

Lesson Plan: Quantification and Characterization



75 minutes

Lesson Description



This lesson explains the importance and the challenges of quantifying and characterizing faecal sludge. Participants learn what excreta and faecal sludge are made of. They discuss the key differences between faecal sludge and wastewater characteristics, focusing on faecal sludge variability. The difficulties of quantifying and characterizing faecal sludge are also introduced.

Prerequisite: Participants should already be familiar with faecal pathogens and disease transmission routes.

Learning Outcomes



At the end of this session participants will be able to:

1. Identify the characteristics of excreta and faecal sludge.
2. Explain the difference between faecal sludge and wastewater characteristics.
3. Explain the variability of faecal sludge characteristics.
4. Discuss the difficulties in reliable faecal sludge quantification and characterization.

Materials



- Flip chart paper
- Markers
- Tape
- Activity: What is Faecal Sludge? (1 for every 4 or 5 participants)
- Activity: Excreta Icons (2 of each icon)
- Case Study (1 per participant)
- Faecal Sludge Management Exercise Book (1 per participant)

Optional:

- PowerPoint: Quantification and Characterization
- Computer and projector

Preparation



- Review Chapter 2: Quantification, Characterization and Treatment Objectives in the book *Faecal Sludge Management: Systems Approach for Implementation and Operation and Design Approach* presentation from Lesson Plan: Design Approach
- Write the heading “*Quantification*” on flip chart paper
- Write the heading “*What is in Faecal Sludge?*” on flip chart paper. Draw the outline of a poop underneath the heading.
- Write the heading “*Excreta*” on flip chart paper.

- Write the heading “*Variability Factors*” on flip chart paper.
- Print the Activity: What is Faecal Sludge? (1 for every 4 or 5 participants)
- Print the Activity: Excreta Icons (2 of each icon)
- If using PowerPoint: Quantification and Characterization
 - Review the PowerPoint presentation
 - Print the speaker’s notes
 - Check that the projector is working
 - Cue the PowerPoint on the computer

Introduction
5 minutes

1. Explain that you are the leader of the local fishing agency. You have been asked to quantify or count all the fish in your local lake. Ask participants, “How would you quantify all the fish in a lake?” Share some responses as a large group.
2. Explain that now you need to categorize the fish by species (type), size, weight, and colour. Ask participants, “How would you do that?” Share some responses as a large group.
3. Explain that quantifying and characterizing faecal sludge is similar to quantifying and characterizing fish in a lake – it is difficult and will never be 100% accurate. But we can come up with reasonable estimates.

Faecal Sludge Quantification
5 minutes

1. Explain that we will first look at faecal sludge quantification, and then we will discuss characterization in more detail. Remind participants that you need to quantify and characterize faecal sludge to design a treatment facility.
2. Ask participants, “What data would you need to estimate faecal sludge quantities for a town?” Record responses on the “*Quantification*” flip chart.
 - *Number of users*
 - *Location*
 - *Types and number of on-site sanitation technologies*
 - *Faecal sludge accumulation rates*
 - *Socioeconomic levels (this could be an indicator of faecal sludge characteristic. For example, maybe in high-income areas on-site containment is better constructed, and there is more use of flush toilets and greywater.)*
3. Explain that there is no proven method to quantify faecal sludge. There is a need to develop a methodology to estimate faecal sludge quantities. This is something that Eawag-Sandec is working on. Sandec has hypothesized that demographic data could be used to develop citywide characterization and quantification plans, to collect data for the design of faecal sludge treatment facilities.

More information can be found on the Eawag-Sandec website (www.sandec.ch).

4. Explain that a vacuum truck counting study is a method to estimate the amount of faecal sludge currently delivered to a discharge location. In a vacuum truck counting study, record the number of vacuum trucks and their discharge volume. The study should be implemented over at least one week and repeated a few times at different times of the year. This should ensure that the weekly and annual variability of faecal sludge collection is considered. For example, less faecal sludge is commonly discharged on Sundays or during the year when major investments (such as school fees) are due.

A vacuum truck counting study does not quantify all of the faecal sludge generated in a community, nor can it predict future developments. As well, it can only be done in cities where faecal sludge discharge locations exist.

What is Faecal Sludge?

30 minutes



1. Explain we will now discuss faecal sludge characterization. To understand faecal sludge characterization, you first need to understand what faecal sludge is. Faecal sludge is what you find in an on-site sanitation technology, like a pit latrine or septic tank. It includes faeces and urine (which is known as excreta), as well as other components. We will first focus on faeces and urine. We will then discuss the other components of faecal sludge.
2. Explain that we need to know what excreta is, to understand faecal sludge characterization. Ask participants, "What is excreta (faeces and urine) made of?" Tape icons on the "Excreta" flip chart as they are mentioned.



- *Water: Both urine and faeces are largely made of water. On average, 91-96 % of urine is water and 75% of faeces are water.*
- *Organic material: Organic material in excreta comes from the remains of living organisms such as plants and animals that our body is not able to digest. When we eat a meal that has vegetables and meat, we are eating organic material. 25% of faeces are solids, of which 84-93% is organic material. 4-9% of urine is dissolved and suspended solids, of which 65-85% is organic material.*
- *Nutrients: Nutrients are found in the food we eat. They go through our digestive system where some are used by our bodies and others are excreted. Humans need nutrients to grow and stay healthy. Examples of nutrients are nitrogen (N), phosphorous (P) and potassium (K). They are excreted through our urine and faeces, with more of the nutrients in urine. For example, 88% of nitrogen is excreted in urine and 12% in faeces, however, 67% of phosphorus is in urine and 33% in faeces.*
- *Pathogens: Bacteria, viruses, helminths and protozoa can all be found in excreta.*
- *Trace organics: Natural hormones, synthetic hormones and pharmaceuticals that can be passed through excreta and could still be biologically active.*
- *Salt: There is not a significant amount of salt in faeces. Urine has high concentrations of salt. The salt concentration in urine depends on what a person eats and how much they drink. For example, one study reported we excrete on average 8.8 g of salt per litre of urine (Ganrot, Dave, & Nilsson, 2007). Salt in urine is not a health issue.*



3. Participants will brainstorm in groups what they think faecal sludge is. To help them brainstorm, ask participants, “What else goes into an on-site sanitation technology other than excreta?” They have 2 minutes to write or draw the components of faecal sludge on the handout.
4. Divide the participants into groups of 4 or 5 people. Hand out the Activity: What is Faecal Sludge? to each group.
5. After 2 minutes, ask the groups to share some of their responses. Record responses on the “*What is in Faecal Sludge?*” flip chart. Add “*Excreta*” and “*Faecal Sludge*” to the Word Wall.
 - *Faeces and urine*
 - *Cover material*
 - *Anal cleansing material*
 - *Solid waste*
 - *Flush water*
 - *Greywater*
6. Summarize the two activities.
7. Explain that people often confuse faecal sludge and wastewater. Faecal sludge is from on-site sanitation technologies, like a pit latrine or septic tank. Wastewater is used water from any combination of domestic, industrial, commercial or agricultural activities, surface runoff (stormwater), and any sewer inflow (infiltration). Wastewater can be managed on-site or off-site. Wastewater managed off-site is often called sewage. Add “Wastewater” to the Word Wall.
8. Ask participants, “What is the difference between faecal sludge and wastewater characteristics?” Explain that there are two key differences.
 - *Faecal sludge is **highly variable** in consistency, quantity, and concentration. Wastewater is not as variable because it is mixed as it is transported in the sewer.*
 - *Wastewater is transported through the sewer system to the wastewater treatment facility. Whereas faecal sludge is stored for a certain period of time in a containment technology (like a latrine pit or septic tank). Depending on the length of storage, faecal sludge **can be more degraded** and stabilized than wastewater.*
9. Ask participants, “Why is faecal sludge highly variable?” Record the responses on the “*Variability Factors*” flip chart.
 - *Variety of on-site sanitation technologies: Septic tank, pit latrine, dry latrine*
 - *Storage duration: faecal sludge will be more or less stabilized depending on how long it is stored.*
 - *Infiltration: faecal sludge will be more or less viscous (thick) if there is a high infiltration rate into or out of the containment.*

- *Amount of greywater: faecal sludge will be more or less dilute depending on the different used water streams going into the on-site sanitation technology (for example, water from bathing, dishwashing, laundry, and cleaning)*
 - *Emptying method: Water could be added to help liquefy faecal sludge for pumping. Some emptying methods can only remove part of the contents, for example, faecal sludge at the bottom of a containment technology that is very thick. Other methods can remove the entire contents, for example manual emptying. Sometimes the household can only afford to get part of the contents removed.*
 - *Climate: During rainy seasons, on-site sanitation technologies can fill up with runoff and overflow. Warmer temperatures increase degradation rates.*
 - *Solid waste: Quantities of solid waste disposed in the on-site sanitation technology, depending on access to solid waste management and awareness.*
10. Optional: Use PowerPoint: Quantification and Characterization to show pictures of faecal sludge from different containment technologies (for example, public latrines, pit latrine, septic tank).

Faecal Sludge Characterization

15 minutes

1. Ask participants, “Has anyone tried to characterize faecal sludge before? If so, how did you do it?” Discuss responses as a large group.
2. Ask participants, “Why is characterizing faecal sludge not common?”
 - *Lack of knowledge of how to do so*
 - *Lack of simple methods to characterize faecal sludge*
 - *No guidelines or standards exist*
 - *Time consuming and expensive*
3. Explain that every on-site sanitation technology is like a person – it has its own characteristics. We will never be able to characterize every type of faecal sludge. There are, however, easier qualitative methods that allow a good understanding of sludge characteristics:
 - *The actual latrine itself can provide a lot of information about faecal sludge characteristics. Key information includes the excreta containment technology, type of user interface, and how long the faecal sludge has been stored. The sludge from a privately owned pay-per-use toilet facility or public toilet, for example, will tend to be relatively fresh because it requires frequent emptying and was stored for a short period of time.*
 - *Septic tanks are commonly operated with a greater amount of water and therefore tend to have more water than pit latrines. Therefore, the excreta containment technology can be used as an indicator for the moisture content.*
 - *Information can be obtained through observation and conversations with the users, latrine emptiers and maintenance staff.*
4. Emphasize that even though it is difficult to characterize sludge, it shouldn't prevent us from doing the best that we can with the information that we have available. As

explained, information on the on-site sanitation technology and its mode of operation can give us an indication of faecal sludge characteristics such as moisture content and chemical oxygen demand. Characterization and quantification of faecal sludge is particularly important for designing treatment technologies.

Exercise Book**15 minutes**

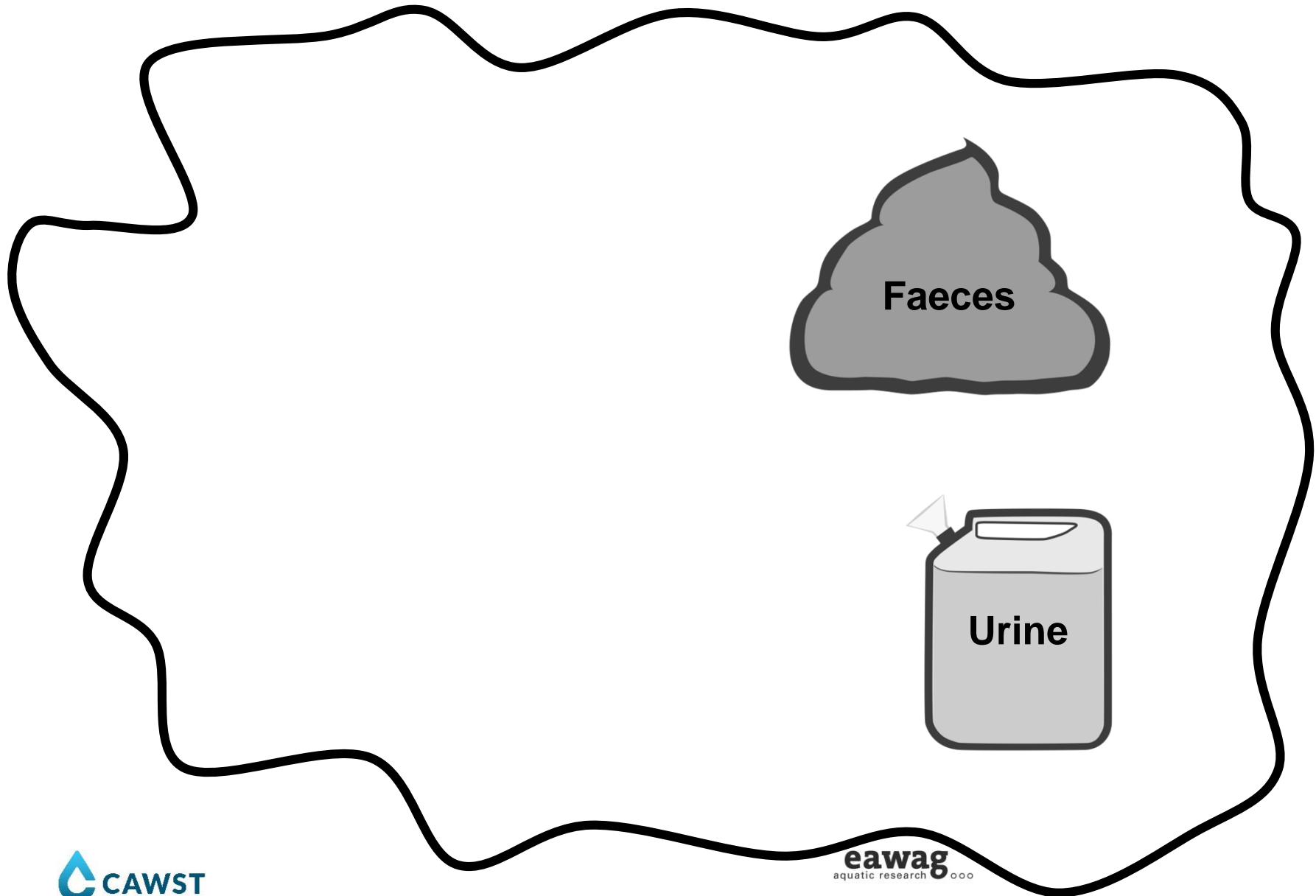
1. Ask the case study groups to use their Exercise Book and complete Section 4: Faecal Sludge Characterization. Groups will list the different on-site sanitation technologies in their case study and describe the characteristics of the faecal sludge. They have 15 minutes to complete the exercise.

Review**5 minutes**

1. Ask participants to find a partner from another case study group. Ask participants to share the on-site sanitation technologies and characteristics of the faecal sludge in their case study.

Reflections on Lesson

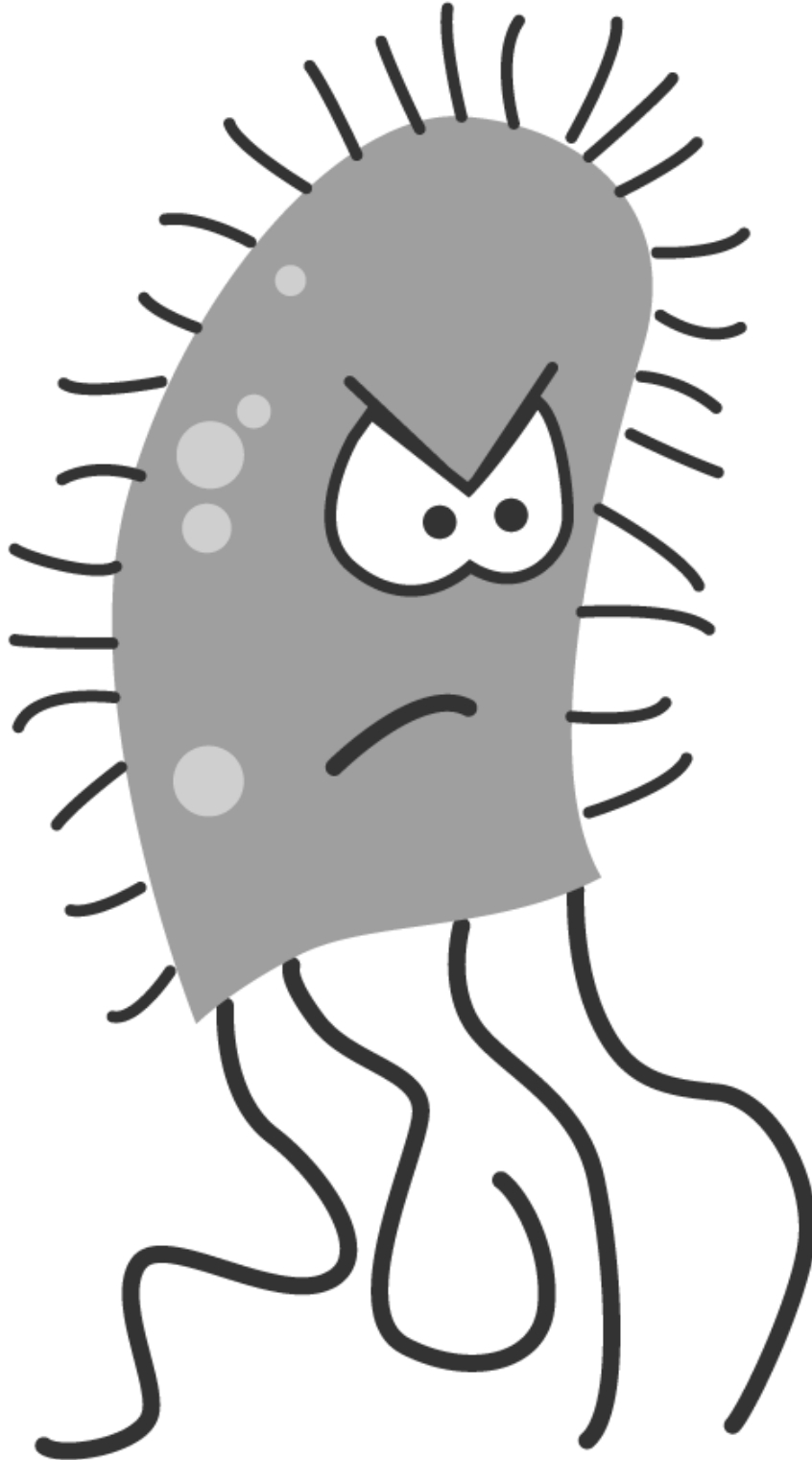
Activity: What is Faecal Sludge?



Activity: Excreta Icons







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