

Aguarico

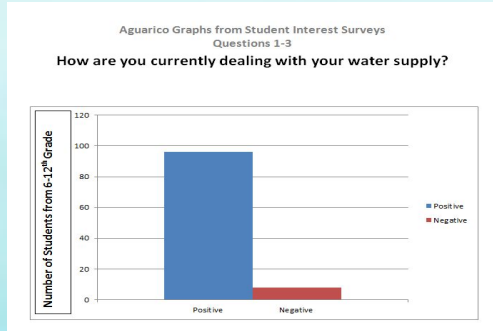
Ramey Unit School, 8th Grade
Aguadilla, Puerto Rico
May 2, 2018

Improving the Drinking Water Quality
After Hurricane Maria Using Natural
Resources

Team members: *Bria Roettger, Kailey Aponte, and Janeliz Guzman*

Engineering Design Process

Problem in our Community



- According to a survey taken on our school about one month after Maria hit, 83% had running water, though most of the tap water was contaminated.
- Victims were required to take desperate measures to gain potable drinking water, as the water was contaminated due to the shutdown of city purification systems because of lack of electricity.
- Many people drank hazardous water from rivers rooftops, and faucets.
- Contaminated water led to the spread of bacteria-related diseases such as Leptospirosis, a dangerous pathogen that thrives in animal urine.
- All of our team members experienced the struggle of getting reliable potable water. Based on these events, Aguarico became motivated to find a possible solution to this issue.
- Water contamination is not a new issue in Puerto Rico.
- In 2015, 70% of Puerto Rico's population received water that violated federal health standards.
- Water contamination is a critical problem that Puerto Ricans face, especially after the hurricane.

Problem Statement/ Hypothesis

Problem Statement:

How can we prevent bacteria-related illnesses through water contamination during the aftermath of Hurricane Maria?

After creating our problem statement,

we made inferences, observations, and predictions to produce the hypothesis.

Hypothesis:

If we filter contaminated water using a modified solar water distiller and secondary filtration system, then the output water quality will be purified and safe for consumption.

Engineering Design

Resources Used: Websites, articles, journals, interviews, books, and presentations

*Annotated Bibliography available upon request

Subject Matter Experts:

Drew Koslow: Biologist and conservationist who works for the nonprofit organization Ridge to Reef:

- He handed out water filters after Hurricane Maria, and discussed with us certain effective filtration materials. He also gave us information on our water treatment infrastructure, and his opinion on where Puerto Rico stands as far as infrastructure both before and after the Hurricane.

Ruby Rivera: Marine biologist who also works for Ridge to Reef

- She was valued for her knowledge of Puerto Rico, as she is Puerto Rican herself. She talked to us about her work, handing out filters and supplies to the locals post-storm, and how the filters worked.

Science and computer teachers at Ramey Unit School

- The science and computer teachers at Ramey Unit school, helped us create our prototype, and test the water samples.

David Sasscer: Civil Engineer

- Mr. Sasscer visited our classroom to observe our presentations and give us feedback about being an engineer. He said that he process is ongoing and at times you need to say that a product is good enough for now.

Steve Tamar: Microbiologist

- Mr. Steve Tamar helped us in running the water tests and taught us how to make those test ourselves. He informed us the the current water contamination issue that Puerto Rico.

What we Learned in our Research

Aguarico learned about the water crisis and effects of Hurricane Maria from personal experiences, interviews, field trips, observations, and research.

Most importantly, we learned how to problem solve without the conveniences we had before Hurricane Maria, and we connected with friends, family, and community members as we all joined to help recover and improve after the storm.

Our team researched the following topics:

- Water Contamination before the storm
- How Hurricane Maria contributed to water contamination
- Types of bacteria-related diseases carried through contaminated water
- Resources that were brought to Puerto Rico as part of the relief effort
- Issues with the Guajataca Reservoir and water sanitation systems
- Local and natural resources found around Puerto Rico

Materials Used to Build the Prototype

Our team constructed two different prototypes with materials that are natural resources and accessible to residents in Puerto Rico such as:

- Coconut charcoal (Burnt inner nut of a coconut)
- Coconut husks
- Sand

We also implemented materials that were common in everyday households. These materials include:

- PVC pipes
- 5 gallon buckets
- Screens/mesh
- Coffee filters
- Copper tubing

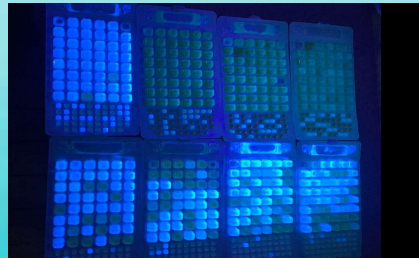
Testing Materials and GLOBE Protocols

After constructing various prototypes, we ran the water through these devices and tested the water samples for: E.coli, Enterococci, Coliforms, Dissolved Oxygen, Conductivity, pH, and Temperature

GLOBE Materials:

Using the Globe Materials, we used probes to test for:

- Conductivity
- Dissolved Oxygen
- pH
- Water temperature



Additional Testing Materials:

Because there were no GLOBE protocols for testing water samples, our team partnered with the Surfrider Foundation to test filtered city and irrigation water for E.coli, Enterococcus, and Coliform bacteria by using:

- Enterolert tests
- Colilert tests



Analysis

We analyzed our data using EPA safe drinking levels

Source:

<https://www.epa.gov/ground-water-and-drinking-water/national-primary-drinking-water-regulations#three>

Contaminant	Instrument Used to test for contaminants	MCL (mg/L)
Enterococcus	Enterolert	0
Tot. coliforms	Colilert	0
E.coli	Colilert	0
Dissolved Oxygen	Dissolved Oxygen Probe	Minimum 5 mg/L
Conductivity	Conductivity probe	5.9
PH	PH sensor	6.5-8.5
Temperature	Thermometer	*Not specified

Comparing our results to the EPA safe drinking levels allowed us to evaluate the effectiveness of our device.

First Test Results

The results of our first test included running tap water (AAA) and irrigation water from the Guajataca watershed through our filter which is shown below:



Aguarico Filter Test from Feb 1				
Sample Source		Enterococcus CFU/100ml	tot. coliform CFU/100ml	E. coli CFU/100ml
AAA				
Raw		2	0	0
Agaurico		2419.6	>2419.6	0
Irrigation				
Raw		135.4	>2419.6	178.2
Aguarico (student)		4.1	>2419.6	110

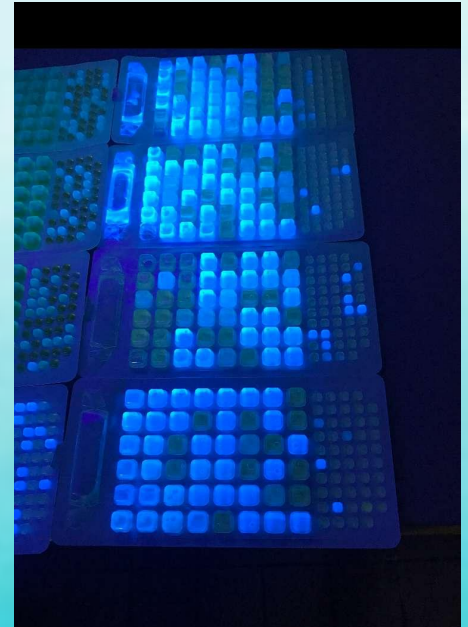


Second Test Results

Our second prototype included sterilizing all of our filtration materials (sand, husk, and coconut charcoal), and transferring them to one five-gallon plastic bucket. The results are shown below:

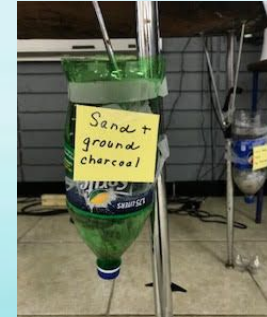


Aguarico filter test results from Feb 20				
Sample source				
Irrigation				
raw	19	>2419.6		104
Aguarico old irrigation water	2	0		0
Aguarico new irrigation water	24.5	1986.3		67
AAA				
raw	0	0		0
Aguarico (no other ID)	0	0		0
AAA from hot water filter	0	244		0



Third Test Results

Our final test was conducted by testing four different filters, as shown below. According to the table, the sand/husk/regular charcoal proves to filter the water most effectively and maintains EPA levels safe drinking water.



Aguarico Filter Test Results from Feb 27

Sample Source			
Irrigation			
Sand/husk/reg charcoal	0	0	0
Sand/Ground Charcoal	0	30.7	43.5
Sand/husk/ground charcoal	1	49.6	30.1
Sand/ Reg charcoal	4.1	33.3	52

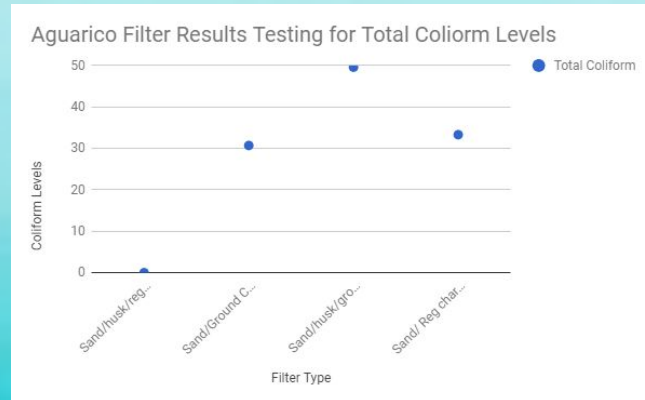
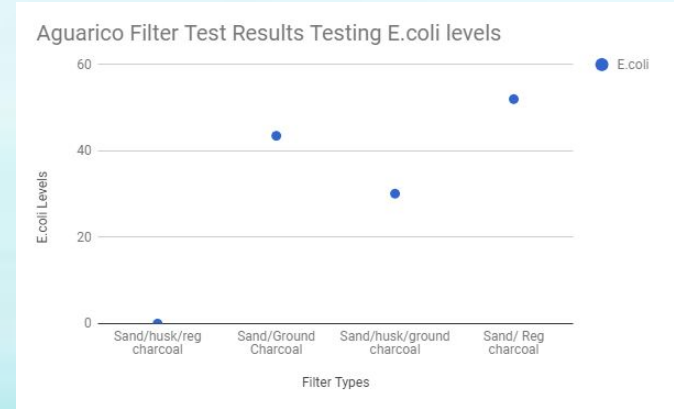
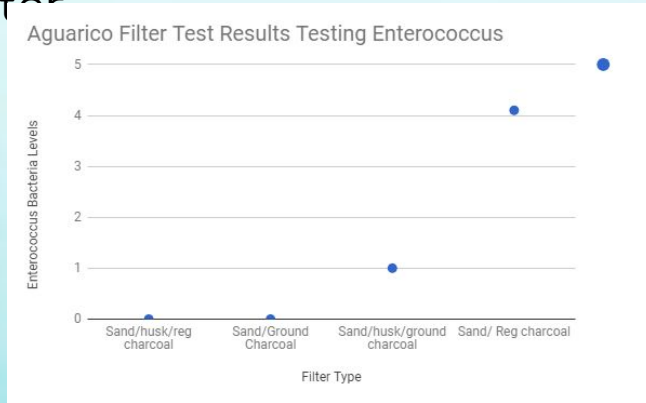
Final Test Results

After analyzing the data we came to the conclusion that the **sand/husk/regular** filter performed better than the other prototypes tested. The results from this filter are shown below:

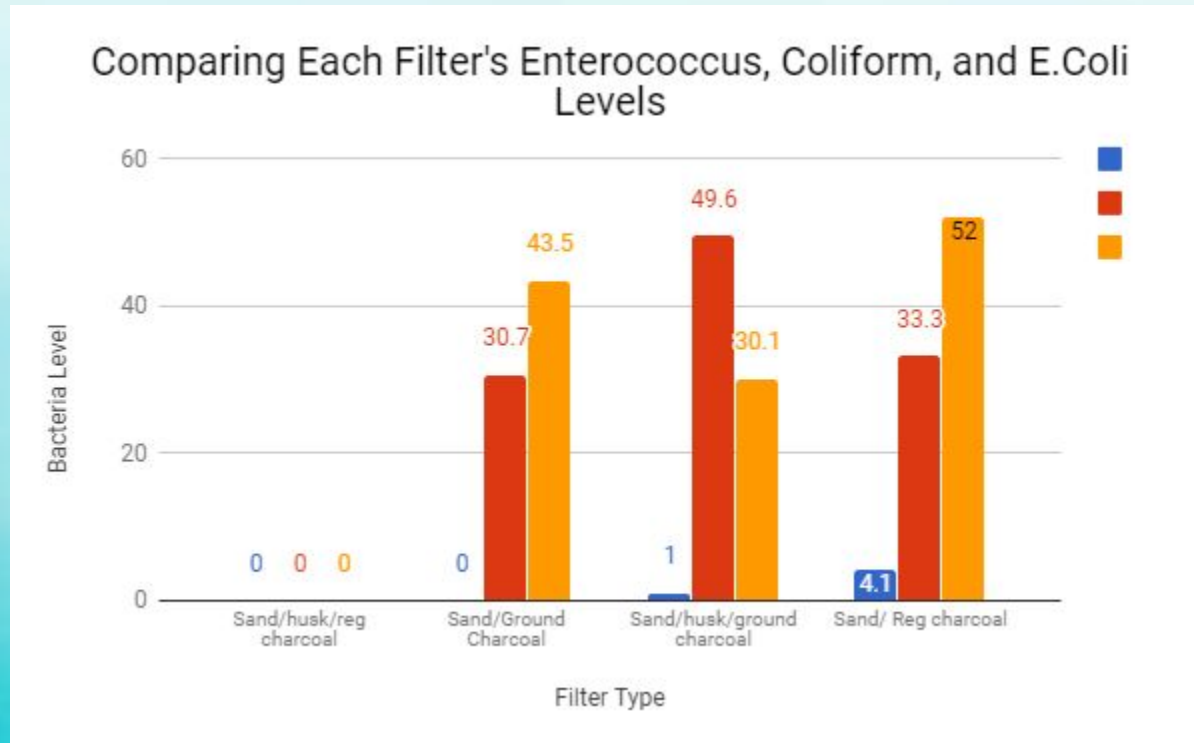


Aguarico Final Prototype Test Results											
Sample Type	Enterococcus	tot. coliforms	E.coli	Dissolved Oxygen mg/l	Conductivity ms/cm	PH Sensor	Temperature °C	EPA Approve?			
Irrigation											
Raw	19	>2419.6	104								
Sand/husk/reg charcoal (Final prototype)	0	0	0	8.42	312	6.84	22.4	Yes	Decreased all bacteria levels to safe drinking conditions		
AAA											
Raw	0	0	0								
Sand/husk/reg charcoal (Final prototype)	0	0	0	N/A	N/A	N/A	21.6	Yes	Maintained safe drinking levels		

The following charts compare the four different filter results in the amount of **Enterococcus**, **coliform**, and **E.coli** levels found present in the water



The following graph represents the effectiveness of the different filters tested for enterococcus, coliform, and e.coli levels. This supports that the sand/husk/regular charcoal filter performs the best in filtering out the contaminants.

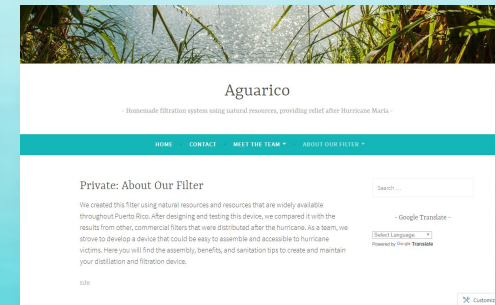
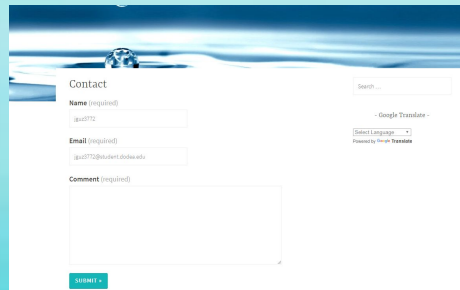
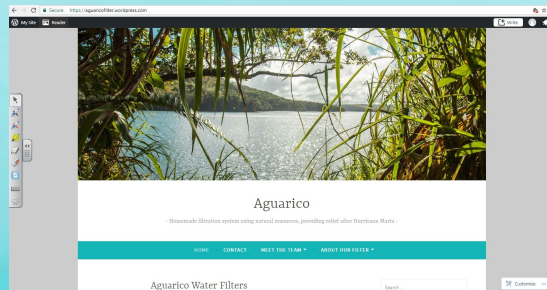


Data Analysis

- According to our results, not only did we manage to improve our prototype with each trial, we were also able to succeed in eliminating all coliforms, enterococcus, and e.coli from both city (AAA) and contaminated irrigation water samples.
- Our data supports that our sand/coconut husk/ regular charcoal, filter works most effectively in purifying contaminated water.
- This means that we reached our goal and supported our hypothesis of developing an effective filtration and decontamination device using local materials that could be used during the aftermath of Hurricane Maria.

Developing our Website

- Our team later transferred all of our information from our test results into a website, through wordpress
- Our hope would be to allow the users to easily access the website, and learn how to assemble our Aguarico filter, using the natural resources required.



Link: <https://aguaricofilter.wordpress.com/filter-design/>

Community Impact



Image Produced by:
<https://www.nbcnews.com>

- Our device could provide a new and reliable source of safe drinking water for all residents across the island.
- By simply empowering people to build their own filters, Aguarico could possibly reduce the number of deaths or illnesses that resulted from the consumption of contaminated water.
- Because resources used to construct our device are widely available throughout Puerto Rico, the production and distribution of it would be more reliable than other commercial filters.

In the future, we would like to modify our filtration device by applying silver infused ceramic within the filter. We would also modify the distilled water section to verify that it is a reliable source to sterilize contaminated water. In addition, our team would like to educate our community to construct our system for their own use, through the use of our website.

Improving the Drinking Water Quality after Hurricane Maria Using Natural Resources



Aguarico

Kailey Aponte, Janeliz Guzman, Bria Roettger
8th Grade, Ramey Unit School
Aguadilla, Puerto Rico, 2018



THE GLOBE PROGRAM

Global Learning and Observations to Benefit the Environment

Abstract

On September 20, 2017, Hurricane Maria, a strong Category 5 storm, devastated Puerto Rico. Millions of people were left without potable water or electricity. As a result, people drank contaminated water that led to health-related diseases.

Our research question was: (1) How can we prevent health-related diseases from water contamination during the aftermath of the storm Maria? (2) If we filter contaminated water using a modified water filter and secondary filtration systems, will the output water quality be safe for consumption? This problem developed into our hypothesis: If we filter contaminated water using a modified water filter and secondary filtration systems, then the output water quality will be potable. Therefore, the objectives were to (1) create a prototype for filter water using natural resources along with filtering waters collected from a water main disaster and (2) produce potable drinking water after a natural disaster.

A prototype was created using natural resources and tested to verify that pathogen in the water were reduced after filtration. In addition, the modified was used against the filter after emergency use during the relief effort. The methods used to filter the prototype and secondary filtration systems included potability, viruses, and bacteria levels. The results were tested and reported on a spreadsheet.

In conclusion, our team, Aguarico, created an effective prototype for distilled and filtered water using natural resources and natural resources. Although only water (H₂O) resulted in zero contaminants, the final results for the filtration were not contaminated. Finally, our last test resulted in zero bacterial pathogens from the filter in tap water. Various tests to ensure water quality were in Puerto Rico to only be natural resources to filter drinking water through our prototype and secondary filtration into Aguarico and Aguarico.

Research Methods

The methods used to test our prototype and compare it with other water filtration systems used in Puerto Rico included potability, viruses, and bacteria levels. The results were tested and reported on a spreadsheet. The methods used to filter the prototype and secondary filtration systems included potability, viruses, and bacteria levels. The results were tested and reported on a spreadsheet.

Data was collected and included in the report of the water filter, potability, viruses, and bacteria levels to present in the water sample collected. The prototype followed the water filter and secondary filtration systems. The prototype followed the water filter and secondary filtration systems. The prototype followed the water filter and secondary filtration systems.

We compared our data collected on September 1, 2017, February 20, 2017, February 27, 2017, and February 28, 2017. Our data showed that the water filter, our filter's performance improved. Secondly, it did not include all of the bacteria necessary to be effective. This data supported our idea to improve the water potability of our filter. We could do this by following other secondary filtration systems, testing our materials, changing our design, or testing it on a different type of water filter. On the last test, completed on February 28, 2017, zero bacteria, zero viruses, and zero bacteria were present for our test results. This was significant because our prototype successfully filtered contaminated water. In the process of drinking. This is a significant achievement of our filter supported our hypothesis.

How did we create the water filter using a modified water filter and secondary filtration systems? How did we create the water filter using a modified water filter and secondary filtration systems?



Study Site

Guajataca Water Shed, Puerto Rico



GLOBE Badges

- Four Star Research Badge
- Collaboration
- Community Impact
- Engineering Solution



Hurricane Maria devastated Puerto Rico and its infrastructure on September 20, 2017.

Results

In order to test our data from our filter, we compared it to a spreadsheet to compare it with other filtration systems. Using this spreadsheet, we placed our data in a spreadsheet to compare it with other filtration systems. Using this spreadsheet, we placed our data in a spreadsheet to compare it with other filtration systems. Using this spreadsheet, we placed our data in a spreadsheet to compare it with other filtration systems.

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Aguarico tested the potability, viruses, and bacteria levels for all our prototype water samples. In addition, we tested the modified water filter, secondary filtration, and the output of our first prototype water sample. We compared our results to the EPA water drinking water standards for all our prototype water samples.

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Discussion

According to our results, we managed to improve our prototype water filter and secondary filtration systems. According to our results, we managed to improve our prototype water filter and secondary filtration systems. According to our results, we managed to improve our prototype water filter and secondary filtration systems.

Comparison with Similar Studies



Comparison with Similar Studies

Comparing Each Prototype Tested



Comparing Each Prototype Tested

Conclusion

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