

BACKGROUND

Miami Waterkeeper's documentary *Waves of Change* offers three episodes discussing South Florida's relationship with the water. Each episode explores how the natural splendor is directly related to societal reliance on aquifers and aquaculture. The South Florida peninsula thrives on a codependency with its marine and land-based ecosystems. Over a century of industrialization, development, and widespread agriculture has impacted the natural resources that fuel society in the region, and without thoughtful attention and direct intervention the land and water will become inhospitable to residents. *Waves of Change* explores these facets of the water's history in South Florida in three episodes: "Past", "Present", and "Our Vision of the Future".

The following lesson plans are designed to accompany *Waves of Change* Episode 3: "Our Vision of the Future". The materials provided are adaptable to grades 6-12, using state educational standards in STEM and Social Sciences.

I. INTRODUCTION AND DOCUMENTARY PRE-SCREENING DISCUSSION

A. How might the term "Waves of Change" suggest a way of contemplating the future?

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(1) Organize the class into groups of 3-4.

How might the term "Waves of Change" suggest a way of contemplating the future?

(3) Project or share the provided Question Focus image- do not explain, introduce, or provide context. Groups should react based on uninformed impressions.



Credit: "Follow the Leaders"- Isaac Cordal, sculpture. Berlin, Germany

(4) Have the groups write as many questions as come to mind based on the Question Focus. Allow several minutes for this. They should not share with other groups or discuss- just have a group member record the questions that come up. Do not offer feedback on student results or work in progress- you can thank them for contributions, but it is crucial for this method that you do not offer criticism or praise for their materials. They are to be in control of analysis and interpretation here.

(5) Have the groups revise any questions that provoke closed-ended responses (yes/no, single word)- all questions should be open-ended for contemplation and analysis.

(6) Each group should choose 2-3 questions that they think are the most compelling or provocative. Share these out with the class and record them. Do not answer them- instead collect and share them, then have the class respond and discuss. The teacher should not be providing answers, but instead facilitate discussion. At most, ask for follow-up or suggest conducting research for any responses that seem misinformed.

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C. "Waves of Change" review:

1. Episode 1: "Past":

- a) What were some of the environmental impacts of settlement and urban expansion in the South Florida area?
- b) What legislation and advocacy efforts have been designed and utilized to limit damage to the environment?
- c) In what ways might environmental concerns impact economies and harm disadvantaged communities?

2. Episode 2: "Present":

- a) What is the job of a "Waterkeeper"?
- b) What are today's challenges impacting South Florida's environment, especially its waters?
- c) What are some of the ways in which Florida residents can take action to improve sustainability and protect the waters?

ci. **SCREEN WAVES OF CHANGE EPISODE 3: "OUR VISION FOR THE FUTURE"**

ENCOURAGE NOTE-TAKING

III. DOCUMENTARY REVIEW AND DISCUSSION:

1. Open Discussion:

- a. Ask for first impressions or lasting impacts.
- b. Ask if there are follow-up questions or needs for clarification.

2. Guided Discussion:

- a. What challenges to South Florida's ecosystems and water access are expected in the near future?
- b. How might some of these challenges already be observable?
- c. In what ways might Florida residents prepare for and limit damage to the environment and infrastructure?
- d. What advocacy efforts are underway to address specific environmental issues?
- e. What steps can residents take to voice their concerns on the state of the environment?

IV. SEA LEVEL RISE TRACKING AND IMPACT ACTIVITY

SEE THE ATTACHED WORKSHEET

- A. Students will use an interactive map provided by the National Oceanic and Atmospheric Administration to study models for sea level rise and impacts on low-lying areas in South Florida.
- B. Analysis includes studying flooding trends and impacts on neighborhoods and infrastructure.
- C. Further analysis includes instruction on freshwater aquifer systems and saltwater intrusion.
- D. This exercise is intended to have students develop correlative analysis, recognize patterns, and make predictions regarding environmental impacts on a specific region.
- E. Students will be required to use their findings as a means to communicate the significance of sea level rise impacts to others, and for a foundation for further assignments on advocacy and developing master plans.

V. ADVOCACY LETTER

SEE THE ATTACHED ASSIGNMENT CRITERIA

- A. Students will draft and submit a letter to a business/community leader or elected official regarding their concerns for an issue addressed in Waves of Change.
- B. Time should be allocated in class to discuss possible topics and to offer suggestions for recipients.
- C. Students will need guidance on researching the appropriate officials to receive these letters, as well as suggestions on tone and content. There are suggested guidelines for composition on the assignment criteria.
- D. The final product will be collected in unsealed envelopes so they may be graded and approved by the educator before being sealed and mailed.
- E. Return addresses are up to the teacher's discretion, although it is recommended that the letter be mailed care of the instructor and via the school's mailing address.
- F. Grading rubrics are to the teacher's discretion, although composition grades are recommended.

VI. MASTER PLAN PROJECT

SEE THE ATTACHED ASSIGNMENT CRITERIA

- A. Students should be arranged in groups of 3-4.
- B. They are encouraged to use notes and materials from each of the Waves of Change episodes and units.
- C. Time allocated for this work should be both synchronous and asynchronous, including class time allocated for check-ins and updates.
- D. Each group's final master plan should be shared with the class on a presentation day with the option for questions and answers.
- E. Grading rubrics are to the teacher's discretion, although project grades and presentation grades are recommended.
- F. Google Forms or other anonymous survey platforms are recommended for follow up and review of this work, so that each participant can account for their contributions and offer commentary on their working dynamics. This should be used for teacher's reference and consideration in grading.

SEA LEVEL RISE: TRACKING AND IMPACTS

Name: _____ Date: _____ Class: _____

Background:

From the National Oceanic and Atmospheric Administration (NOAA) website: <https://oceanservice.noaa.gov/facts/sealevel.html>

Global sea level has been rising over the past century, and the rate has increased in recent decades. In 2014, global sea level was 2.6 inches above the 1993 average—the highest annual average in the satellite record (1993-present). Sea level continues to rise at a rate of about one-eighth of an inch per year.

Higher sea levels mean that deadly and destructive storm surges push farther inland than they once did, which also means more frequent nuisance flooding. Disruptive and expensive, nuisance flooding is estimated to be from 300 percent to 900 percent more frequent within U.S. coastal communities than it was just 50 years ago.

The two major causes of global sea level rise are thermal expansion caused by warming of the ocean (since water expands as it warms) and increased melting of land-based ice, such as glaciers and ice sheets. The oceans are absorbing more than 90 percent of the increased atmospheric heat associated with emissions from human activity.

The following prompts require research and analysis regarding the impacts of Sea Level Rise (SLR). Study the provided materials and then answer the follow-up questions.

Local Sea Level Rise Study:

Open the NOAA Sea Level Rise Viewer (<https://coast.noaa.gov/slr/>) in your web browser and click “Get Started”. Explore the map and settings for several minutes before responding to the prompts provided. Try using the tool bar on the left-side side and display settings at the top right to discover different viewing options, data collections, and explanations. Note that there are areas without mapping, particularly if they are land-locked or not in coastal cities. Areas with low populations may not be mapped, either.

When you adjust the Mean Higher High Water (MHHW) level on the left side, you are observing how water levels change based on SLR, weather conditions, and high tide. Areas that turn blue anticipate sustained flooding with each foot of SLR; areas that turn green are low-lying regions, and may be subject to intermittent flooding during higher tides or heavy precipitation.

You will need to keep the NOAA Sea Level Rise Viewer open throughout this assignment.

Instructions:

- 1. Enter “Florida, USA” into the search bar. Zoom into South Florida so that you can see both coasts and the Everglades. Adjust the Mean Higher High Water (MHHW) meter to study the different water levels. Record your observations when adding the following MHHW levels to feet of ocean rise:**
 - a. 1 foot:
 - b. 5 feet:
 - c. 10 feet:

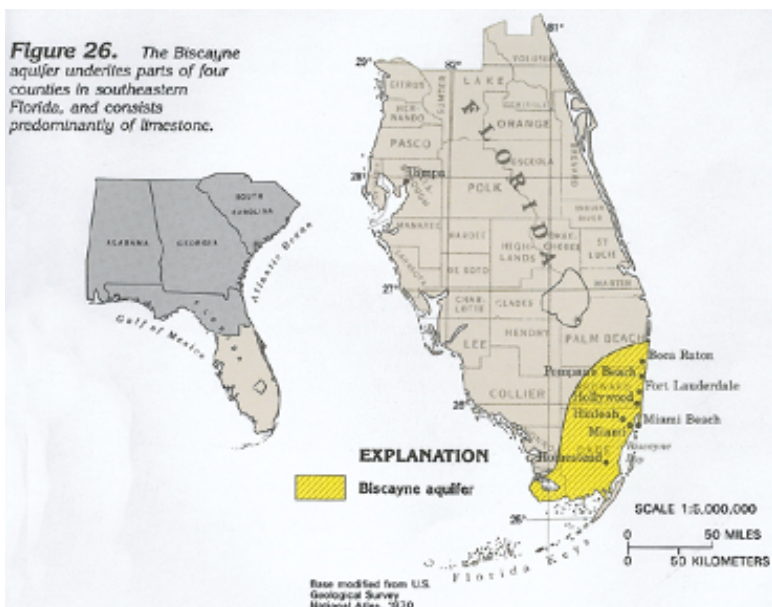
2. Enter “Miami, Florida” into the search bar. Return the MHHW meter to the current (lowest) level. Answer each of the following prompts:

- a. Set MHHW to 1 ft.- Where in Miami are the low-lying areas concentrated?
- b. Set MHHW to 2 ft.- What happens to those low-lying areas?
- c. Set MHHW to 5 ft.- What further changes occurred?
- d. Set MHHW to 10 ft.- What happens to the map?

3. Low-lying areas are susceptible to flooding when tides are high or heavy rain occurs. Generally, these are among the first areas to be impacted by permanent flooding due to SLR.

- a. Why might the low-lying areas and flood zones you observed after 5 feet of MHHW changes challenge assumptions or popular ideas of how sea level rise will impact South Florida?
- b. Hypothesize a reason why sea level rise will impact the regions of low-lying areas and flood zones in South Florida in this manner.

4. **Aquifer Systems:** This map shows the Biscayne Aquifer, South Florida’s most abundant natural source of freshwater. Aquifers are underground collections of freshwater filtered from the surface by porous rock. They can be tapped by a well for consumption. Each resident of South Florida uses water from the Biscayne Aquifer in some manner every day, whether for drinking or utilities.



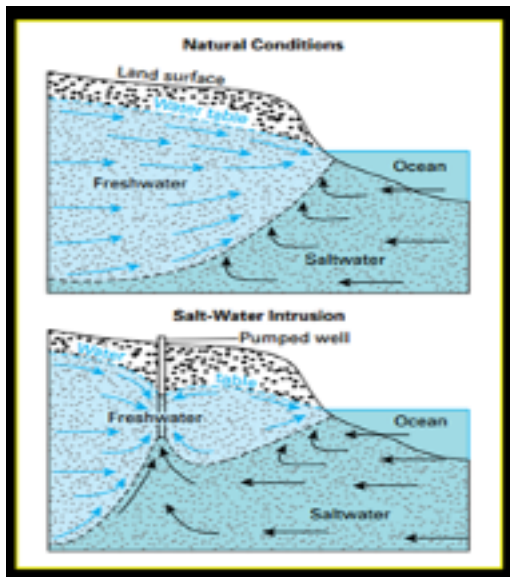
United States Geological Survey - http://pubs.usgs.gov/ha/ha730/ch_g/jpeg/G026.jpeg, Public Domain,

- a. Compare this map to your study of the sea level rise map. What connections can be made between the location of the Biscayne Aquifer and your study of MHHW changes in low-lying areas in South Florida?

- b. Why might the map specify that the Biscayne Aquifer “consists predominantly of limestone”? How does this help to understand the Aquifer?

- c. In your estimation, is sea level rise of benefit or concern to the Biscayne Aquifer? Explain your reasoning.

5. Saltwater Intrusion: The images below demonstrate the process of saltwater intrusion into aquifer systems, which can be a result of sea level rise. The spotted areas represent porous rock, such as limestone, which filters water as it collects in a freshwater aquifer. Wells inserted into freshwater aquifers are used to supply households, neighborhoods, and industries with water.



USGS.gov (Public Domain)

I. Use the above image to describe the process of saltwater intrusion into freshwater aquifers:

II. What are three problems that could result from saltwater intrusion?

A.

B.

C.

III. Refer to the NOAA Sea Level Rise Viewer, the Aquifer map, and the Saltwater Intrusion diagram for the following prompts:

- A. On the Sea Level Rise Viewer, click the “Local Scenarios” Option. Select the pin on Miami Beach. The table that opens provides estimates over the course of this century as to the extremities of sea level rise. You can adjust the MHHW and the year to see where extreme high tides will impact the area. The ruler on the left indicates the estimated timeline for flooding, and options on the right provide a range from “low” to “extreme” high levels. Explore these adjustments for a few minutes and record your personal impressions and findings here:
- B. Make sure your map is zoomed out enough to show the Greater Miami Area and its border along the Everglades:
1. Around what year might the Intermediate High level of flooding convert the majority of the area from Sweetwater to the Broward County line into low-lying flood zones?
 2. How many feet of Sea Level Rise are anticipated at that time?
 3. Adjust the ruler to see the Intermediate High levels in 2080. What is the expected Sea Level Rise by then?
 4. Describe the anticipated changes to the Greater Miami area for Intermediate High flooding in 2100.
 5. Based on these trends, what parts of Miami will experience the most flooding over the next 60-80 years? How might these flood patterns go against popular images or impressions regarding how Sea Level Rise will occur?
- C. Compare your findings from the Intermediate High SLR study to the Biscayne Aquifer Map and Saltwater Intrusion diagram. What implications can be drawn between these three pieces of information regarding impacts to quality of life in South Florida due to SLR?

6. Summative Overview: In 1-2 sentences, how would you explain the information you’ve just studied to someone who is unfamiliar with the issue?

ADVOCACY LETTER- ASSIGNMENT CRITERIA

Objective: Compose and send a professional letter on a water issue you find personally compelling based on material covered in the Waves of Change unit. The documentary episodes and activities we worked on should help you generate ideas for your topic, but ultimately you will be responsible for choosing subject matter and recipients for this letter based on personal concerns or interests. Recipients may be influential representatives from political, social, or economic realms. Your finished product will be a persuasive argument in letter form calling for action and expressing your concerns, hopes, and possible solutions for an issue impacting South Florida's water systems and quality of life.

Deliverables: Mail a finished product to the recipient of your choice. You will need to research possible figures, such as in businesses or in local, state, or national government, to decide who would be the most appropriate and helpful recipient. Draft a persuasive argument directed to a specific audience as a means to advocate your personal interests.

The following criteria are required to complete this assignment:

- **A typed formal letter, including:**
 - **Formal heading**
 - **3 paragraphs**
 - **1 reference to a reputable current events article or research**
 - **Single spaced**
 - **Signature**
 - **Submitted in an unsealed addressed envelope with a stamp**

Suggested Format:

I. Paragraph 1- Introduction:

- A. Offer appreciation for the time your recipient is taking to address your concerns.
- B. Recognize and offer thanks for one or more of your recipient's accomplishments.
- C. Thesis: Broadly express the issue you are concerned about and appeal for help.

II. Paragraph 2- Argument:

- A. Define the issue you are concerned about using key terms and direct explanations.
- B. Provide evidence for your concerns- this can be a quote from reliable news sources, the studies you've conducted in class, as well as content from Waves of Change.
- C. Explain why this evidence should be of concern.
- D. If you have suggested solutions, offer them- otherwise, indicate that you are appealing to your recipient for their help in addressing the issue.

III. Paragraph 3- Conclusion:

- A. Once more, offer appreciation for your recipient's time and effort.
- B. Define your concern in one sentence.
- C. Ask an open-ended question of your recipient- challenge with a question that would provoke a detailed answer.
- D. Indicate that your continued support (vote, endorsement, brand loyalty) depends on your recipient's actions in addressing this issue.

IV. Sign and type your name

MASTER PLAN PROJECT- ASSIGNMENT CRITERIA

A *Master Plan* is both a document and a presentation that outlines a major issue and offers proposed solutions with a timeline for completion. Governments and organizations use Master Plans to explain a comprehensive problem in need of a solution and demonstrate plans to resolve it over a period of time. These documents vary in length, but are often highly visual representations of agendas, data, and suggested outcomes. The final product is often presented in an official capacity for approval by government representatives or concerned citizens, and then used as a reference for goals and accomplishments over the course of its lifetime.

Objective: Each group will design a Master Plan addressing an issue related to South Florida's water systems. These plans may address environmental, infrastructural, or legal concerns regarding challenges illustrated in the documentary *Waves of Change*, as well as from research into credible external sources. The timeline and outcomes of the Master Plan will vary per group. All groups are expected to produce a Master Plan document meeting the specifications provided, and will present their findings to their classmates for feedback and questions. How would you plan to shape the future?

Criteria: Master Plans offer a range of material. Your Master Plan will include the following:

1. At least 15 pages of content including:
 - a. Cover Page
 - b. Table of Contents
 - c. Overview of Concerns
 - d. Historic Information on the Issue
 - e. Detailed Description of the Problem
 - f. Projected Problems in the Next 50-100 years
 - g. Research and Analysis
 - h. Proposed Solutions
 - i. Timeline for Proposals
 - j. Description of Resources Needed
 - k. Conclusion
 - l. Glossary
 - m. Bibliography

2. Much of this content must be accompanied or represented by images, including:
 - a. Photographs
 - b. Charts
 - c. Infographics
 - d. Diagrams
 - e. Illustrations

3. All content must be referenced and credited, including research from external sources, credit for photographs (even if they are taken by group members), and any imagery that is cited from external sources

Suggested Resources:

- Sample Master Plans:
 - [City of Miami Beach Blueways Master Plan](#)
 - [City of Miami Parks & Recreation Master Plan](#)
 - [The Underline Master Plan](#)
- Design and Layout:
 - [Canva](#), [Google Slides](#)

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[Click here to review this lesson plan!](#)

Your responses will help make these resources and future ones better!