Sargassum in the coasts

GLOBE		Associated SDG	Type of Activity
Spheres	**Associated Protocols**		
Biosphere	Land Cover (in the coasts)	6 (Clean Water and Sanitation) 13 (Climate Action) 14 (Life Below Water)	Exploratory
Hydrosphere	Water Temperature, Dissolved Oxygen, Salinity, Nitrates, Transparency, pH.		
Bundle	Oceans		

Overview

Information from satellite imagery processed with the *Floating Algae Index* and maps are analyzed to determine the impacts of sargassum growth at local and regional scales. Current information is compared to the massive bloom event that occurred in 2018. Students analyze local and regional impacts and potential commercial uses of sargassum, and explore ways to engage citizen science participation.

Time

3 or 4 classes

Prerequisites

Basic knowledge of ecosystems, food webs, populations, meteorology, marine currents, water quality and ICT. Ability to interpret satellite images and maps. Ability to locate points using latitude and longitude.

School Level

Upper Elementary, High School and University students

Purpose

To analyze the "Great Atlantic Sargasso Belt" phenomenon and its impact on the Caribbean coasts

Student outcomes

- To know the impact of the "Great Atlantic Sargasso Belt" phenomenon in the Caribbean coasts on human activities, health and the environment
- To interpret satellite images processed with the Floating Algae Index and maps of different coastal areas of the Caribbean
- To analyze the annual seasons of massive sargassum blooms and compare with the years of greatest impact
- To explore information on possible contributions as citizen scientists

Background

The macroalgae called sargassum or "seaweed" is a group of species belonging to the genus Sargassum that includes large brown or blackish-green algae containing gas-filled vesicles that allow them to float. Sargassum is very abundant and forms large floating masses in the open ocean that can extend for many kilometers. Historically, it was found in an area between the Gulf of Mexico and the North Atlantic Ocean, forming the Sargasso Sea. Sargassum provides habitat, food, shelter and breeding grounds for many marine species such as fish, sea turtles, seabirds, crabs, shrimp and others. Some species live their entire lives in this habitat, such as the *sargassum fish*, others only live in the early stages of their lives, including commercially important fish such as *mahi mahi, jack mackerels* and *amberjack*. When the sargassum loses its buoyancy, it sinks to the sea floor providing energy in the form of carbon to deep sea fish and invertebrates, contributing to the deep-sea food web.

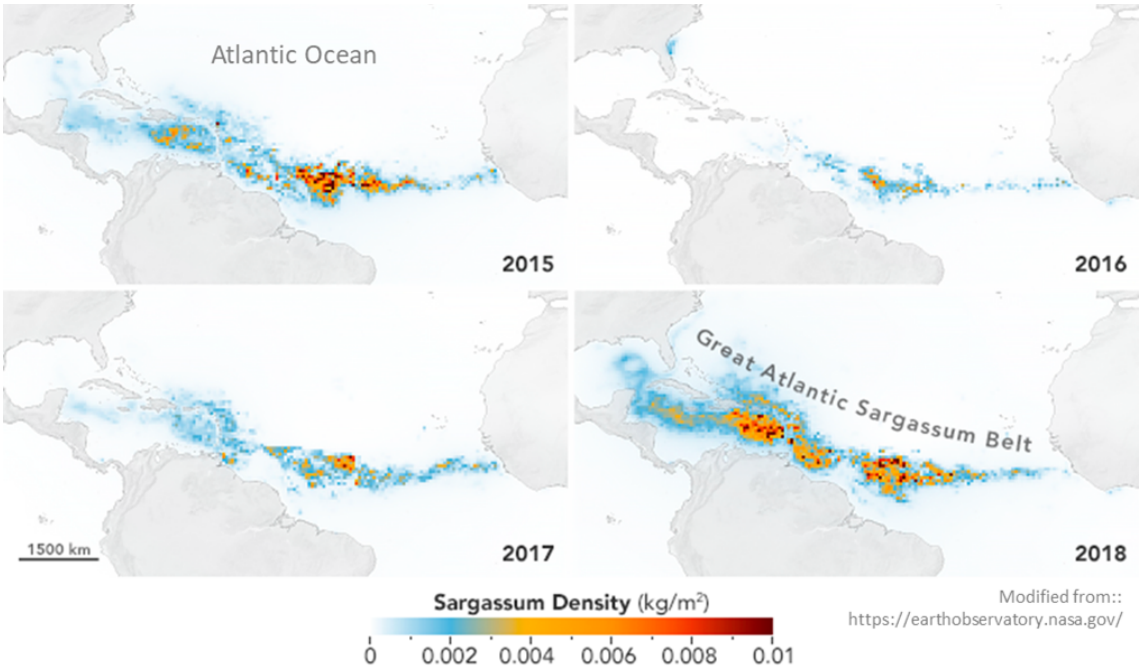

Fig. 1. Changes in sargassum densities

The presence of sargassum in the Caribbean coasts has been constant over time, but since 2011 massive quantities of sargassum transported by currents began to arrive, affecting different locations throughout the year. In the following years the blooms increased reaching dimensions never seen before in 2018. Scientists called this phenomenon the "Great Atlantic Sargasso Belt". These blooms caused economic impacts (in: tourism, fishing, nautical activities), environmental impacts (disturbance of marine species because when sinking in large quantities it can suffocate corals, mangroves and seagrasses; it also produces beach erosion) and even sanitary impact (the decomposition of algae releases gasses, including hydrogen sulfide that emits an odor similar to rotten eggs, and cases of nausea, headaches, skin rashes and respiratory issues have been detected). Watch the videos "*El sargazo enferma el Caribe Mexicano*", and the articles "El Caribe se une contra el sargazo" and "¿Podrá la ciencia resolver el problema de las algas en las playas del Caribe?" [In Spanish] or video "Caribbean struggles with smelly seaweed invasion" and the articles "Caribbean nations join forces against giant seaweed bloom" and Can science solve the seaweed problem on Mexican beaches?

Satellite images provide a valuable contribution to the monitoring of algae and to the prediction of their arrival to the coasts. Direct sampling in the ocean is also of great relevance in understanding water quality. While more research is needed on large sargassum blooms, scientists suggest that this algal belt is formed by the input of key nutrients- in spring and summer mainly by discharge from the Amazon River, but also the Orinoco and other rivers that add nutrients, which may have increased in recent years due to increased deforestation and fertilizer use in the watersheds.

Fig. 2. Sargassum harvesting in the coasts of Mexico. Source: https://quintanaroohoy.com

In the winter, upwelling of nutrients from deep to shallow waters occurs off the west coast of Africa where sargassum grows. Ocean currents then transport the sargassum to different regions. Salinity and temperatures also influence sargassum growth. To detect sargassum in satellite images and monitor its movements, the *Floating Algae Index* (FAI) is used. Recently, the *Alternative Floating Algae Index* (AFAI) was incorporated and other specific indexes are being developed to differentiate sargassum from other floating algae. Managing large quantities of sargassum is an economic, infrastructure and equipment challenge for its collection, transport and storage. Ways of using sargassum are being explored in the chemical and food industry with the production of gels, as fertilizers, biogas, fodder, extraction. The main difficulties for its use are the annual variation in the volume of sargassum that reaches the coasts, and its rapid decomposition.

Guiding Research Questions

- What´s sargassum and what is its historic area distribution?
- What is the role of sargassum in marine ecosystems?
- What are the impacts of mass bloom events? What is the "Great Atlantic Sargasso Belt"?
- What are the possible causes of sargassum mass blooms?
- How do the sites and densities of sargassum arriving onshore vary throughout the year?
- What is the trend in annual variation?
- Has sargassum affected your area? What impacts did you detect?

Scientific Concepts

- Ecosystems

- Changes in the populations of some species.
- Interrelationships of matter and energy in ecosystems
- Ocean currents
- Environmental risks and vulnerability

Materials and Tools

Video:

El País (2019) *El sargazo enferma al caribe mexicano*. YouTube https://youtu.be/qFcrIfDoYXw [In Spanish]

Reuters (2021) *Caribbean struggles with smelly seaweed invasion.* YouTube https://youtu.be/quG2uI_vLf4 [In English]

Articles:

1. Guzmán Hormazábal, L. (2019) *El Caribe se une contra el sargazo*. SciDev.Net https://bit.ly/3deu6yX [In Spanish]
2. Guzmán Hormazábal, L. (2019) *Caribbean nations join forces against giant seaweed bloom*. SciDev.Net https://bit.ly/3vtpE5s [In English]
3. Jolley, A. (2021) *México: ¿Podrá la ciencia resolver el problema de las algas en las playas del Caribe?* National Geographic. https://bit.ly/3JDdLQB [In Spanish]
4. Jolley, A. (2021) *Can science solve the seaweed problem on Mexican beaches?* National Geographic. https://on.natgeo.com/3VIBFig [In English]

Satellite images processed with the *Floating Algae Index (*FAI) from online sargassum monitoring:

1. CERMES. Sargassum. Outlook Bulletin. https://bit.ly/3SCZEPh
2. NOAA. AOML (2022) *Experimental Weekly Sargassum Inundation Report*. https://bit.ly/3SvKATC
3. SIMAR (2022) Cobertura diaria del Sargazo (acumulado de 7 días previos) https://bit.ly/3QpZE3b
4. USF (2022) *CARICOOS. Imágenes de Algas Flotantes (Sargazo)* https://bit.ly/3zFCGP1
5. USF. OOL (2022) *Satellite-based Sargassum Watch System (SaWS)*. https://bit.ly/3PcDPDb

What to Do and How to Do It

1. ***Beginning***

1. Watch the videos "Caribbean struggles with smelly seaweed invasion" and read the articles "Caribbean nations join forces against giant seaweed bloom" and Can science solve the seaweed problem on Mexican beaches?

2. Development

1. Ask your students about the role of sargassum in marine ecosystems and then make a conceptual map with the expressed ideas.

2. Divide the class into small groups to analyze satellite images processed with the Floating Algae Index. Assign each group an area to analyze:
    - Look at images from the latest CARICOOS images and images from previous months on the USF Optical Oceanography Laboratory website. (Use the calendar to choose dates). You can download the images to view them in Google Earth in more detail.
    - For the Gulf of Mexico area see SIMAR
    - Have there been any changes in the last few days?
    - Look at the maps in the weekly reports, corresponding to the same dates of the analyzed images and the quarterly sargassum bulletin.
    - During which months do the highest concentrations occur and in which months do they decrease? What explanations can you suggest for these changes?
    - Does the analyzed site have large variations in sargassum concentration?
    - Compare the current image of the analyzed site to any day in July and August 2018. What changes can you visualize?
3. Bring the groups together and share the sites they analyzed.
4. Did all sites receive sargassum? Did any region remain unchanged?
5. Did the densities of sargassum vary from site to site? To what can this variation be attributed?
6. Are there differences in sargassum densities between the open ocean and the coasts?

3. Ending

Complete the previously made concept map above with the examples of sites they analyzed and the comparison with 2018.

If your school is in a region affected by this phenomenon, you can showcase some citizen science projects where your students can participate on a voluntary basis or organize participation as an extension of this activity. For participation options see the publication "Sargassum White Paper - Turning the crisis into an opportunity" (from page 43 onwards)

Frequently Asked Questions

How can I observe sargassum rafts in the open ocean and on the coasts from satellite images? The Floating Algae Index (FAI) is used, recently the Alternative Floating Algae Index (AFAI) was added and other specific ones are being developed to differentiate sargassum from other floating algae.

Where can I find satellite images processed with the FAI index? In CARICOOS and in the Optical Oceanography Laboratory (OOL) bulletins.

Where can I find maps with the history of sargassum arrival events in the Caribbean coasts? In SIMAR.

Suggested Resources for Further Information

As an extension of this activity, students can look for citizen science projects to join them, either by identifying species of sargassum that reach their area or by reporting the state of the coasts.

To learn more about this phenomenon, the following resources are suggested:

LANOT (2022) *Visualizador de Sargazo* https://bit.ly/3p6btjm

NADIS app (In development) – Download from Google Play https://bit.ly/3P8ehHF

NOAA (2022) *CoastWatch OceanViewer* (Select Sargassum Insitu) https://cwcgom.aoml.noaa.gov/cgom/OceanViewer/

UNEP-CEP (2021) *Sargassum White Paper – Turning the crisis into an opportunity.* Ninth Meeting of the Scientific and Technical Advisory Committee (STAC) to the Protocol Concerning Specially Protected Areas and Wildlife (SPAW) in the Wider Caribbean Region. Kingston, Jamaica. https://bit.ly/3A4AP7A

Tutorials: Worldview, EO Browser, Story Map

Bibliography

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NASA Earth Observatory (2012) *Life in the Sargasso Sea*. https://go.nasa.gov/3vIsG6w

NASA Earth Observatory (2022) *Scientists Discover the Biggest Seaweed Bloom in the World*. https://go.nasa.gov/3SBaxkW

The GLOBE Program (2022) *Ocean Protocol Bundle*. https://bit.ly/3vK1KmA

Wang, M., Hu, C., Barnes, B. B., Mitchum, G., Lapointe, B., & Montoya, J. P. (2019). The great Atlantic sargassum belt. *Science*, *365*(6448), 83-87. https://par.nsf.gov/servlets/purl/10126160