Think Before You Drink

New Mexico

Supercomputing Challenge

Final Report

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Executive Summary

The need for clean and accessible drinking water around the world is great and continuously growing. The scarcity and economic implications of accessing clean water is a global issue. There are many water filtrations systems being used and developed to solve this problem. Through the use of modeling our team is hoping to continue to develop a data collection system that would allow the world to find an easy and effective filtration system suitable for many different situations.

The development of such a model has proved to be a large undertaking. As beginners to modeling and programming, our team is taking their time to carefully learn how to write programming language in Netlogo. Agent-based modeling seemed to be the best fit for developing such a model. We have learned many things and hope to continue to learn and advance the development of a sustainable drinking water system.

Problem Definition:

Approximately 844 million people around the world lack access to clean drinking water, this is more than 1 of every 10 people on the planet. (worldvision.org) Water is essential for survival. Water that is safe and available is important for public health, whether it is used for drinking, domestic use, food production, or recreational purposes. According to the World Health Organization, “Improved water supply and sanitation, and better management of water resources, can boost a countries’ economic growth and can contribute greatly to poverty reduction.” (who.int) Water.org claims, “Nearly 1 million people die each year from water, sanitation, and hygiene-related diseases which could

be reduced with access to safe water or sanitation. Every 2 minutes a child dies from a water-related disease." (water.org)

Problem Solution:

Access to safe and clean water can be as simple as providing a low-cost and efficient filtration system. Filtration systems should be able to filter harmful bacteria, viruses, and other materials from water sources. Many efforts are currently being done to combat this issue. Planet Water Foundation has created "Aqua Towers" that serve schools, children, and rural communities around the world with clean water and health education services. (classy.org) Other simpler solutions that have been created include the Lifestraw. Lifestraw helps make contaminated water safe to drink and is a method of bringing potable water to undeveloped nations. Introduced in 1994, this unique technology uses a cloth filter to block contaminating diseases, making water secure to drink.

Other current methods for providing clean drinking water include; rainwater harvesting, recycling of greywater, SODIS method, harvesting of dew and fog, drawing water from the air, and desalination. UNESCO predicts a worldwide water shortage; but for developing countries, this shortage came as early as 2016. A unique way to teach nations water salvage and management is through rainwater harvesting. Rainwater harvesting means capturing, diverting, and storing non-potable water for later use. In Cameroon, harvesting rainwater saves dozens of lives daily, suppressing cases of cholera caused by unsafe floodwaters. Gathering rainwater works in a four-part process — either active or passive. Active harvesting addresses the needs of human life,

wildlife, and irrigation. Passive is more for green life — landscape and gardening. The passive process follows the same process with the exception of treatment and usage and addresses the survival of plant and soil life. The Active Process, on the other hand, involves the following steps:

- **Collection** – Catch rainwater on a surface like a roof and then direct it into a storage container.
- **Storage** – Depending on the size of the populace (city/town), this step involves clean barrels, tanks and/or reservoirs to catch as many gallons of water as possible.
- **Treatment** – The screening of water for debris and bugs via the use of fine mesh or cloth to help sift waste and rubbish from the water. Boiling the water for a few minutes prior to use kills disease and parasites in the water.
- **Usage** – Uses smaller cisterns for distribution, and it's imperative to use only what one needs.

Safe drinking water isn't the only concern. There is a scarcity of water for bathing and sanitation. Recycling greywater is another way to provide water for developing countries. Recycling water helps with water conservation and management. Greywater is leftovers from gently used water from baths, laundry, and cooking, and if kept free from feces, filtered greywater is safe for reuse.

Another cost-effective method was discovered in the 1980s by Lebanese scientists, the SODIS method. The SODIS method is an inexpensive way to bring clean water to poor countries. SODIS, also called Solar Water Disinfection, works by sitting a PET bottle filled with clear water in the sunlight for hours. The process reduces viruses, bacteria, and diarrheal diseases in the water.

Dew and fog are other alternative sources of freshwater, and harvesting both requires little to no expense. The process is simple: hang harvesting nets vertically to catch fog droplets and make them flow down into a reservoir. The mesh catches debris, keeping the water clean for multiple uses. This process, however, is limited to areas where dew and fog are common. Another similar method allows developing governments to supply water to their nations by harvesting water from humid air. Atmospheric Water Generators, created by Watergen, generate water from thin air. This method involves dehumidifying clean air through a heat exchange system. The heat cools the air and concentrates water vapor, which then gets stored in an internal tank until it's ready for use. Atmospheric Water Generators (AWGs) are energy efficient and generally low-cost.

Salt makes up 97 percent of the Earth's water; unfortunately, someone from a developing nation can't walk down to the seashore and quench their thirst. Desalination offers hope by turning saltwater into freshwater. This technology doesn't shy away from

cost, but with help from organizations like Ride4Water, poor countries can produce more freshwater for consumption and sanitation from their saltwater counterpart.

There are numerous ways to provide water for developing countries. These options speak directly to governments seeking solutions to providing water to their nations while enlisting the help of other organizations. Many countries are faced with differing needs and economic capabilities. The developed methods may not be suitable for every situation.

One way that we plan to help others visualize the benefits of clean water is to model the problem and propose some possible solutions with a computer simulation. Our plan to create a water filter simulation was to use NetLogo. Here is a list of our goals with that simulation:

> We plan to use agents to represent the water, the water contaminants, as well as various filtering materials. When the Setup button is pressed, contaminated water agents represented by blue and brown Turtles will be introduced at the top of the NetLogo Interface. Several layers of filters will also appear horizontally below the contaminated water. These will be composed of agents that represent the texture and color of each filter. When the Go button is pressed, the water agents will randomly “fall” to the reservoir at the bottom of the screen. As the agents come in contact with various filters, some of the contamination will be removed,

represented by some brown agents being replaced with blue agents. Once all the water reaches the reservoir at the bottom, the water should be less contaminated. Sliders and switches will be used on the Interface to allow the filters to be adjusted by the user in order to determine what filters work best.

Expected Results:

We expect to explore the global issue of safe drinking water and provide some very basic solution ideas. The NetLogo model can help students visualize how water filtration systems work and how they could be used to improve our drinking water. Students will explore the effects of various filters and hopefully conclude that the solution to creating an effective filtration system is not just using one type of filter or method, but rather a combination of filtration methods. In the end, we hope this project will make students more aware of the importance of safe drinking water and realize the global impact of this issue.

Current Status

Our team wanted to truly learn how to produce this type of model using Netlogo. As beginners to the programming and modeling world, we wanted to understand the language that we were utilizing and how that works to develop and run a model. We have learned the basics of language writing. We have analyzed how models in the Netlogo models library work. We have not reached our goal of developing a working model that can produce true data for developing a water filtration system. However, this is not a project that we are ready to abandon and the need for this project is great. Our team plans to continue to develop and work on this project and to develop a working

model that produces data. We plan to expand this model to include an economic impact study so that we can find the most cost-effective measures. We look forward to continuing our research and work on this project.

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