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Greywater and Filtration

Detailed Teaching Material

April 6, 2018

Introduction

The material provided in this document is intended to provide the user with the material necessary to conduct workshops about greywater filtration, as it was conducted for a group of twelve high school students (level 3 and 4) in Longido, Tanzania. Several images and informational content was adapted from the CAWST (Centre for Affordable and Water Sanitation Technology) WASH (Water, Sanitation, and Hygiene) handbook.

Intended Audience

- Upper level high school students

Learning Objectives

By the end of this workshop participants will gain a better understanding of the following:

- Different drinking water sources,
- How water becomes contaminated,
- Why water should be cleaned before drinking,
- What greywater is and why we should filter and reuse greywater,
- How a sand filter cleans water,
- How to maintain a sand filter and keep water clean.

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Required Resources

Presentation:

- This detailed workshop material,
- The PowerPoint presentation,
- Overhead projector and board to project presentation.

Activity:

- Greywater filter,
- Greywater in a container (2 L),
- pH meter,
- Turbidimeter with 2 vials,
- 250 mL beaker,
- 1 L beaker,
- Clean water in wash bottle,
- Tissues.

Details

This workshop consists of 14 slides of teaching material that first explains the water cycle, how water is contaminated and why filtration is needed. The second part of the workshop is an activity where students will use the greywater filter and test the pH and turbidity of unfiltered and filtered greywater samples. When the workshop was conducted in Longido, a prototype greywater filter had been built and tested and was used for the activity. The last part of the presentation explains what greywater is, the benefits of filtering and reusing greywater, and more detail on how a sand filter works.

Below are the details of the workshop material. This includes content to be delivered for each slide of the PowerPoint presentation. Additionally, questions to ask the students are suggested to check for their understanding of content, to learn what the students know on the subject, and make the presentation interactive.

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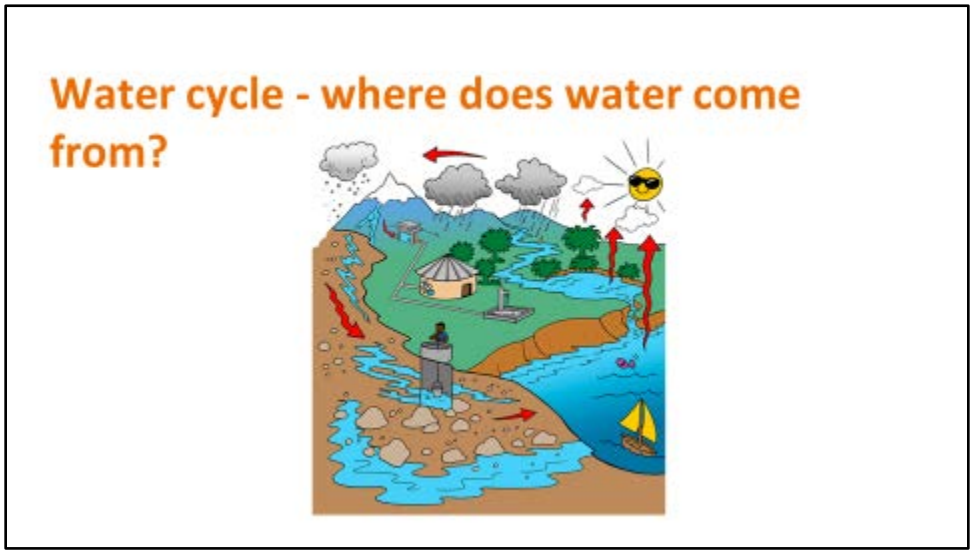
Water Filtration and Greywater

Part 1: Water and Microbes



Content:

a. Water is constantly moving on, above, and below the surface of the Earth.
b. This is called the water cycle. Water exists as moisture in the air, creates clouds and falls as rain. Then it evaporates from surface water and the cycle begins again.
c. Drinking water comes from three main sources: fresh water bodies (lakes and rivers, etc.), rain, and groundwater.
d. Groundwater is the water that seeps into the ground and is stored in the earth's aquifers.

Questions you can ask:

- What is the main source of water for your household and which source do you drink from? Which source of water do you prefer and why?
    - Get students to understand that rainwater is the cleanest drinking water source because it has less opportunity to become contaminated before it is collected.
- During the dry season, do you use a different source of water?
    - Get students to understand the difficulty in water scarcity in their area and the importance of sustainable water use to conserve the minimal amount of water that they do have during the dry season.

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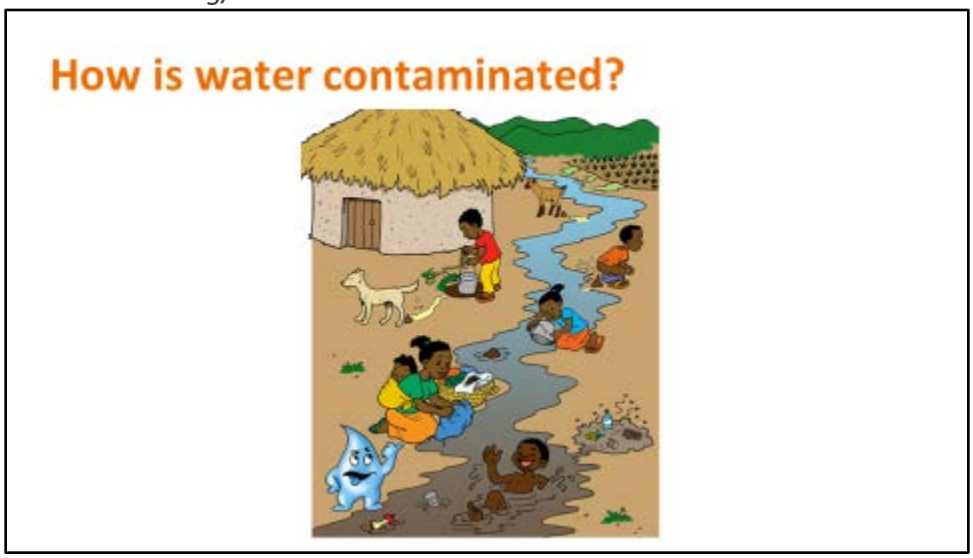

Content:

a. Water that contains dirt and germs (called microbes) is contaminated.
b. Humans and animal feces are the main sources of water contamination. This can occur through improper use of latrines or defecation near a water source.
c. Contaminated water can flow through rivers, wells, and be carried into your home in pipelines or buckets and make everyone sick.
d. Water can also become contaminated when water storage containers are not covered, or the container used to collect water contains dirt.
e. Water can look clean but be contaminated with microbes the eye cannot see, which can cause illness.
f. The purest source of water is rain water; however, it can become dirty when collected from a roof.
g. Groundwater is of good quality but can be contaminated from spilled chemicals or feces.
h. Surface water is of poor quality because there are many ways it can become contaminated.

Questions you can ask:

- What are sources of water contamination? (a, d)
- If water looks clean does this mean it is safe to consume? (e)
- What source of water can easily be contaminated? (h)
- What source of water is the purest? (f)

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Content:

a. Contaminated water can make someone ill if they drink it. It is more harmful to children who have not adapted to the harmful microbes.
b. Microbes are the bacteria that are not detectable with the human eye and can be harmful to humans.
c. Animal and human feces, garbage, the human body, clothing, and industrial waste are sources of microbes that can contaminate surface water.
d. Be careful not to drink water than may contain microbes.
e. Clear water that looks clean can contain microbes since it cannot be seen with the human eye.

Questions you can ask:

- Is clear water always safe to drink? (No, b, e explain why)
- What water is more susceptible to being contaminated? (surface water, c)
- Where do microbes come from? (c)

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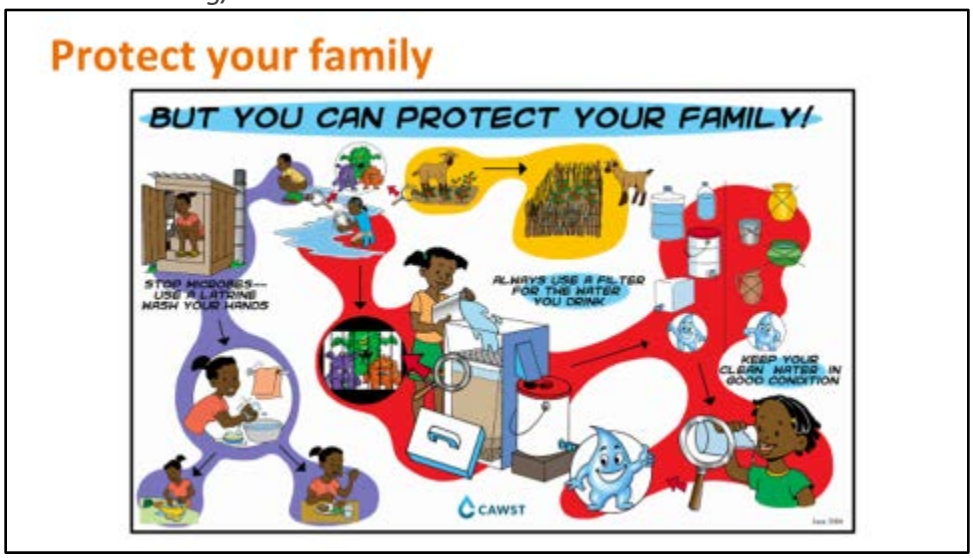

Content:

a. Use latrines to ensure feces do not get into surface water.
b. Keep clean water storage containers closed with a lid to maintain cleanliness of water.
c. Water needs to be filtered to remove microbes so that it is safe to drink.
d. Wash hands after going to the latrines/washrooms and before cooking and eating to keep yourself safe from microbes.

Questions you can ask:

- How can we keep water clean? (a, b)
- How can we clean water and keep ourselves safe from harmful microbes? (c, d)
- When should you wash your hands? (d)

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Content:

a. Water can be treated in many different ways.
b. The first method of treatment is called sedimentation. This means letting particles in dirty water sink to the bottom of the container; microbes will attach to the dirt particles and sink to the bottom as well. Seeds or chemicals can be used to help the dirt particles sink.
c. The second method of treatment is filtration. This means passing dirty water through a cloth, sand filter, or ceramic filter.
d. Sedimentation and filtration physically remove dirt and microbes.
e. The third method of treatment is disinfection which chemically removes microbes. This means boiling, adding chlorine pills, or using solar disinfection to kill microbes in water.
f. After all three methods of disinfection are complete, the water will be safe to drink.

Questions you can ask:

- Why should we treat our water? (d, e)
- Do you treat your water, if so how?
    - Students can share and compare methods by which they or their family treat water at home. This will also help you gauge the students understanding and familiarity with water treatment.

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Part 2: Activity - Testing the Filter

Content:

- Greywater and the greywater filter will be explained in forthcoming slides.
- This activity will test and compare the pH and turbidity of greywater before and after filtering.
- Turbidity indicates the relative number of particles within a liquid.
    - A higher number means the water has more particles and is dirtier.
    - A lower number means the water has less particles and is less dirty.
- pH indicates the acidity or alkalinity of water from a scale of pH 1 (acidic) to pH 14 (alkaline).
    - pH 7 is neutral which is what is desired for drinking water.
    - pH 6 to 9 is acceptable for greywater reuse.

Volunteers:

- One volunteer to pour greywater through the filter slowly.
- Two volunteers to test the pH of the greywater and filtered water.
- Two volunteers to test the turbidity of the greywater and filtered water.

Procedures:

- One volunteer pours the unfiltered greywater into the turbidimeter vial. Place vial into the turbidimeter and cover. Press READ on turbidimeter and record the number and share the number with the class. Rinse the vial with water and dry using a tissue.
- At the same time, the second volunteer place the pH probe in the unfiltered greywater container. Press READ, record the number, and share the number with the class. Rinse the probe with water and dry using a tissue.
- One volunteer pours 2 L of greywater into the filter, slowly.
- Place a 250 mL beaker under the outlet tube of the filter to catch a sample of filter greywater.
- Once the beaker is about half full remove the beaker and place a 1 L bucket under the outlet tube.
- Repeat the same procedure for testing the turbidity and pH for the filtered greywater sample (two different volunteers).
- The turbidity of the filtered greywater should be lower than the unfiltered water. The pH of the filtered water should be between 6 -9.
    - This indicates that the filter removed particles in the greywater and the water is suitable to reuse.

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Part 3: Greywater Filtration and Reuse

Content:

a. Greywater is water that has been used for activities such as bathing, washing dishes, and laundry.
b. Greywater contains dirt and microbes, but less than water that has been used for latrines and toilets.
c. The dirt and microbes from greywater can be removed and then this water can be reused (for example for cleaning floors and watering plants; not for drinking).

Questions you can ask:

- Would water used from bathing or from toilets be better to reuse? Why? (a, b)
- What must we do before reusing greywater? (c)

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Content:

a. A greywater sand filter was created to filter greywater so that it can be reused.
b. Reusing filtered greywater reduces the need for new clean water which is difficult to obtain in a dry climate.
c. To create a design of a large filter that will work, a prototype filter was built to test the level of filtration achieved by a specific design.
d. Only water should be poured into the filter.
e. The lid of the filter should be replaced whenever not in use.
f. The water needs to be poured into the filter at a slow rate for better filtration.

Questions you can ask:

- Why is it a good idea to filter greywater and reuse it? (b)
- What are some things that should and should not be done while using a sand filter? (d, e, f)

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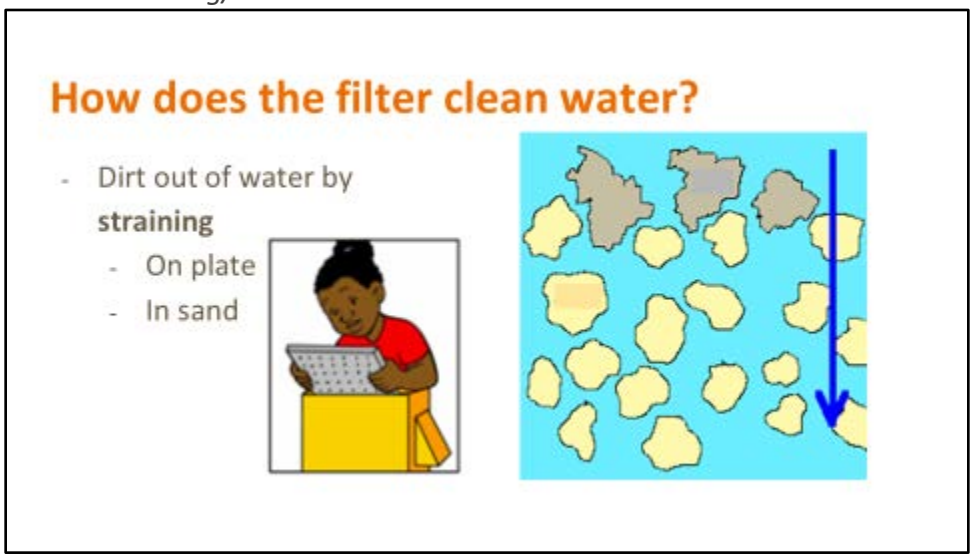

Content:

a. Large particles build up on the diffuser plate through straining.
b. This means if the particles are larger than the holes in the diffuser plate, the particles will be stuck on top of the diffuser plate.
c. Particles that are smaller than the holes in the diffuser plate will get into the filter and are removed through straining in the sand layers.
d. (Refer to image on right of slide) This happens when dirt particles (grey) are larger than the sand particles (yellow) and get stuck in the sand.
e. Then water flows through the sand and comes out of the filter while the dirt particles are trapped in the filter.

Questions you can ask:

- How does the filter remove dirt particles on the diffuser plate and in the sand? (a, c)
- Would a particle larger than the hole on the diffuser plate be removed in the sand? (b)

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Content:

a. Sieves are used to sort the sand to obtain sand that is a specific size so that the filter works properly.
b. Sieves are also used to sort a specific size for the other layers in the filter (small and large gravel). The graduated layers in a sand filter allow for proper filtration in the sand layer, while allowing for adequate drainage so water flows through the filter without sand coming out in the filtered water.

Questions you can ask:

- Why is it important to use sieves in the design of a sand filter? (a)
- What is the purpose to the graduated sand and gravel layers in a sand filter? (b)

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Content:

a. A filter needs to be cleaned when the water no longer flows out of it. The water is being clogged by trapped dirt and particles in the sand.
b. To clean the filter first remove the diffuser plate and clean it (remove any dirt that is on the diffuser plate).
c. Next remove the top layer of sand in the filter. The top layer will contain the most amount of dirt particles and needs to be thrown out and replaced with clean sand. After this is complete the diffuser plate can be placed back.
d. Water should now flow out of the filter.

Questions you can ask:

- How do you know the filter needs to be cleaned? (a)
- Why should the top layer of sand be replaced? (c)

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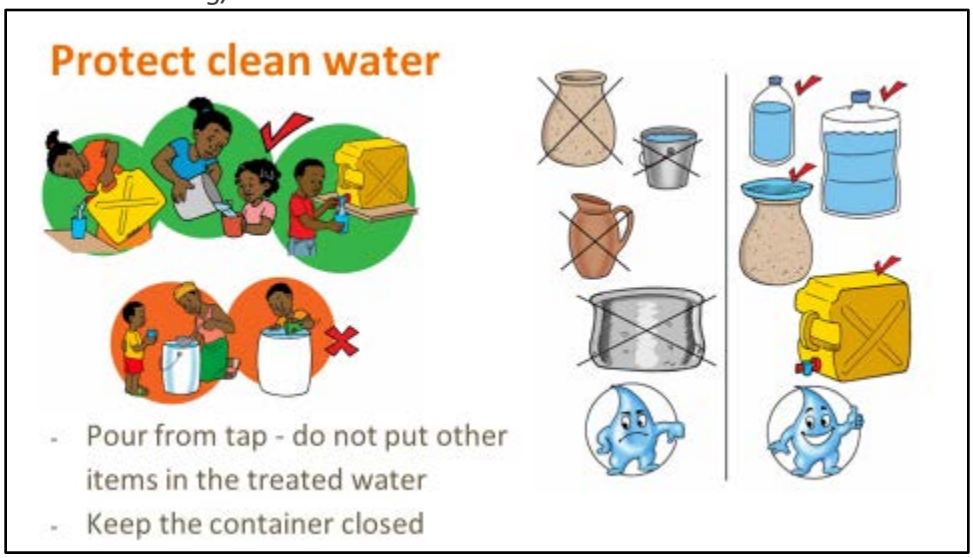

Content:

a. To keep cleaned water clean, always pour from the storage container to another container. Putting dirty cups or containers in the storage container to collect clean water can contaminate the clean water.
b. Always use a storage container with a lid to protect clean water.
c. Storage containers need to be cleaned once a month so that cleaned water does not become contaminated.
d. Clean the storage containers using clean water and soap, then rinse with clean water.

Questions you can ask:

- What kind of storage container do you use for clean water? (b)
- Why does a good storage container have a lid? (b)
- How often should the storage container be cleaned? (c)
- Why does the storage container need to be cleaned? (c)
- How should the storage container be cleaned? (d)
- How should water be removed from a storage container? (a)