

# South Florida Rising Tides:



## Should We Stay? Or Should We Go?



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# SOUTH FLORIDA RISING TIDES: SHOULD WE STAY OR SHOULD WE GO?

## SUMMARY

In this case study, all students assume the role of a concerned citizen scientist living in one of four south Florida counties. Each student is assigned to a county/city committee and to one of three stakeholder perspectives—water managers, residents, and business leaders. Using the jigsaw collaborative learning approach, students alternate meeting in county and community stakeholder groups to analyze current articles, data, and GIS maps to identify the specific sea level related problems, socio-environmental impacts, and current and future adaptation strategies. Each county group will make recommendations to the city managers through a mock city planning meeting.

## CLASSROOM MANAGEMENT OVERVIEW

### ***COURSE(S) FOR WHICH THIS THIS CASE MIGHT BE APPROPRIATE:***

We are piloting this case with several graduate level courses (i.e., Climate and Society, Sea Level Rise and Society, Methods for Marine and Atmospheric Education) taught at Florida Atlantic University and University of Miami. We also plan to teach the case study in science methods courses for future teachers and to share the case study with local decision makers for potential use in facilitating discussion among different citizen stakeholder groups. This case study is best implemented with class sizes of 12-18 students. If the class is larger, you may wish to divide the class and have two Mock Town Hall Meetings.

### ***LEVEL(S) FOR WHICH THIS THIS CASE MIGHT BE APPROPRIATE:***

We plan to implement this case with both undergraduate and graduate students.

### ***INSTRUCTIONAL MATERIALS:***

This case study includes three separate instructional resources. The **Teaching Notes** guide the teacher or facilitator of the case study. The **Case Study Resources** contain the case introduction, directions for different activities, scientific background for citizens and water managers, city and county statistics and maps, as well as links to several additional resources. The **Case Study Worksheets and Assessments** should be provided to the students for recording responses throughout the activities. (These may also be used as formative and summative assessments of the learning goals and objectives.)

### ***ESTIMATED TIME TO IMPLEMENT:***

We estimate that this lesson could be implemented in five 80 minutes classes. The following table is a suggested path for implementation.



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	Activity	Time Frame to Implement	Materials needed	
<b>DAY ONE</b>				
<b>INTRODUCTION</b>	Brief Introduction	~10 minutes	Explain the students' upcoming role as a citizen scientist.	
	Pre-Assessment	~10 minutes	Print the assessment and have students circle "Pre."	
	Read Case Study: <i>Should We Stay or Should We Go?</i>	~10 minutes	From the <b>Case Study Resources</b> , print copies of the 2-page case study for students to either read in groups or alone.	
	View the YouTube video: <i>South Florida's Rising Seas - Sea Level Rise Documentary</i>	26:36 minutes	Load documentary on Youtube.com <a href="https://www.youtube.com/watch?v=xkFTcrK5E_8">https://www.youtube.com/watch?v=xkFTcrK5E_8</a>	
	Answer questions about the case study and video	~10 minutes	From the <b>Case Study Worksheets and Assessments</b> , print the <i>Case Study Introduction</i> Questions - (Teacher Key on Page 8)	
	Class discussion	~10 minutes	Review the questions and have your answer key available.	
<b>COLLABORATIVE RESEARCH</b>	Introduce the Jigsaw Activity	~5 minutes	From the <b>Case Study Resources</b> , print the <i>Scientific Background for Citizens</i> and provide as homework for all students.	
	<b>DAY TWO</b>			
	Assign County and Stakeholder Roles	~5 minutes	Divide the class into four groups and assign each group as one of the four counties: Palm Beach, Broward, Miami-Dade, and Monroe. Within their groups, have the students self-select the role of water manager, resident, or business leader.	
	Part 1 – First County Representatives Meeting where students learn about future sea level rise scenarios for their county	~55 minutes	From the <b>Case Study Worksheets and Assessments</b> , print the <i>South Florida's Future Sea Level</i> worksheet for the <a href="#">NOAA's Digital Coast Sea Level Rise Viewer</a> activity (Teacher Key – Pages 9-10)	
	Part 2 – Community Stakeholders review worksheet and assigned readings	~20 minutes	From the <b>Case Study Resources</b> , print the <i>Scientific Background for Water Managers</i> and 3 copies of each of the articles (links on the worksheets) to create one packet of resources for each community stakeholder group. (No teacher key for this activity is provided as answers will vary.) Student may identify additional articles to complete this worksheet.	
	<b>DAY THREE</b>			
	Part 2 – Community Stakeholders identify socio-environmental impacts	~30 minutes	Make sure students have stakeholder group handouts. (see above)	
	Part 3 – Second County Representatives Meeting	~50 minutes	From the <b>Case Study Worksheets and Assessments</b> , print student worksheet for NOAA's Digital Coast Sea Level Rise viewer activity #2. (Teacher Key – Page 11)	
	<b>DAY FOUR</b>			
	Part 3 – Second County Representatives Meeting - <i>Continued</i>	~20 minutes	Students compare and contrast answers on worksheet.	
	~60 minutes	From the <b>Case Study Resources</b> , print Adaptation Strategies handout (IFAS). These will be considered with their recommendations.		
<b>MOCK CITY PLANNING MEETING</b>	<b>DAY FIVE</b>			
	Presentations to class – <i>This serves as a summative assessment for this case.</i>	~15 minutes per group = 60 minutes	Each county presents their recommendations at a mock city planning meeting. From the <b>Case Study Worksheets and Assessments</b> , print the <i>Presentation Scoring Guide</i> and provide to each group.	
	Class Discussion	~10 minutes	Class compares and contrasts the different findings for the different counties.	
	Post-Assessment	~10 minutes	Print the assessment and have students circle "Post."	



## EXTENSION

- [Study the town of Kivalina in Alaska.](#)
- [Read a Case Study on the Netherlands and sea level rise.](#)
- Write a sci-fi story about our south Florida coast by discussing technologies that don't yet exist
- Discuss business opportunities
- Discuss new careers

## S-E SYNTHESIS LEARNING GOALS

- Co-develop research questions and conceptual models in inter- or trans-disciplinary teams.
- Find, analyze, and synthesize existing data, ideas (e.g. frameworks or models), or methods.

## CASE STUDY LEARNING GOAL &amp; OBJECTIVES

To identify specific risk factors to the general population and to suggest ways in which the community can act to reduce impacts and provide for mitigation, adaptation and resilience to the resulting impacts of sea level rise. After completing this case study, students will be able to:

- Identify the physical factors that contribute to sea level rise.
- Recognize the socio-environmental impacts of sea level rise.
- Analyze sea level rise and vulnerability data.
- Develop recommendations for adaption strategies to sea level rise.
- Discuss and evaluate adaptation recommendations from the perspectives of different stakeholders and counties.

## TEACHING THIS CASE STUDY

## INTRODUCTION TO CASE STUDY

- *Introduction* – Students will participate in this case study as “citizen scientists” who are concerned about the impacts of sea level rise in their specific county. A citizen scientist is a community member who partners with scientists to answer real-world questions. The students will be tasked with conducting research and developing a series of recommendations to present to a city planning committee to help them prepare an adaptation action plan for their county. To do this, students must educate themselves about the science of sea level rise, with a specific focus on south Florida. Then each student is assigned to a county/city committee and to one of three stakeholder perspectives—water managers, residents, and business leaders. Using the cooperative learning jigsaw approach, students alternate meeting in county and stakeholder teams to analyze current articles, data, and GIS maps to identify the specific sea level related problems, socio-environmental impacts, and current and future adaptation strategies. Each county group will make recommendations to the city managers through a mock town hall meeting.
- *Case Study* – Students read the case study *Should We Stay or Should We Go?* either to themselves or aloud as a class.
- [South Florida's Rising Seas - Sea Level Rise Documentary](#) – Students will view this [documentary](#) which is a compilation of stories that were produced by 33 video production students at Florida International University's School of Journalism and Mass Communication. It premiered on WPBT2 on June 24, 2015.



- *Worksheet* - Students can work in pairs to answer questions on the *Case Study Introduction Questions*.
- *Review the Questions* – Students will review the answers with the class.
- *Scientific Background for Concerned Citizens* – Students can read this document as homework.

## COLLABORATIVE RESEARCH

The jigsaw instructional strategy engages students and promotes cooperative learning (<http://serc.carleton.edu/sp/library/jigsaws/index.html>). This approach is an effective method for studying and addressing complex socio-environmental issues that involve a variety of stakeholders. Through the jigsaw approach, students become more knowledgeable about one aspect of an issue and then share that knowledge with their group. Adaptation to rising seas requires expertise from stakeholders who are not only knowledgeable of the unique geology of South Florida and factors affecting sea level, but also of the issues facing residents, water managers, and business leaders.

To begin the collaborative research activities, each student should be assigned to one of four County Representative Groups (Palm Beach, Broward, Miami-Dade, or Monroe) and should also be assigned to a Community Stakeholder Group (resident, water manager, or business leader). In Part 1, students learn about the sea level rise issues for their assigned county. In Part 2, each student becomes an “expert” on the specific sea level rise issues that affect their community stakeholder group. Finally, in Part 3, students return to their county as an “expert” of their community stakeholder group.

The final outcome of their research will be presentation of their county’s socio-environmental impacts from sea level rise with recommendations for a city planning committee to help guide the committee prepare an adaptation action plan.

### **Part 1 – First County Representatives Meeting**

County Representatives use [NOAA’s Digital Coast Sea Level Rise viewer](#)

- Each county gets together in their group and:
  - reviews the *Scientific Background for Citizens*, and
  - looks at flooding frequency for their area using NOAA’s Digital Coast Sea Level Rise Viewer – Students will be provided a worksheet and can work in pairs to use the tool and answer the questions on the worksheet.

### **Part 2 – Community Stakeholders Meeting**

*Identify socio-environmental impacts*

- Students meet with their specific community stakeholder group. They are given the corresponding community stakeholder worksheet for their group.
- Students will review several articles and search for information that will help them fill out their worksheet. These can be printed and provided to the students, or viewed online.

### **Part 3 – Second County Representatives Meeting**

*Identify socio-environmental vulnerabilities*



- Students return to the county representative groups to use [NOAA's Digital Coast Sea Level Rise viewer](#) again to analyze the socio-environmental vulnerabilities. Students answer questions based on their findings, using the *City and County Statistics and City GIS Maps* specific for their county as a reference.
- Students discuss their results from their community stakeholder groups, comparing and contrasting the information from their worksheets.
- Students prepare a presentation of their county's socio-environmental impacts from sea level rise with recommendations for a city planning committee to help guide them with preparing an adaptation action plan. They will use the presentation scoring guide worksheet to help them prepare their presentations.

## MOCK CITY PLANNING MEETING

- *Presentations to the City Planning Committee* - Each county presents their recommendations to the rest of the class, which takes on the role of the City Planning Committee.
- *Class Discussion* – Students discuss, compare and contrast the problems and recommendations for each county and example city.

## CASE STUDY EXTENSION

- [Study the town of Kivalina in Alaska.](#)
- [Read a Case Study on the Netherlands and sea level rise.](#)
- [Review the U.S. Climate Resilience Toolkit](#)
- Write a sci-fi story about our south Florida coast by discussing technologies that don't yet exist
- Discuss business opportunities
- Discuss new careers

## ACKNOWLEDGEMENTS

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## REFERENCES

### Articles

- [Treading Water, National Geographic, February 2015](#)
- [Why the City of Miami is Doomed to Drown, Rolling Stones, June 2013](#)
- [Miami Beach's battle to stem rising tides – Part 1, Miami Herald, October 2015](#)
- [Beyond the high tides, South Florida water is changing – Part 2, Miami Herald, October 2015](#)
- [Water, Water, Everywhere: Sea Level Rise in Miami](#)
- [Sea-Level Rise And Its Impact On Florida – WRI, 2012](#)
- [Sea-Level Rise And Its Impact On Miami-Dade County – WRI, 2015](#)



**Videos**

- [South Florida's Rising Seas: Impact - Sea Level Rise Documentary](#)

**Publications**

- [Unified Sea Level Rise Projection - Southeast Florida Regional Climate Change Compact – October 2015](#)
- [Climate Change and Sea-Level Rise in Florida an Update of the Effects of Climate Change on Florida's Ocean & Coastal Resources – December 2010](#)
- [Climate Change and Water Management in South Florida](#)
- [Critically Eroded Beaches In Florida – FDEP – June 2019](#)
- [Adaptation Approaches to Sea-Level Rise in Florida – UF/IFAS](#)

**Books**

- High Tide on Main Street

**Websites & Tools**

- [Digital Coast: Sea Level Rise and Coastal Flooding Impacts Viewer](#)
- [NASA's Scientific Visualization Studio](#)
- [Climate Science Investigations \(CSI\)](#)
- [U.S. Climate Resilience Toolkit](#)
- [Tidetable.net](#)
- [Weather Underground's Storm Surge Maps](#)



## CASE STUDY INTRODUCTION – TEACHER KEY

After reading the case study introduction, watch the South Florida's Rising Seas: Impact – Sea Level Rise Documentary video and answer the following questions while watching.

1. According to the 2014 National Climate Assessment, how high could seas rise by 2060?  
**2 feet (discussed at 1:23 in the video)**
2. In Florida, 2.4 million people live within how many feet of the high tide line?  
**4 feet (discussed at 1:32 in the video)**
3. In the fall, many organizations hold events that coincide with what phenomenon? (Hint: In the video, FIU's School for Journalism & Mass Communication held one to help students understand climate change and sea level rise.)  
**King Tide (discussed at 8:03 in the video)**
4. What is one way that sea level rise is being monitored in Miami?  
**Using helium balloons equipped with high-definition cameras (discussed at 12:55 in the video)**
5. How does the CEO of Alta Systems, John Ciampa, describe the difference between King Tide and Sea Rise?  
**King Tide is a symptom, Sea Rise is the problem (discussed at 14:08 in the video)**
6. Virginia Walsh, Ph.D. discusses what as being the real emergency on top of Sea Level Rise?  
**Storm surge (discussed at 16:15 in the video)**
7. From the case study, describe how you felt after reading it and hearing Dr. Wanless's perspective.  
**Student responses will vary**
8. Now that you have read the case study and watched the video, make a list of several questions for topics related to sea level rise that you want to know more about?  
**Student responses will vary**



## South Florida's Future Sea Level – TEACHER KEY

As people who live in coastal areas learn more about rising sea levels, one of the first questions they may ask is, “How will my home and community be impacted by rising seas?” As a way to help communities, including private citizens and decision-makers, visualize what these changes will look like, NOAA has developed a tool called [Digital Coast: Sea Level Rise and Coastal Flooding Impacts Viewer](#). This tool allows anyone to see a visualization of projected sea levels along the U.S. coasts.

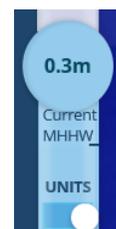
This tool allows anyone to see a visualization of projected sea levels along the U.S. coasts. You can watch [Explaining the NOAA Sea Level Rise Viewer](#) and the [Tips](#) for using the tool before you begin.

For this activity, you will use the viewer to answer the following questions. Launch the **Digital Coast** application showing the city and surrounding area by clicking on the name of the city that you have been assigned: [Delray Beach](#), [Hollywood](#), [Miami Beach](#) or [Key West](#). **NOTE: MAKE SCREENSHOTS AS YOU GO THROUGH THE ACTIVITY THAT YOU CAN USE LATER FOR YOUR CLASS PRESENTATION.**

1. Click on the Legend Toggle in the upper, right hand corner. What does the legend indicate that the bright green areas represent?

**Students should observe that the bright green areas represent the low-lying areas.**

2. Where are most of these areas located?
  - **Delray Beach: Students should observe that there are very few low-lying areas and the areas that are green are located along the coast.**
  - **Hollywood: Students should observe that there are several low-lying areas in the west and along the coast.**
  - **Miami Beach: Students should observe that there are several low-lying areas on the west side of the island.**
  - **Key West: Students should observe that the low-lying areas are on the southeast side of the island (specifically the airport).**
3. Selected the **Sea Level Rise** tab and change the units on the slider on the left to meters. Move the slider up one unit to 0.3 meters of sea level rise. How did this change the amount of surface area covered by bright green? Are any areas under water?
  - **Delray Beach: Students should see few changes from 0 meters of sea level rise. However, areas that were previously low-lying (green) are now under water.**
  - **Hollywood: Students should see few changes from 0 meters of sea level rise. However, a few areas are now under water and there are a few more low-lying (green) areas.**
  - **Miami Beach: Students should see few changes from 0 meters of sea level rise. However, there are a few more low-lying (green) areas.**
  - **Key West: Students should see few changes from 0 meters of sea level rise. However, there are a few more low-lying (green) areas.**
4. Continue to move the slider. At what height of sea level do the majority of bright green areas turn light or dark blue, indicating that these areas are underwater?
  - **Delray Beach: Students should observe that at 1.5 meters all of the areas along the intracoastal are underwater and there are a few inland areas that are now green.**
  - **Hollywood: Students should observe that at 0.9 meters many areas along the coast are now under water and at 1.5 meters the areas in the west that were low-lying are beginning to turn blue.**



- **Miami Beach:** Students should observe that at 0.9 meters Miami Beach's low-lying areas turn light/dark blue
  - **Key West:** Students should observe that at 0.9 meters that more than half of the island is under water.
5. Describe the changes that occur when sea level is 1.8 meter higher than today.
- **Delray Beach:** Students should observe that at 6 feet all of the areas along the intracoastal are underwater and there are many more inland areas that are now green.
  - **Hollywood:** Students should observe that at 6 feet all of the areas along the intracoastal are underwater and there are many more inland areas that are now underwater.
  - **Miami Beach:** Students should observe that at 6 feet Miami Beach is almost completely underwater.
  - **Key West:** Students should observe that at 6 feet Key West is almost completely underwater.
6. Look at **High Tide Flooding** and click on the symbol for the Tide Gauge  at **Virginia Key** near **Key Biscayne**. Select **Gauge Homepage** beneath the bar graph. Click on the **Tide/Water Levels** drop down menu and select **Water Levels**. Click the **Units** dropdown menu and select **metric**. Enter the dates below, and click **Plot** to fill out the table below. Hover the cursor over the line graph to find exact values.

## Tides/Water Levels

Date Range	Highest Verified Water Level	Lowest Verified Water Level	Highest Observed Water Level	Lowest Observed Water Level
1/1/19-1/31/19	0.926 m	-0.136 m	0.685 m	-0.195 m
9/22/19-10/23/19	1.243 m	0.3 m	0.891 m	0.066 m

- a. Why do you think the water levels are higher in September/October than in January?  
**King Tide occurred in September/October**
- b. Why do you think the observed water levels are different than the verified water levels?  
**Other events including a hurricane off the coasts of Florida in September/October can influence water level.**
7. How do you think rising sea level will affect tides levels?  
**Sea level rise will result in tides that reach areas of higher elevation.**

*Sea Level Rise: How Vulnerable Are We? – TEACHER KEY*

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For this activity, we will again use NOAA's [Digital Coast: Sea Level Rise and Coastal Flooding Impacts Viewer](#). This time you will analyze the data under the Vulnerability tab. This data was compiled by overlaying social and economic data on a map that depicts sea level rise. By doing this, a community can see the potential impact that sea level rise can have on vulnerable people and businesses.

The Social Vulnerability Index, which shows areas of high human vulnerability to hazards, is based on population attributes (e.g., age and poverty) and the built environment. By looking at the intersection of potential sea level rise and vulnerable Census tracts, one can get an idea of how vulnerable populations might be affected by sea level rise.

You will use the viewer to answer the following questions. Launch the **Digital Coast** application showing the city and surrounding area by clicking on the city name that you have been assigned: [Delray Beach](#), [Hollywood](#), [Miami Beach](#) or [Key West](#). Make sure that you have clicked on the Vulnerability tab. **NOTE: MAKE SCREENSHOTS AS YOU GO THROUGH THE ACTIVITY THAT YOU CAN USE LATER FOR YOUR CLASS PRESENTATION.**

- Notice the areas highlighted with various shades of red on the map. What does the legend indicate that these areas represent?  
**Dark red indicates tracts having a high vulnerability, and the lighter reds indicate less vulnerability.**
- Where are the majority of the areas that are lighter red?  
**Delray Beach: Students should observe that the lighter red areas are more to the south and along the coast.**  
**Hollywood: Students should observe that the lighter red areas are to the northeast.**  
**Miami Beach: Students should observe that the lighter red areas are on the west side of the island.**  
**Key West: Students should observe that the lighter red areas are on the south east side of the island.**
- Where are the majority of the areas that are darker red?  
**Delray Beach: Students should observe that the majority of darker red areas are in the west.**  
**Hollywood: Students should observe that the majority of red areas are in the west and on the south side of the city.**  
**Miami Beach: Students should observe that several red areas on the southeast side as well as the northern end of the island.**  
**Key West: Students should observe that there are no darker red areas and that there are medium red areas on the north and east side of the island.**
- Does your city have more areas that are lighter red, medium red or darker red?  
**Delray Beach: Students should observe that the majority of the city is dark and medium red.**  
**Hollywood: Students should observe that the majority of the city is dark and medium red.**  
**Miami Beach: Students should observe that there seems to be an even mix of dark, medium and light red, with the light red clustered together and the darker and medium red areas scattered.**  
**Key West: Students should observe that the majority of the island is medium red.**
- Why do you think that is? Use your city data information to help you with this response.  
**Answers will vary but students should discuss the socio-economics and the age groups of the people living in these areas.**

