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Wetlands: Nature's Water Filter

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Objective

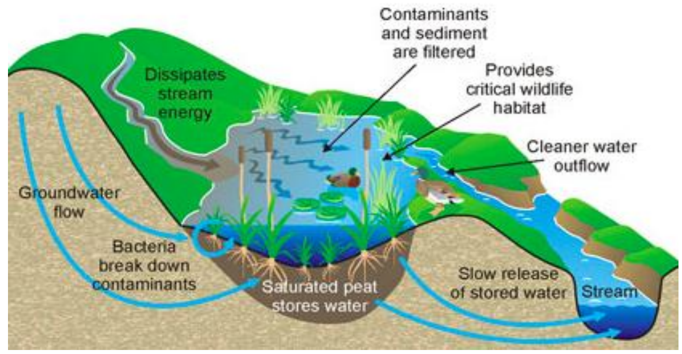
The objective of this lab is to understand how natural materials can sorb dissolved chemicals and filter particles from water, hence improving water quality.

Standards Met: NGSS

HS-ETS1-1. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
HS-ETS1-3. Evaluate a solution to a complex real-world problem-based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

Background

Natural wetlands, such as swamps and marshes, absorb contaminants from runoff and help control flooding. Runoffs can contain different chemicals; for example, runoff near agricultural areas can contain pesticides and fertilizers while urban runoff can contain e.g. gasoline.



http://butane.chem.uiuc.edu/pshapley/Environmental/L32/1.html

Wetlands provide large amounts of food for the diverse array of animals that inhabit them, particularly fish, amphibians, insects, and shellfish that form the base of the food web. They are one of the most productive ecosystems in the world, on a level similar to coral reefs and rainforests. Wetlands also store carbon in their soil and plant communities, making them an important tool in climate mitigation. They also provide direct benefits to humans, such as water quality improvement and shore erosion prevention.

Environmental engineers have created many constructed wetlands, which have similar benefits. Wetlands are sustainable since their operation do not require any machinery or added energy.

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Experimental Part

Materials

Part 1.

- 2 transparent plastic cups
- 1 x 0.5 L plastic bottle
- Turbidity meter (if not available, tests can be done by observation only)
- Funnel; can be made out of 0.5 L plastic soda bottle with cut bottom
- Peat moss
- Potting soil
- Tablespoon

Part 2.

- Food coloring
- 1 x 0.5 L plastic bottle
- 5 transparent plastic cups
- Celery

Part 3.

- Food coloring
- Potting soil
- Peat moss
- Tablespoon
- Scissors
- Tape
- 3 x 2 L plastic soda bottle with caps
- Plastic container (500 mL)
- Turbidity meter (if not available, tests can be done by observation only)
- 3 transparent plastic cups

Teacher's Prep:

- *Plastic container (500 mL)* ***Container B*** *in Part 3: Make a small hole at 2 inches from the top of the container and glue an appropriate diameter size tubing so that approx. 1 feet of the tubing hangs on the container side (any type is good).*

- *3 x 2 L plastic soda bottle with caps: Cut the bottom of one bottle. Make few small holes in the cap of that bottle (****Container C*** *in Part 3).*

Procedure

Part 1. Cloudy water

1. Turbidity is a word that describes how clear or cloudy water can be. You would describe clear water as having low turbidity and muddy water has having high turbidity. In this simulation, you will be monitoring water turbidity and how the wetlands affect it. Cloudy water carries small particles which adversely affect water quality in different ways.
2. Add two tablespoons of potting soil in 0.5 L plastic bottle and add water. This represents the runoff water containing different particles. Shake for 30 seconds, mixing all of the solids in the water together. You should avoid allowing the solids to gather at the bottom.
3. Mark one plastic cup as **Cup 1** and pour 1/3 of the bottle of turbid water. Note how clear the water is. Add detailed descriptions of how cloudy the water is. ***Hint for Teacher!*** *Students can measure turbidity using turbidity meter if it is available.*
4. Mark plastic cup as **Cup 2**. Put peat moss in a funnel so that it fills up the half of funnel and place funnel on **Cup 2** (or hold if it doesn't fit the cup). Carefully pour the rest of turbid water through the moss. Note the level of turbidity in the filtered water and how the turbidity changes after pouring the water through the moss.
5. What happens if you pour water you filtered through moss and pour over funnel with moss again (make sure to place cup underneath the funnel before you do that)? How many times you had to repeat that step until water becomes totally clear (has low turbidity)?

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Part 2. Dye in water

1. Prepare "contaminated water" by adding few drops of food coloring in 0.5 L plastic bottle and add water. Write down how many drops you added per 0.5 L.
2. Mark 5 cups from number 1-5. Fill the cups up to 100 mL with prepared dyed water (evenly distribute whole amount of dyed water you prepared among 5 cups).
3. Trim the ends of the celery stalks so they are freshly cut. Place different amount of celery stalks in each jar (up to 5) while leaving one jar without celery stalks (control). Make a table where you define how many stalks you added in each jar. Secure cups from flipping over when celery stalks are added.
4. Leave the plants in the cups overnight. Observe the plants and water the next day.

- Did water in each cup have the same color? Was the food coloring absorbed in any of the cups? If so, which performed the best and why?

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- Cut the plants open and look inside the stalks. What do you notice?

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- If the food coloring represents chemicals, what is the celery doing to the water?

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Hint for Teacher! *Plants absorb harmful chemicals and improve water quality, which is why wetlands are so important. They improve the water quality which benefits the organisms that rely on them (including humans!).*

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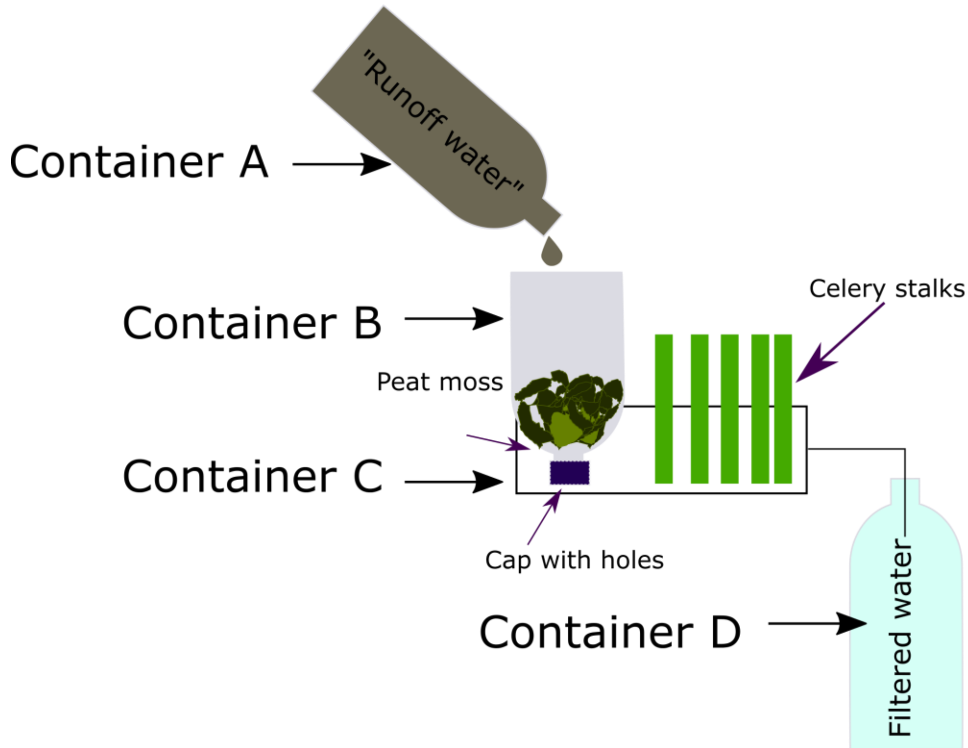
Part 3. Your wetland

Here you will construct your own wetland as you see in the schematic bellow.



1. Prepare your "runoff water" in 2 L plastic bottle (**Container A**): add 8 table spoons of potting soil and number of drops you added in Part 2. and multiply by 4=____. Mix, take small sample in transparent cup and leave aside (some particles will settle).

2. Take a plastic container (**Container B**) and place 10 celery stalks in the container.

3. Take another 2 L plastic bottle with cut bottom and holes in cap (**Container C**). Turn the bottle so that cap is down and place peat moss until 1/3 is filled. Place **Container C** in **Container B** and secure with tape.

4. Place the collection container (**Container D**) beneath the **Container B** and place tubing on the side of **Container B** into the **Container D**.

5. Now mix your "runoff water" from **Container A** and start adding small increments of the "runoff water" into **Container C**. Do that for 30 minutes and use the whole amount of runoff water.

6. In the meantime, mark 2 small transparent cups and take sample after 10 and 20 minutes of adding "runoff water" to compare with the initial sample you took at the beginning. Write down what you observed regarding water sample**.**

   How is water turbidity and color in **Container B** (after peat moss) versus **Container D**? Does your wetland remove both dye and turbidity? If not, how can you make it be more efficient?

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   Hint for Teacher! *If dye is not sufficiently removed students can add more celery stalks or lower the flow to allow for longer contact time. If turbidity is still high, more moss can be added. Either way water recirculation would support higher retention time, so if there is a pump they can use to create recirculation, at least one test can be left to run overnight so they can observe the impact.*

Take Home Messages

Nature has its own way of filtering out harmful chemicals, and it is something that engineers have learned from to create sustainable artificial wetlands.

Lesson Adopted From

http://www.discovere.org/our-activities/single-activity-detail/Wetlands:%20Nature's%20Water%20Filter

https://www.epa.gov/wetlands/why-are-wetlands-important

https://coast.noaa.gov/data/SEAMedia/Lessons/G5U2L2%20Natures%20Water%20Filter.pdf