Project

The influence of atmospheric pollution on the ecosystems of Ria Formosa

Does atmospheric pollution influence the balance of the Ria Formosa ecosystems?


Theoretical Framework

The increase in CO2 and CH4 concentrations in the atmosphere due to anthropogenic activities contributes to global warming.

Gases emitted by industries and motor vehicles using fossil fuels, agriculture, and intensive livestock production for human consumption are undoubtedly significant contributors to these changes.

Seagrasses not only serve as shelter and food for biodiversity but also consume carbon dioxide, release oxygen (during the day through photosynthesis), and sequester carbon, known as blue carbon.

On the other hand, carbonate shells of living organisms prevent a sudden decrease in pH, combating ocean acidification at the expense of shell dissolution (buffering effect).

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GOALS

1) Investigate the combined effect of CO_2 and CH_4 on water quality and biota in the ecosystems of Ria Formosa.

2) Determine which of these two greenhouse gases (GHGs) would have a greater effect on the degradation of aquatic systems.

How did we investigate?

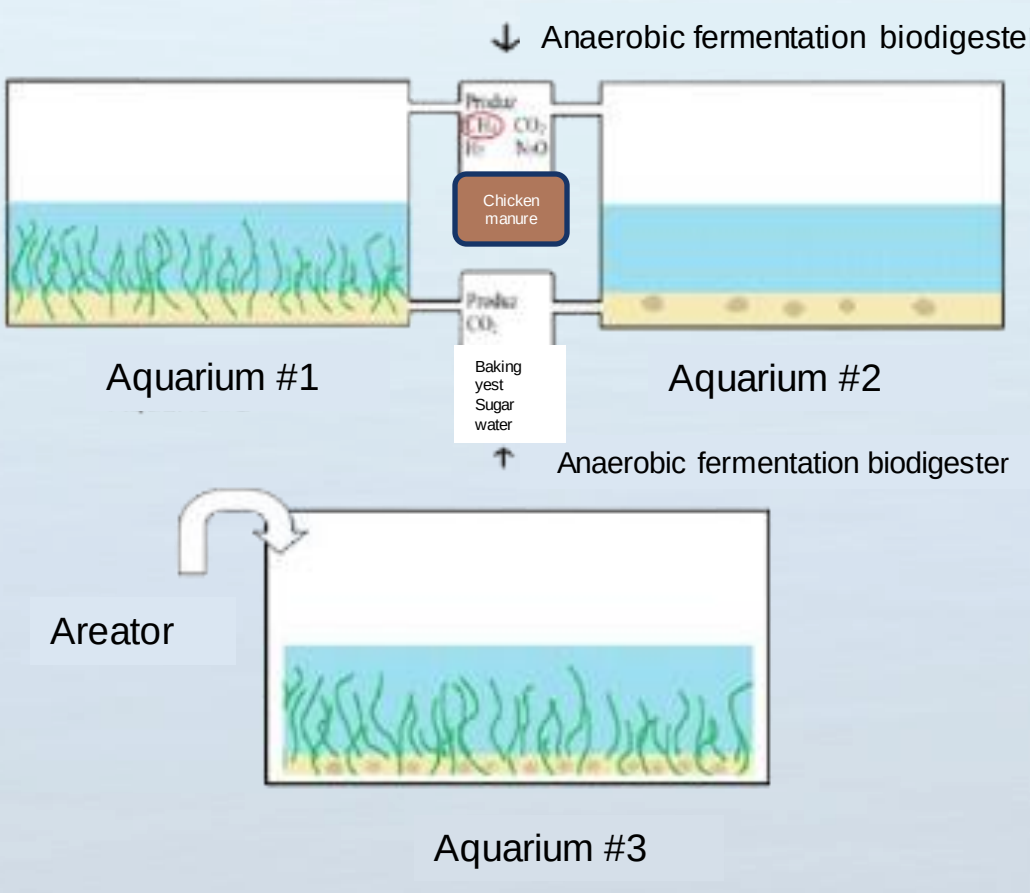
In the first phase…

Water, sediment, seagrasses, and shells were collected to replicate the two ecosystems of Ria Formosa in the laboratory:

1. Sandy bottoms with shells.
2. Seagrass meadows.

In the second phase…

Three aquariums were set up according to the experimental model outlined.



In Aquarium #1, a seagrass meadow was replicated.

In Aquarium #2, the sandy ecosystem with shells was replicated.

In Aquarium #3, the control aquarium, both ecosystems were replicated. An air pump/aerator was placed in this aquarium.

In Aquariums #1 and #2, both greenhouse gases (methane and carbon dioxide) were simultaneously and continuously injected. These gases were produced by two biodigesters:

In the biodigester for CO_2 production, yeast and sugar were used, employing aerobic fermentation.

In the biodigester for CH_4 production, chicken manure was used for anaerobic fermentation in a container lined with aluminum foil to prevent light entry, eliminating the possibility of photosynthesis.

In the third phase…

Visual monitoring of the apparent water and sediment quality, as well as the behavior of some gastropods present in the experimental systems (Aquariums #1, #2, and #3), was carried out.

Conducting mass monitoring of the shells.

Regarding nitrates, nitrites, phosphates, and total ammonia, their monitoring was conducted using colorimetric tests.

A multiparametric probe was used to monitor temperature, pH, dissolved oxygen content, and electrical conductivity.

Results Analysis

Day 0

The 3 aquariums are in balance (presenting the same physicochemical parameters as well as those of the natural environment).

The plants and animals seemed to be doing well in all 3 aquariums.

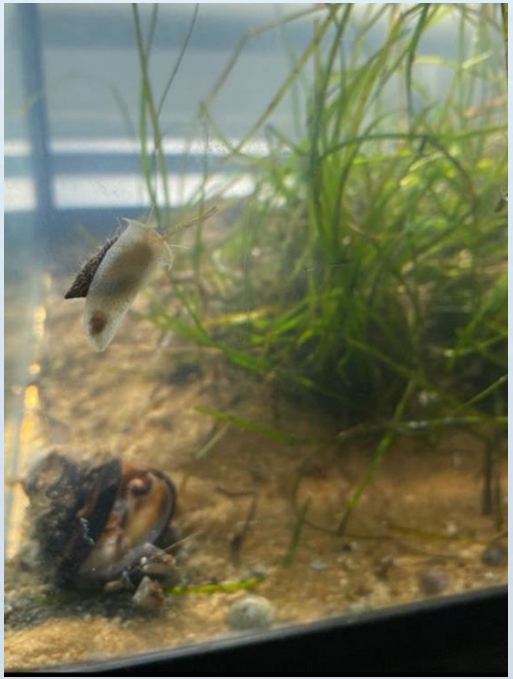
Injection of CH4 and CO2 started in Aquariums #1 and #2, while air was injected into Aquarium #3.

The young scientists discussed among themselves and with their teachers the results obtained, extrapolating them to the reality of Ria Formosa...

Day 1

The water quality in Aquariums #1 and #2 began to deteriorate, evidenced by a decrease in dissolved oxygen levels from 86 to 65%, and movement of organisms, particularly gastropods, started to occur.

At this point, the students transferred these organisms to the control aquarium.



Day 3

Aquariums #1 and #2 already had their side walls and bottom covered by a gray biofilm.

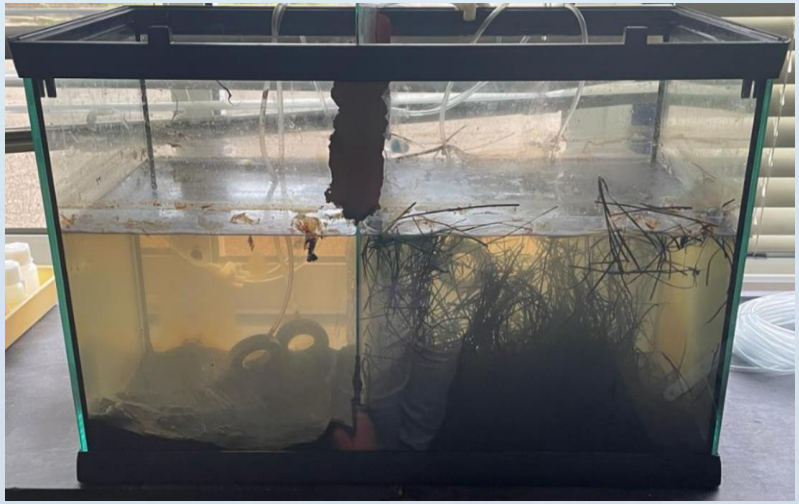
The water was cloudy and grayish, dissolved oxygen dropped to 35%, and an unpleasant smell was noticeable.

Some gastropods were found above the water column, and they were transferred to Aquarium #3.

Day 4

On the fourth day, the dissolved oxygen in Aquariums #1 and #2 measured at 20%.

The color of the aquarium walls and water darkened further, and turbidity increased.



Day 6

The water and walls of Aquariums #1 and #2 were completely blackened, and the water contained only 5% dissolved oxygen.

Day 6

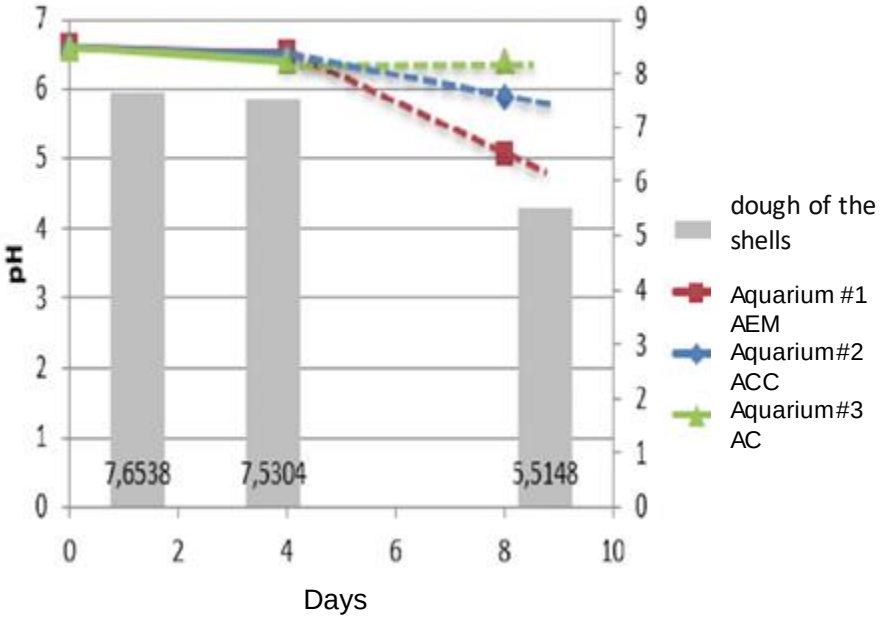
The shells placed in Aquarium #2 appeared worn with visible signs of dissolution, experiencing a loss of mass from 9.020 g to 5.515 g.

The pH of the water in Aquarium #2 decreased from 6.6 to 5.9 due to the buffering effect of $CaCO_3$ dissolution from the shells.

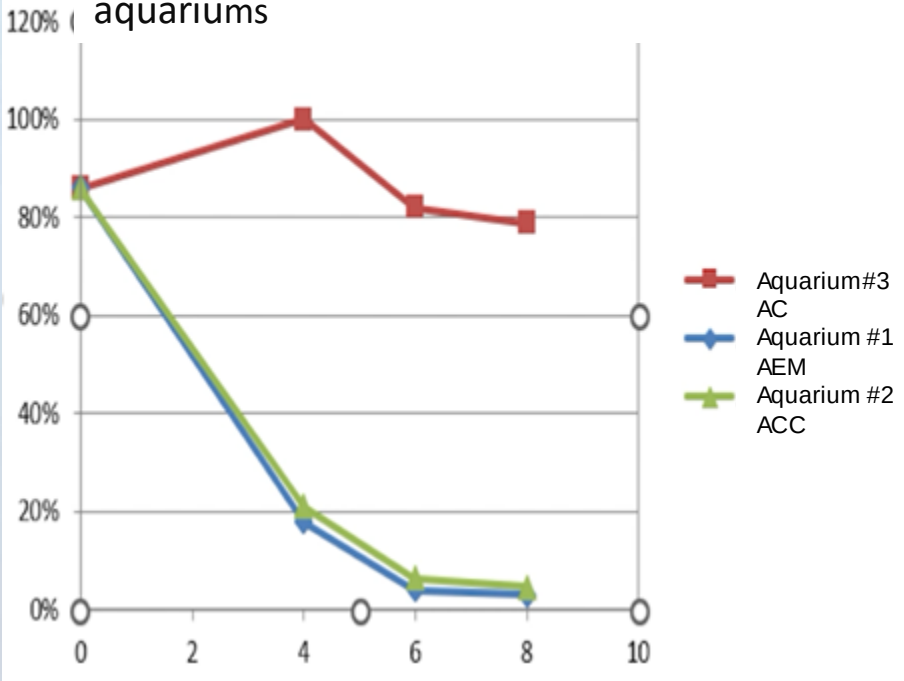
Aquarium #3 continued to exhibit water quality and appearance similar to the beginning of the experiment, with the gastropods remaining alive.

Graphs showing the variation of pH and Oxygen throughout the experiment

Variation of pH in the 3 aquariums and the mass of the shells.



Variation of oxygen content in the 3 aquariums



Final Considerations

- **Atmospheric pollution**, particularly the increase in concentrations of CH4 and CO2, has a significant impact on the ocean, its fauna, and flora.

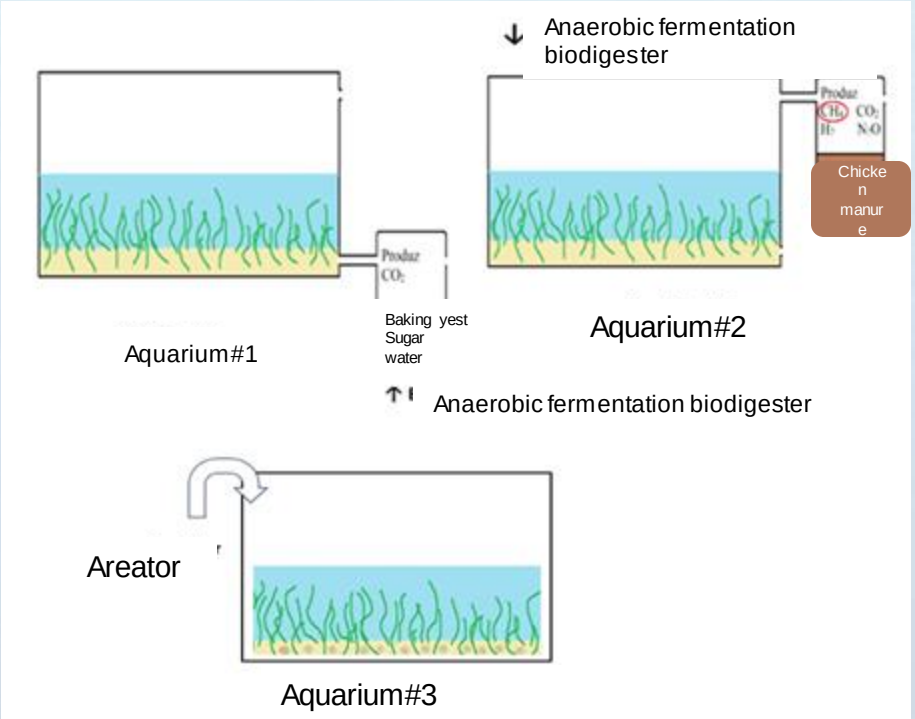
- Living organisms such as bivalves, with their carbonate shells, help control the pH of the oceans, preventing the acceleration of ocean acidification largely driven by global warming.

New Experimental Model - Objective 2

Evaluate which of the two greenhouse gases has the greatest effect on the degradation of the two aquatic ecosystems.

Three aquariums were set up:

- **Aquarium #1** replicated the two ecosystems and was injected with CO2.
- **Aquarium #2** replicated the two ecosystems and was injected with CH4.
- **Aquarium #3** served as a control and was injected with air using an aerator.



Results Analysis

Day 0

The 3 aquariums are in balance (presenting the same physicochemical parameters as well as those of the natural environment).
The plants and animals seemed to be doing well in all 3 aquariums.
In Aquarium #1, CO_2 injection was started.
In Aquarium #2, CH_4 injection was started.
Aquarium #3 started receiving air injection.

When we connected the biodigesters to their respective aquariums, we observed that the carbon dioxide biodigester produced a large number of bubbles at the entrance of Aquarium #1, while the methane biodigester did not generate the same effect in Aquarium #2. We concluded that we were unable to control the flow of greenhouse gases at the entrance of the respective aquariums, which compromised this part of the experiment. Since we needed to ascertain which of these two greenhouse gases (GHGs) would have a greater effect on the degradation of aquatic systems, the amount ejected into the respective aquariums had to be the same.

The **Sustainable Development Goals** (SDGs) reflected in our project...