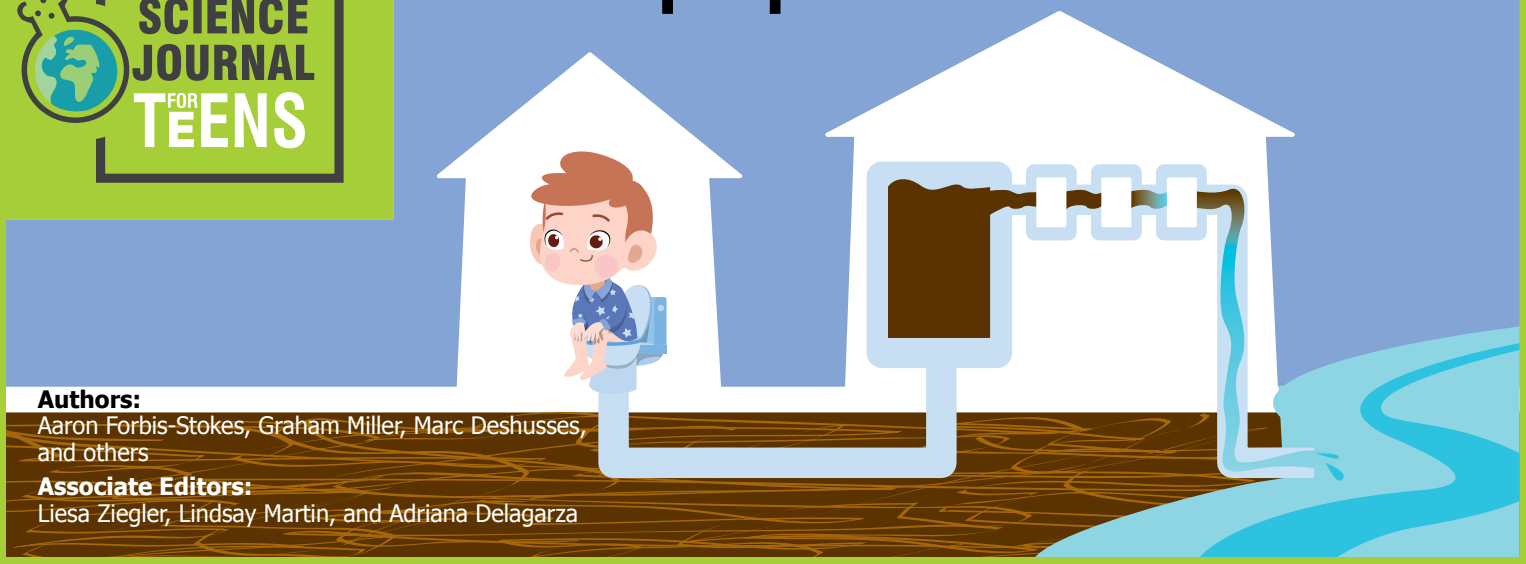
ENVIRONMENTAL SCIENCE JOURNAL FOR TEENS

NOVEMBER 2020

# How can poop be cleaned and reused?



**Authors:**
Aaron Forbis-Stokes, Graham Miller, Marc Deshusses, and others

**Associate Editors:**
Liesa Ziegler, Lindsay Martin, and Adriana Delagarza

## Abstract

Everybody poops. It's the natural cycle of digestion. We dine, we digest, and we defecate. But what happens to our poop after we flush? Does it sit there in the pipes and rot? The process is actually very complex. We have sanitation facilities to thank for that.

In cities of developed countries, it's pretty normal for toilets to be hooked up to the *sewage treatment facilities* nearby. These facilities work to slurp up any essential nutrients from the wastewater and break down any harmful chemicals. When we remove things like nitrogen and phosphorus from the waste, we can help clean the water to return it to our rivers. Miniature versions of these facilities can also be found in suburban or rural areas in developed countries.

However, in developing countries (and even some rural areas in the United States) toilets may not be connected to sewage treatment facilities because of cost, social, or environmental reasons. That means that about 2.5 billion people worldwide don't have access to proper sanitation facilities. We wanted to find out if we could build a low-cost treatment option using only materials found locally to help solve this problem.

## Introduction

It's important to sanitize and treat *fecal waste* so we can reuse it for other purposes. It's harmful to entire ecosystems if it's not treated and removed correctly. This is because our feces contains harmful bacteria that cause diseases and *nutrients* that cause too much algae to grow. When fecal waste enters a river or lake (like during a flood), algae grow faster than anything else. The other plants and animals die because the algae use up all the oxygen they need to survive. Nutrients like different forms of nitrogen or phosphorus must be taken out and *pathogens* need to be *sanitized*.

Many areas without *sewage systems* use *anaerobic digesters*. There, bacteria eat part of the waste and turn it into *biogas* that can be burned to create electricity and heat. With our group's technology, we use the biogas to sanitize the pathogens.

Still, this is not enough: we have to remove the nutrients. A two-step process called *nitrification and denitrification* can remove the different forms of nitrogen. How? First, bacteria convert nitrogen (found as ammonia) into nitrate. Then, the nitrate is turned into nitrogen gas (which is 80% of the air we breathe). This is better for our ecosystem since algae can't take in gas. Next, phosphorus must be removed. Phosphorus easily binds (attaches) to some metals (like iron), which removes it from the wastewater. By combining these methods, we can remove the harmful nutrients.

All of this is simple for countries with many resources. In developing countries (or rural areas), lack of money and materials can make it difficult. To create an effective sanitation solution, we needed to use low-cost materials that could be found locally.

# Methods

We designed a system with three biological filters (Fig. 1) that we tested in Madagascar:

1. We used crushed charcoal from local markets because it should be able to induce (cause) nitrification. Also, bacteria that help during nitrification can grow and enhance the process.

2. We took locally sourced bamboo and shredded it into chips. These chips formed a second filter, to induce denitrification.

3. The third filter consisted mainly of steel wool iron sponges since iron binds the phosphorus.

We pumped the remaining waste through our 3-step filter system for 16 weeks and repeated the experiment twice. The nitrification and denitrification processes induced through the charcoal and bamboo should reduce nitrogen, while iron should reduce phosphorus.

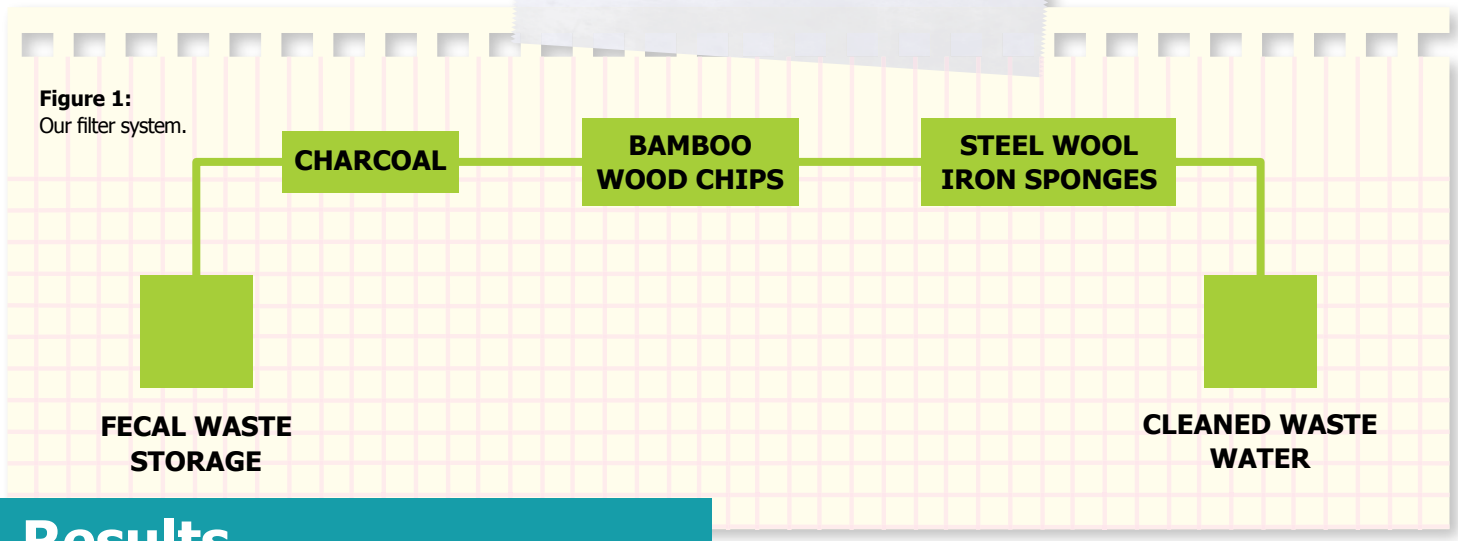
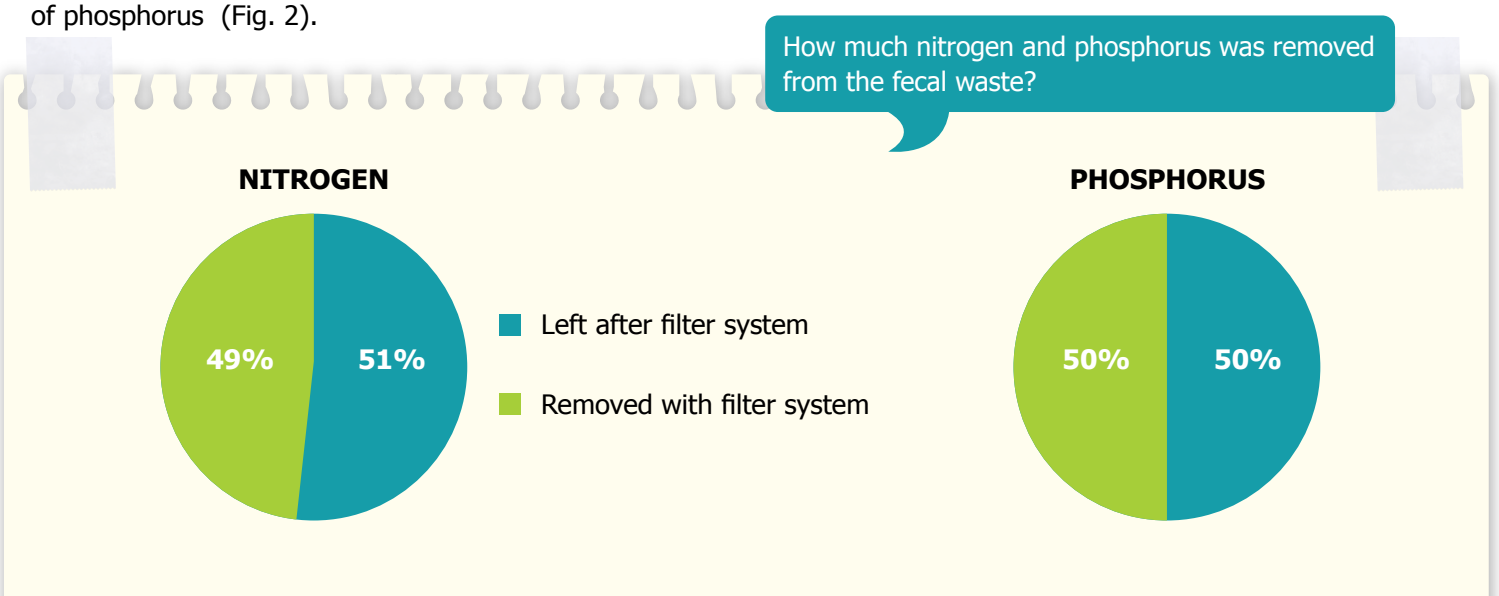



**Figure 1:**
Our filter system.

# Results

Our filter system worked very well. It converted up to 49% of nitrogen into the gaseous form and removed up to 50% of phosphorus (Fig. 2).

**Figure 2:**
Percentage of nitrogen and phosphorus remaining after our filter system.



# Discussion

Our results show two important findings.

**1.** We discovered that our filters are useful for onsite treatment of fecal waste. Before testing our filter system in Madagascar, we conducted the same study on a smaller scale in a lab. We wanted to figure out the nitrogen/phosphorus removal rates by using materials similar to those in Madagascar. Our filter pumping system in Madagascar – which was much larger than the laboratory versions – showed similar removal rates. This means that up-scaling (creating bigger filters) did not reduce the filters' effectiveness, which is often the case in other settings.

**2.** We used only materials from Madagascar that were inexpensive and easy to find. And our pumping system used very little energy. This low-cost strategy makes our filters even more useful for communities without sewage systems. We also think using larger filters would increase our system's performance and make it useful to treat larger amounts of waste.

# Conclusion

Although you may not like to talk about poop, it is important to think of its consequences for the environment. Many people around the world do not have the luxury of a flushing toilet and a usable treatment system. You can help communities in developing countries by supporting organizations like the Water & Sanitation for the Urban Poor (WSUP), https://www.wsup.com/.

Also, you can help your sewage system work better by flushing only waste and toilet paper. Nothing else belongs in your toilet.

## Glossary of Key Terms

**Anaerobic digesters** – tanks with no oxygen, where bacteria can eat parts of fecal waste and turn it into biogas.

**Biogas** – the mixture of gases created from the breakdown of organic material (like fecal or food waste).

**Fecal waste** – solid waste from your body (your poop) or any animal's body.

**Nitrification and Denitrification** – two processes that work together to convert different forms of nitrogen (like ammoniacal nitrogen) into a gas.

**Nutrients** – a substance that is needed for healthy growth, development, and functioning. For example, fruits and vegetables have important nutrients.

**Pathogens** – bacteria or viruses that cause diseases.

**Sewage treatment facilities** – facility to treat wastewater to make it sanitary again.

**Sanitize** – to make something clean and hygienic.

**Sewage system** – an underground network of tunnels and pipes which take the wastewater from houses to treatment facilities.

# Check your understanding

1 Why does fecal waste need to be cleaned?

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2 How many filters did we use, and what did they remove?

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3 What happens during anaerobic digestion, and why is it useful?

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4 How much of the nitrogen and phosphorus were removed?

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5 Why did the researchers repeat the experiment twice?

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## REFERENCES

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