# The Waterbenders

## Evaluating Bacterial Levels in Filtered Water After Hurricane Maria Devastated Puerto Rico


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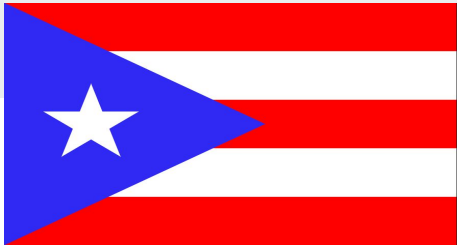
GLOBE Teacher: Richard Roettger

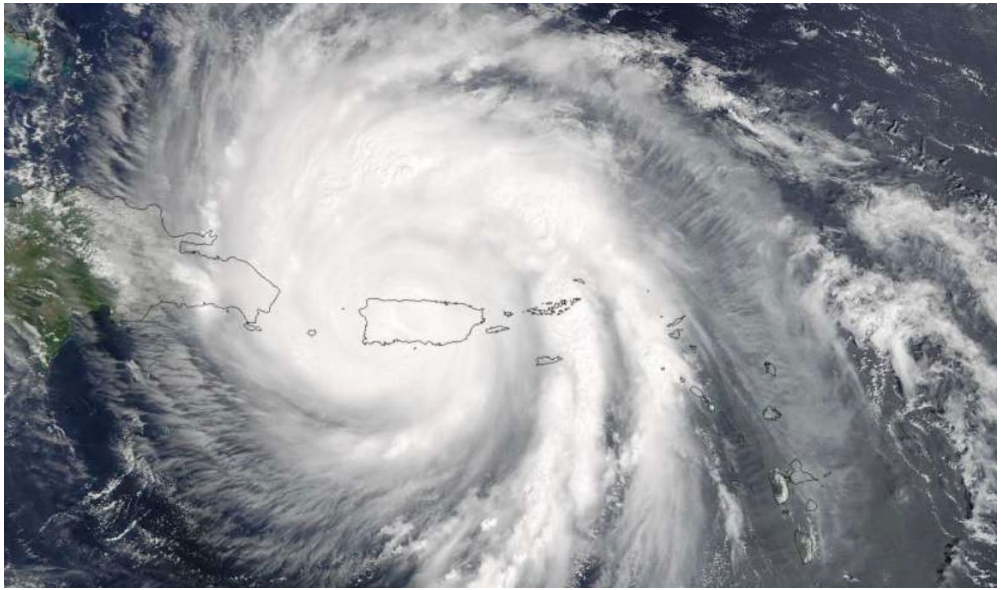
# Puerto Rico



- Puerto Rico is a tropical island located near the equator on both the northern and the southern hemispheres. (18.5N, 67.2W)
- The island is fairly warm year-long with temperatures averaging to about 85 °F.
- Puerto Rico is a commonwealth of the United States
- Part of the Greater Antilles island chain.
- Diverse ecological biomes (rainforests, deserts, coastal plains, and mountains)
- Average rainfall is approximately 61 inches a year


# Puerto Rico Before and During Hurricane Maria

- On September 20, 2017 Hurricane Maria hit Puerto Rico, leaving all systems inoperable. This included an island-wide water and power outage.



# Puerto Rico After Hurricane Maria

- People had to get water from springs, wells, rivers, and rain.
- When tap water did become accessible, civilians were unsure on how safe it was to actually consume this water since there hadn't been any power making it hard for the water to be chlorinated and filtered.

# Research Question

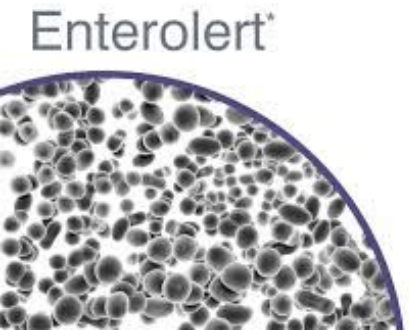
How can we ensure that the water being filtered was safe enough for consumption?

## How?

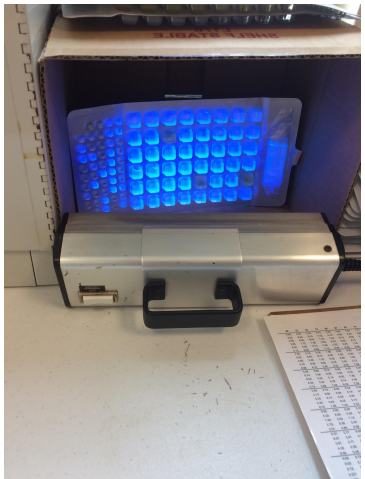
Our team decided to take water samples from our school water sink to represent filtered water as well as the irrigation water in the Guajataca reservoir to represent the unfiltered water after Hurricane Maria. We took these samples and conducted bacterial level testing for enterococci (fecal matter), E.coli, and total coliform.

# Methods

- Partnered with the Rincon Surfrider Foundation to use their protocols and testing methods.
- We filtered irrigation and tap water through the four different filters and compared them to the unfiltered samples.
- Used the reagents to  determine the levels of bacteria within the water using an overnight incubator.
    - Enterolert and  Colilert





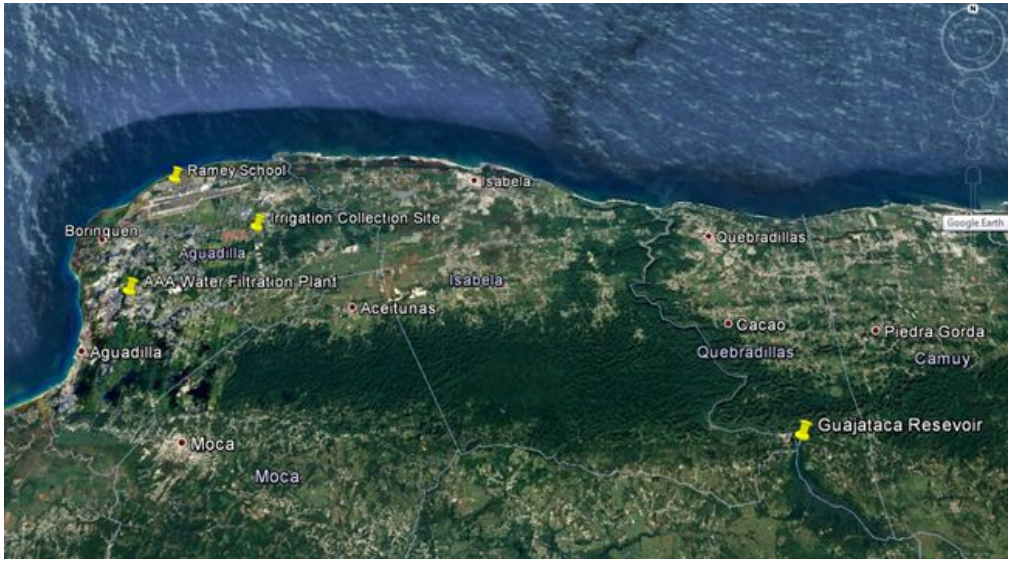


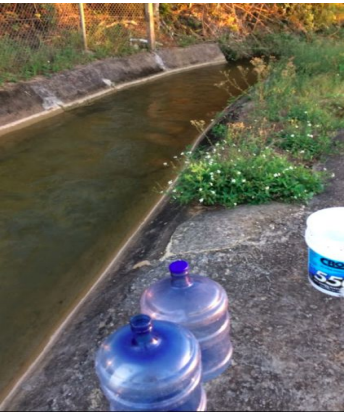
# Problem: Lack of Water or Water Quality Issues?

- Puerto Rico citizens faced problems of lack of *clean* water.
- Potable Water should have 0 coliform bacteria colonies, as well as 0 E. coli traces.

| ORGANISMS | GUIDELINE VALUE |
|---|---|
| All water intended for drinking | Must not be detectable in any 100ml sample |
| Treated water entering distribution system (E.coli ,total coliform count) | Must not be detectable in any 100ml sample |
| Treated water entering distribution system (E.coli ,total coliform count) | Must not be detectable in any 100ml sample<br>In c/o large supplies, must not be present in 95% of samples taken throughout any 12month period |

# Guajataca Reservoir

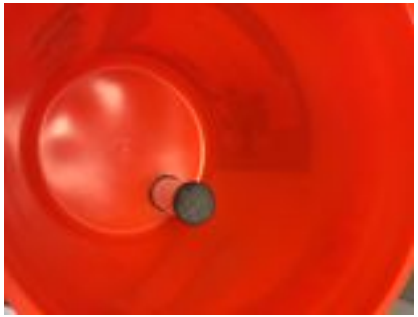


# Donated Water Filters

Aqua Cera: Dome

Aqua Cera: Long



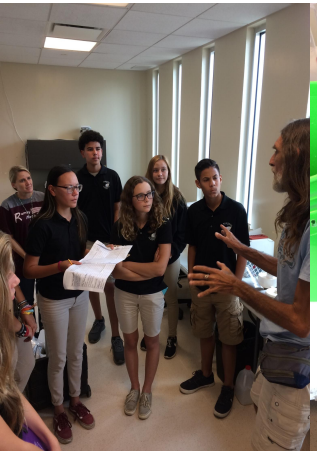
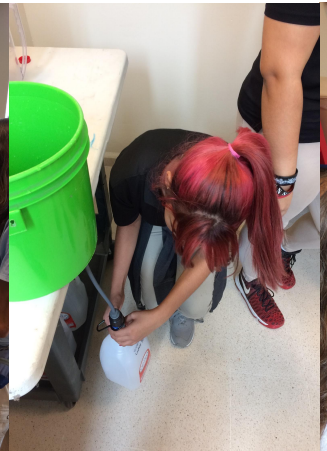
Aqua Cera: Cylinder

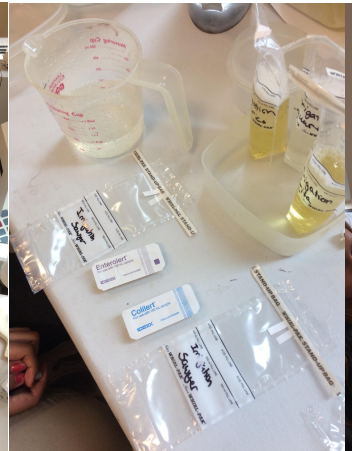
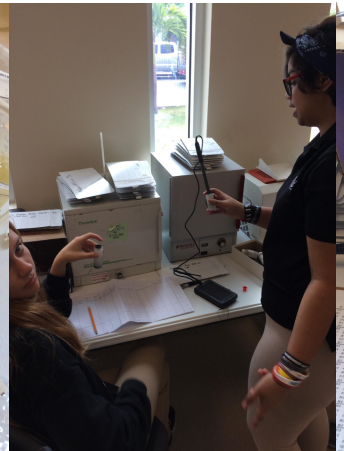
Sawyer

# Rincon Surfrider Foundation

The Rincon Surfrider Foundation is a non-profit community based volunteer group whose mission is to manage and protect coastal regions of the island. After the hurricane, however, they began testing fresh water as an alternative to salt water that they commonly used.

SURFRIDER FOUNDATION
RINCÓN CHAPTER

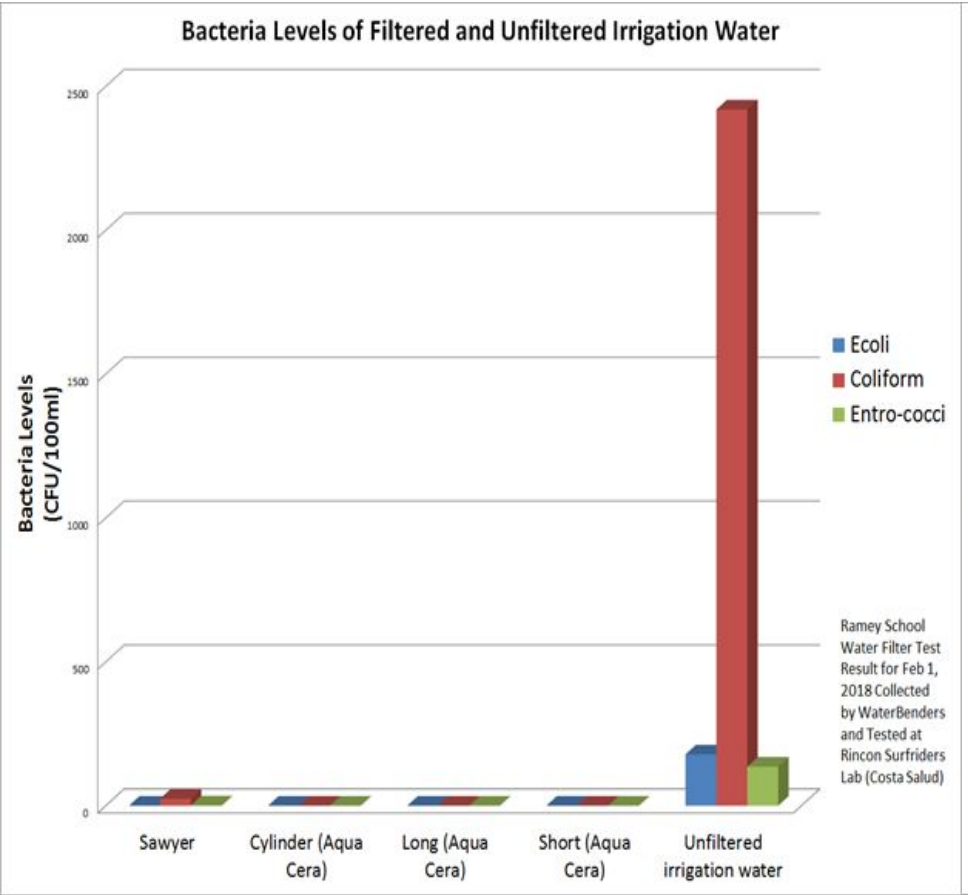



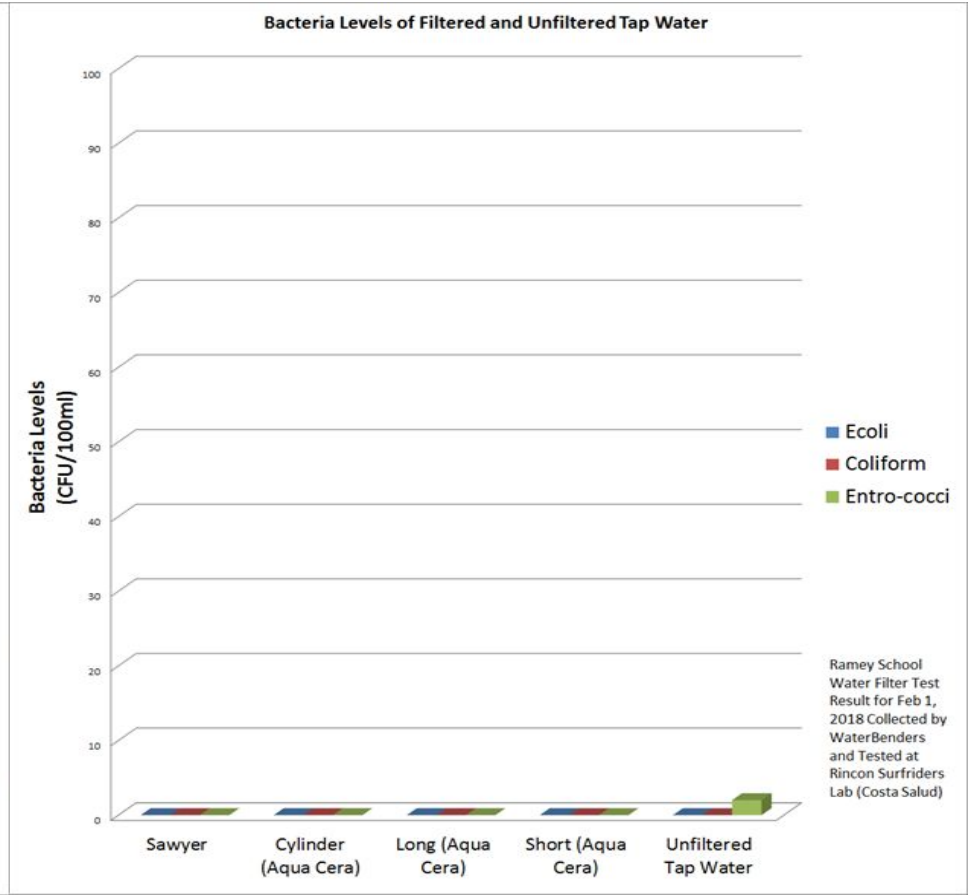




# GLOBE Water Quality Comparison

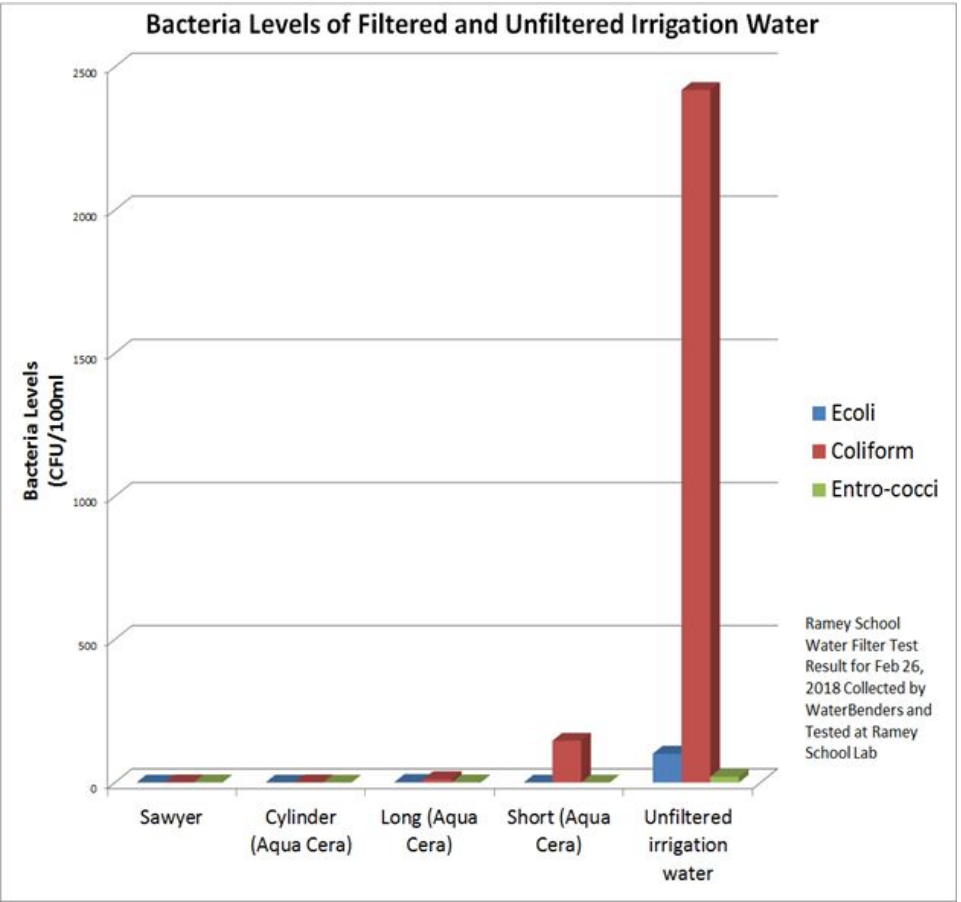
| | Dissolved Oxygen Probe (mg/L) | Conductivity Probe (mS/cm) | ORP Sensor (mV) Not Calibrated | pH Sensor | Temperature (C°) |
|---|---|---|---|---|---|
| Filter Type Irrigation | | | | | |
| Sawyer | 7.8 | 858 | 236.8 | 7.12 | 22.3 |
| Cylinder (Aqua Cera) | 6.2 | 1934 | 203.2 | 7.05 | 21.8 |
| Long (Aqua Cera) | 7.5 | 1934 | 222.1 | 6.63 | 21.4 |
| Short (Aqua Cera) | 5.6 | 1410 | 222.2 | 7.28 | 21.8 |

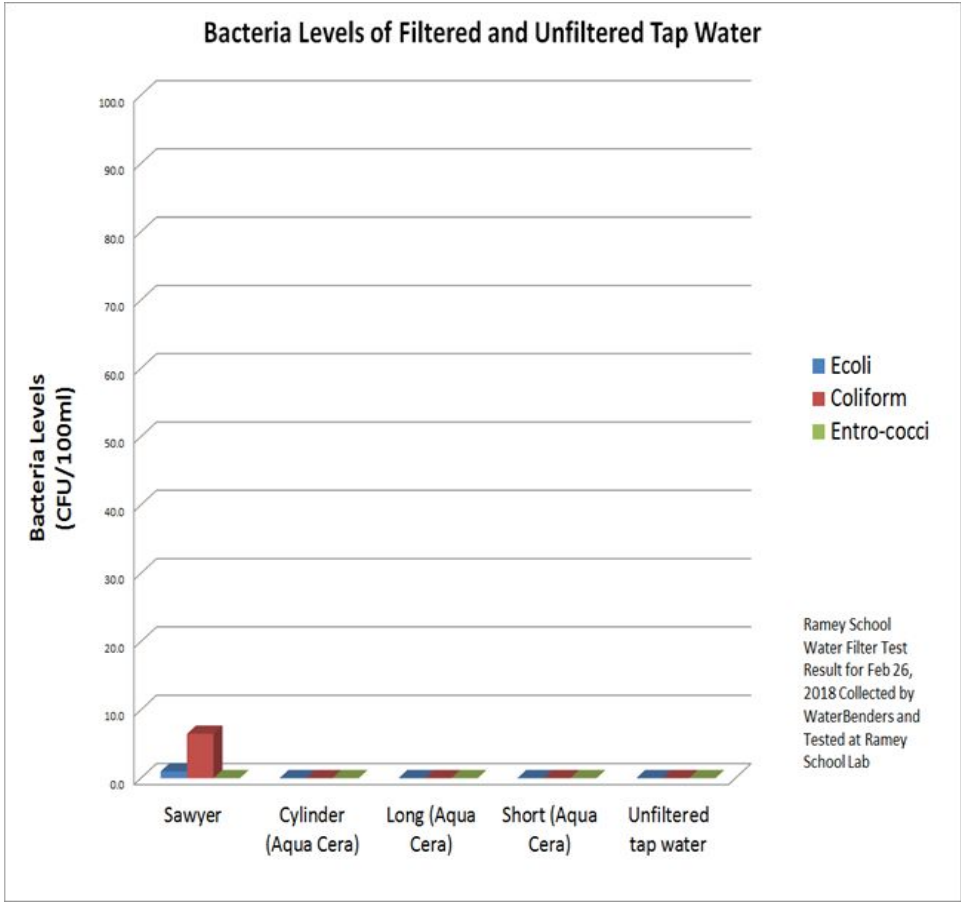
# Results from February 1, 2018



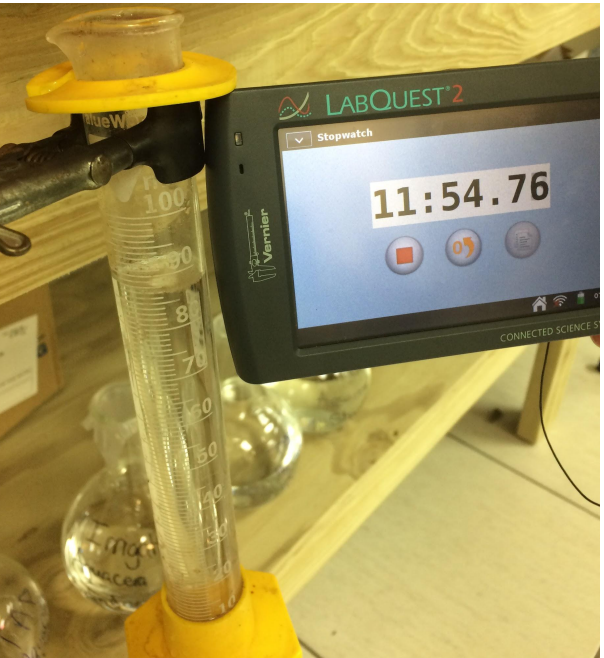
# Results from February 26, 2018

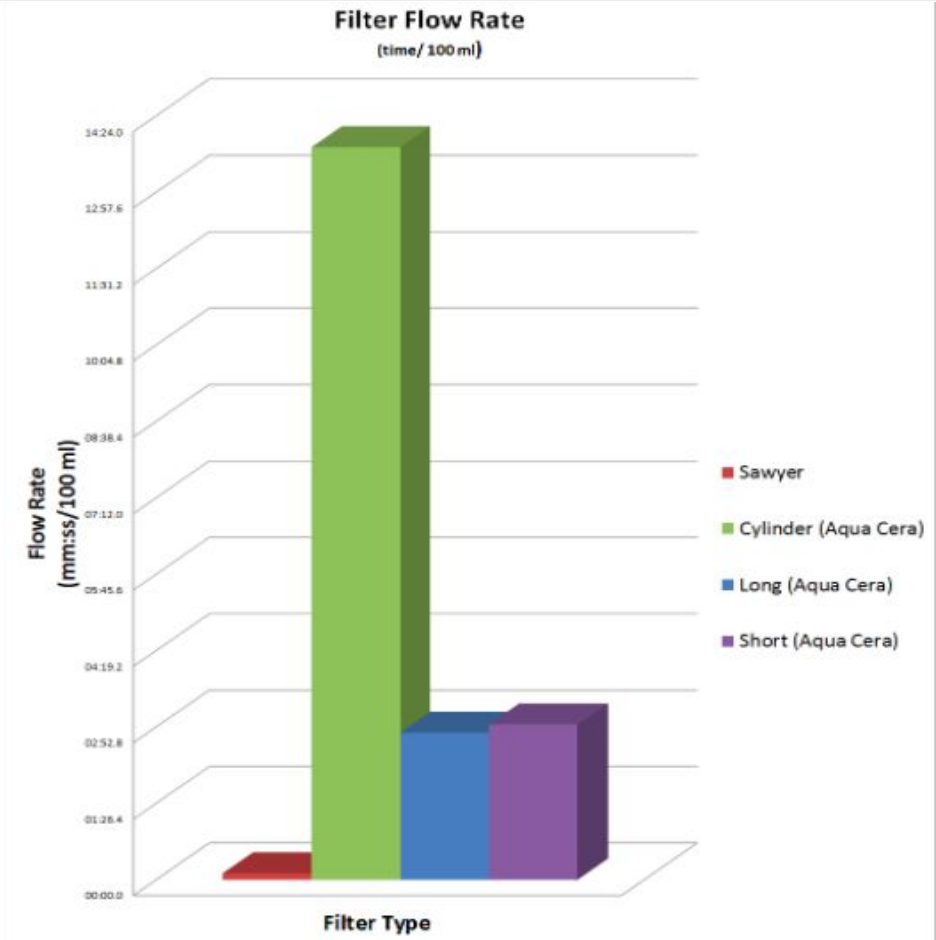


# Filter Flow Rates

The flow rate of the filters were measured by timing the 100 mL of water passing through each filter.



# Conclusion

- The filters showed that they can filter out most to all of the bacteria within the water.
- The most effective filters were the Sawyer and Aqua Cera Long due to their rapid flow rate and their ability to eliminate moderately all of the bacteria
    - Possible reasons for minor spikes in the graphs would be possible contact contamination
- In the future our team hopes to expand our research so that individuals in Puerto Rico can be prepared for the upcoming hurricane season

# Continuing Collaboration with Nigerian Schools and Water Filter Organizations

**Dr. Akin Akinwumija** (ojhakin@yahoo.com): The Federal University of Technology Akure

**Femi Olawale** (walefemi007@yahoo.com): Nigerian Space Agency and Baptist Secondary School

**Water Filters for Puerto Rico** (Sheila Sierts and Michael Sierts)

https://waterfiltersforpr.com/

https://www.facebook.com/waterfiltersforpr

http://christophersoak.org/

# Resources

Fundación Surfrider Rincón
https://rincon.surfrider.org/

Water Filters for Puerto Rico
https://waterfiltersforpr.com/

Waves4water
http://www.wavesforwater.org

Costa Salud Community Health Centers
http://www.costasalud.com/

The Entrolert and Coliert product service sites:
https://www.idexx.com/en/water/water-products-services/enterolert/
https://www.idexx.com/en/water/water-products-services/colilert/

EPA **National Primary Drinking Water Regulations**
https://www.epa.gov/ground-water-and-drinking-water/national-primary-drinking-water-regulations

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**Ramey Unit School, Puerto Rico**
**Elisa Torres, Giovanishka Gonzalez, Kaymarie Jimenez**
**GLOBE Teacher Richard Roettger**

### Introduction:

Hurricane Maria left all systems on Puerto Rico inoperable. This led our team to assume that the water running through the taps was unchlorinated with high bacterial levels. After Hurricane Maria it took several months before our tap water was properly treated. Safe drinking water was essential and the filters were highly valuable for people on the island. Drinking contaminated water leads to a range of health issues, putting additional pressure on the already strained hospital services.

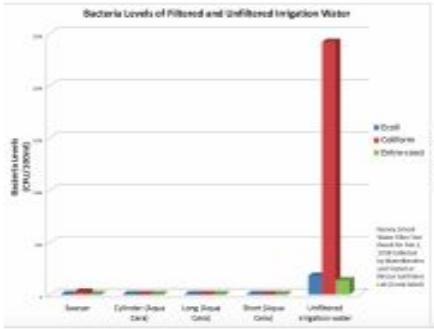
### Research question:

***How can we verify that the water being filtered was safe enough for consumption?***

### Methods:

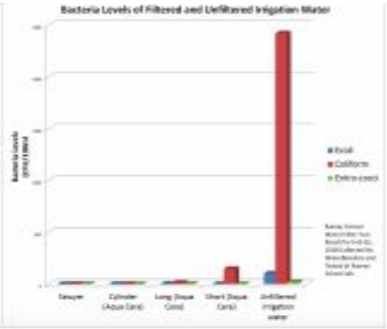
Four different filters were tested using irrigation water and tap water on February 1 and 26, 2018.
We collected 100ml samples from the four different filters and unfiltered irrigation water and tap water were run through the Colibert and Enterolert bacterial tests .
The water samples incubated overnight (24hr period) for analysis the following day.
To test for enterococci, the samples were placed under a black light and if illuminated, then the sample would be positive for the enterococcus bacteria.
To test for E.coli and total coliform, the sample would turn yellow if it was positive for coliforms and if it would iridesce, then it would be positive for E.coli.

### Results February 1, 2018



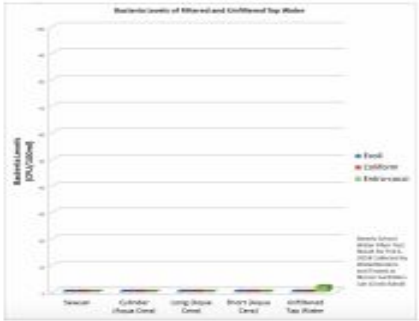

The unfiltered irrigation water had high levels of total coliform (>2419.4 CFU/100 ml), E. coli (178.2 CFU/100 ml), and enterococci (135.4 FU/100 ml).

### Results February 26, 2018



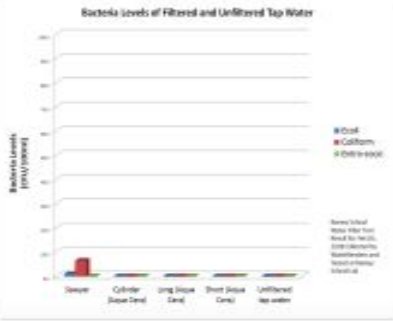

The unfiltered irrigation water had high levels of total coliform (>2419.4 CFU/100 ml), E. coli (101 CFU/100 ml), and enterococci (20.1 CFU/100 ml).

### Results February 1, 2018

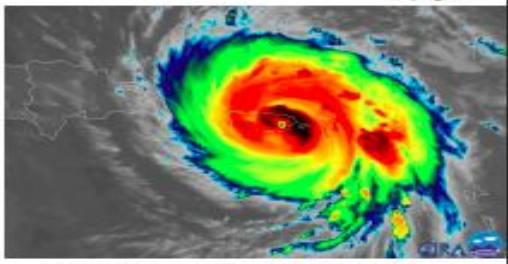



The tap water results show no bacteria except for the unfiltered sample, enterococci (2 CFU/100 ml) which is most likely due to contact contamination.

### Results February 26, 2018




The tap water results show no bacteria except for the Sawyer filter sample, total coliform(6.5 CFU/100 ml), E. coli (1 CFU/100 ml) which is most likely due to contact contamination.



100% of power supply was cut off and access to clean water and food became limited for most.

### Conclusion

The importance of access to safe drinking water became critical in the months after Hurricane Maria hit Puerto Rico.
Our research found that water filters can drastically reduce the bacterial levels found in untreated water. All four of the filters produced similar results of zero or small of bacterial presence compared to the unfiltered water.
The small presence of bacteria in the filtered water was possibly due to contact contamination which is a factor we will need to address in future testing.
As we prepare to enter hurricane season again, these findings will help the people of Puerto Rico, and around the world, to access safe drinking water.

### Acknowledgements

Mr. Steve Tanner, Rincon Surfrider Foundation https://rincon.surfrider.org/
Water filters donated by:
- Water Filters for Puerto Rico https://waterfiltersforpr.com/
- Waves4Water http://www.wavesforwater.org