Sedimentation and filtration in wetlands

GLOBE		SDGs Associated	Type of Activity
Spheres	Associated Protocols		
Hydrosphere	Transparency	13 (Climate action) 14 (Life below water) 15 (Life on land)	Exploratory
Biosphere			

Overview

Participants will create a model to demonstrate how wetland plants reduce water flow and contribute to the settling of potentially hazardous substances. Participants will also learn how plants in mangrove swamps retain sediment (= sand, mud, shells) so that they do not end up in lakes, rivers, creeks, and the ocean.

Time

1 class

Prerequisites

Basic knowledge of ecosystems, ecology, conservation, and meteorology.

School-level

Primary and secondary school students.

Purpose

Participants will learn how plants in mangrove swamps filter runoff and retain sediment (= sand, mud, shells) so that they do not end up in lakes, rivers, creeks, and the ocean.

Students outcomes

- Help students better understand how mangrove forest's function
- Help students understand the importance of mangrove forests
- Help students understand sedimentation and filtration

Background

LEARNING ACTIVITY

A wetland is an area of land that is covered with water all year round, or for part of the year. The soil in wetlands can become waterlogged: this means that the soil is full of water, like a sponge. Most large wetland areas often include a combination of different types of freshwater systems. Between 300 million and 400 million people live close to and depend on wetlands. They support the cultivation of rice, a staple in the diet of half the world's population. Wetlands are important because they:

- Store carbon and help fight climate change,
- Clean and filter water,
- Revive biodiversity
- Boost ecotourism
- Help protect the land against erosion and floods.

Wetlands take many forms including rivers, marshes, bogs, mudflats, ponds, swamps, billabongs, lagoons, lakes, floodplains, and mangroves.

Sedimentation: The settling and accumulation of sediments

Filtration: Filtration is the process in which solid particles in a liquid or a gaseous fluid are removed by the use of a filter medium that permits the fluid to pass.

When wetlands trap and bind sediments to build soils, they provide essential services to people and adjacent ecosystems. Mangroves are well known and increasingly appreciated for their role as coastal defenses – preventing coastal erosion and protecting adjacent villages from storm surges and sea level rise. By filtering suspended particles, mangroves generate clean water and protect adjacent coral reefs from excess sedimentation.

Securing adequate sediment provision in mangrove systems is critical for conservation and restoration efforts. Natural hydrological systems must supply adequate amounts of sediment to prevent sediment starvation on the one hand – and prevent sediment oversupply on the other. The aerial roots of mangroves retain sediments and prevent erosion. By slowing the water flow, they cause the water to "settle," facilitate the settling of sediments, and reduce the outflow of fallen leaves and branches.

For example, mangrove soils can be maintained or even grow vertically upward through the accumulation of sediments and organic matter. In some places, vertical growth may be sufficient not only to maintain mangroves but also to keep pace with rising sea levels. Mangrove systems suffering from an imbalance of sediment supply will lose their efficiency in providing coastal resilience and clean water. Moreover, any attempt at planting or facilitating the natural succession of mangroves will fail if seedlings cannot tap their roots into stable soils. Mangrove soils can act as sponges against excess rainfall and flooding, buffer coastal erosion, and can shield communities in extreme weather.

Mangrove forests also protect fish and other animals that live in these areas from substances that come from land. When mangrove plants slow down rainwater, the sludge (or mud) that comes off land ends up around the roots and trunks of the plants. This helps to protect the ocean from an accumulation of silt and sediment (=sand, mud, shells). By preventing the accumulation of silt, the mangrove trees ensure that the gills of fish and other aquatic animals do not become clogged and the eggs of these animals do not become covered with silt (if this happens they cannot hatch). Excess sediments or silt in the mud can also be bad for the plants growing in the water because it blocks sunlight, which is necessary for photosynthesis. It also helps protect water from contaminants, such as fertilizers and chemicals sometimes used in agriculture. The other plants that occur in the mangrove forests absorb these substances so that they cannot enter the water. If the mangrove forests were not there, these substances would pollute the rivers, creeks, ocean, and groundwater.

When mangrove plants slow down rainwater, the sludge or mud ends up around the roots and trunks of the plants. This helps protect the ocean from a build-up of sediment, which can clog the gills of fish and other aquatic animals and cause their eggs to disappear into the subsurface. It also helps protect water from pollutants and other impurities because the other wetland plants found there can absorb and use the nutrients and other chemicals contained in the sediment. If the Wetlands were not there, these substances would pollute the rivers, creeks, oceans and groundwater. Both coral reefs and seagrass beds rely on the water-purifying ability of nearby mangrove forests to keep the water clear and healthy.

Guiding Research Questions

- *What happens when sediments suspended in water can settle?*
- *What happens when polluted water goes through a mangrove forest?*

Scientific concepts

- Pollution
- Filtration
- Sedimentation
- Erosion

Materials and Tools

- 1-liter bottle or jug (clear)
- Different sediment types such as large and small stones, sand, fine sand particles, and clay
- Pieces of sponge;
- Flat plate, piece of wood or plastic;
- Two shallow containers;
- Glue

What to do and how to do it

Beginning

Divide the participants into groups of 2 or 3.
Pose the guiding questions and then explain the scientific concepts necessary to begin the activity.
Allow the participants to collect different sediment types outside (sand, clay, and other ideas..) (or ask them to bring it from home).

Development

1. Mix the different sediment types (sand, clay, etc.) in the bottle until it is about half or three-quarters full. The bottle is then further filled with water and covered with the cap.

2. Shake the bottle until everything is well shaken and place the bottle on a table (figure 1). Watch the time and start counting down.

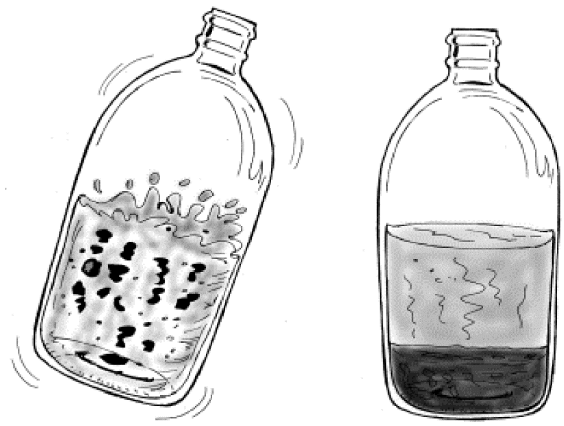

Figure 1 Bottles with sediments before and after shaking

3. Check the bottle with sediment; it will take a while for it to sink in. How long did it take for everything to sink in? Did the sediment settle in layers, i.e. according to particle size?
4. Place the plate/ wood/ plastic on a slope in your container (try to rest it on the edge of the container). This is supposed to represent a damaged wetland, where the plants have all died or been removed. Water enters the 'Wetland' via a creek, flows through the Wetland, and ends in a lake or ocean.
5. Now pour your mixture into the plate and let it flow into the container (figure 2). How long does it take for the mixture to get into the container?
6. Wash the board and stick the sponges on it (rough side down). Let this dry thoroughly.
7. Wet the sponges slightly. This now represents a 'healthy wetland' where plants but also the soil ensure that silt and sediments are retained and do not end up in the ocean.
8. Make another mixture and repeat step 3 with the 'healthy Wetland' and the second container (figure 2). How long does it take for the mixture to get into the container?

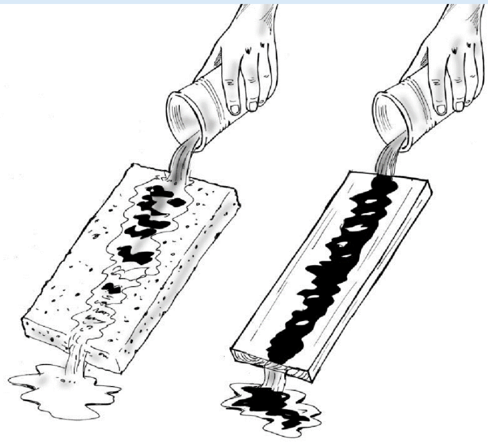

Figure 2 Water going through a “healthy wetland” vs a “damaged wetland”.

9. Compare the water coming from the 'damaged Wetland' with the water coming from the 'healthy Wetland'. Does it look different? If so, what is the difference?

Closing

Discussion/Reflection

- Do you think more sediment would sink to the bottom if the water flowed quickly or slowly?
- How can wetlands reduce the water flow (hint: think of the roots/ plants in the water)?
- In which Wetland does the water drain faster?
- In which Wetland will you get more settling of sediments, the damaged one or the healthy one? Why?
- From which of the two 'Wetlands' will cleaner water flow? Why? Test your theory by looking at the transparency of the water from both wetlands using the GLOBE transparency protocol. Were you right?
- What will happen to the water that is downstream and adjacent to the sea if a canal or well is dug in the Wetland?
- How will the removal of or damage to wetlands affect the quality of the water where the Wetland borders the sea?
- What will be the impact on humans?

Additional questions

- Can you think of any other functions of wetlands?
- Are there wetlands in your area? If yes, what kind of wetlands do you have in your area?
- If possible, visit a wetland in your area. Try to figure out if it is a wetland that always has water or if there are periods during which the wetland is dry. Are there any migratory birds in this area?
- Are there rivers or creeks that run into the wetland? If yes, what type of contaminants can these waterways expel into the wetland (look at the surrounding area of these rivers and creeks)

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