

_____

_____

8. What will probably be the major factor in the ability of different countries to deal with the problem of sea level rise? _____

_____

_____

9. Using Map #1, list all the types of development in the Morgan City area.

_____

_____

_____

Student Activity Sheet #1

10. List the types of ecosystems in the Morgan City area. _____

_____

_____

11. List the freshwater lakes and rivers in the Morgan City area. _____

_____

_____

12. What is the approximate length of the levees in the Morgan City area? _____

_____

13. What are the two main roads in the Morgan City area. _____

14. What is the elevation of most of the land in the Mississippi Delta region?

_____

15. Name the cities that could possible be wiped out by a 55 cm sea level rise?

_____

16. How far inland would the shoreline extend after flooding? _____

17. What is the total length of the Louisiana coastline? _____

18. How much would it cost to stop the flooding with levees? _____

19. List the developed areas around Morgan City that would be affected by the projected sea level rise there? _____

_____

_____

_____

20. What would probably be the economic status of the Morgan City area after flooding? _____

_____

_____

_____

21. How would the flooding affect the wetland areas and lakes and streams? _____

_____

_____

_____

22. What would the impact be on the wildlife in the area? _____

_____

_____

23. Name some species of wildlife that could become extinct? _____

_____

_____

24. What is the total length of the levee system needed to protect Morgan City from severe flooding? _____

25. What would the cost be to install a levee system of this type ?_____

26. What general statement can you make about the "liveability" of the Morgan City area if the projected sea level rise occurs?_____

_____

_____

_____

_____

Student Activity Sheet #2

COMPUTATION SHEET

#1. Approximate length of coastline around Morgan City protected by levees:

#2. Approximate cost to construct additional levees around Morgan City:

#3. Approximate measurements of total Louisiana shoreline:

#4. Approximate cost to protect entire coastline of Louisiana with levees: