

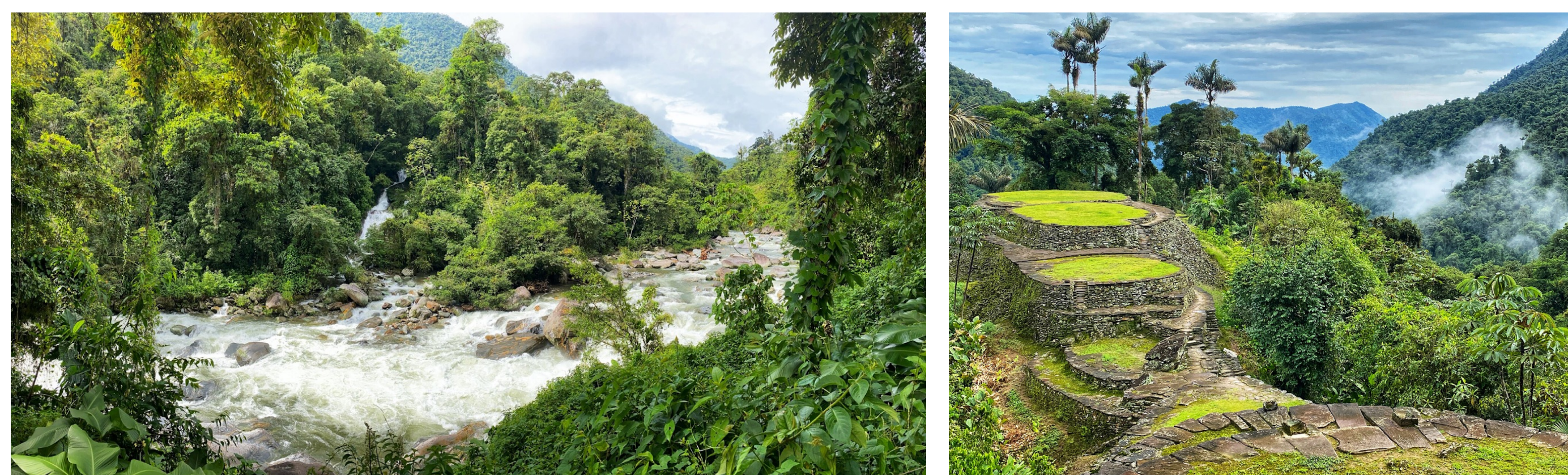
Engineering a Hydropower Water Purification System for Rural Riparian Communities



Introduction and Background

Protecting biodiversity is crucial for mitigating climate risks. With the increase production of single-use plastic, plastic pollution has become one of the most pressing environmental issues. Globally, 400 million tons of plastic waste are produced annually. Biodiversity is especially threatened by microplastic in the soil.

Client Background: The Lost City



- Located in the **Sierra Nevada de Santa Marta (SNSM)** in Colombia, on land of Kogui and Wiwa
- 25,000 visitors annually, **4-5 day guided hike**
- Currently, tourists **rely on plastic water bottles**
- Authority to ban plastic water bottles, but in need of an alternative solution
- SNSM's rich biodiversity and diverse ecosystems are crucial for Colombia's climate resistance and sustainable development but currently threatened by plastic pollution

Design Approach

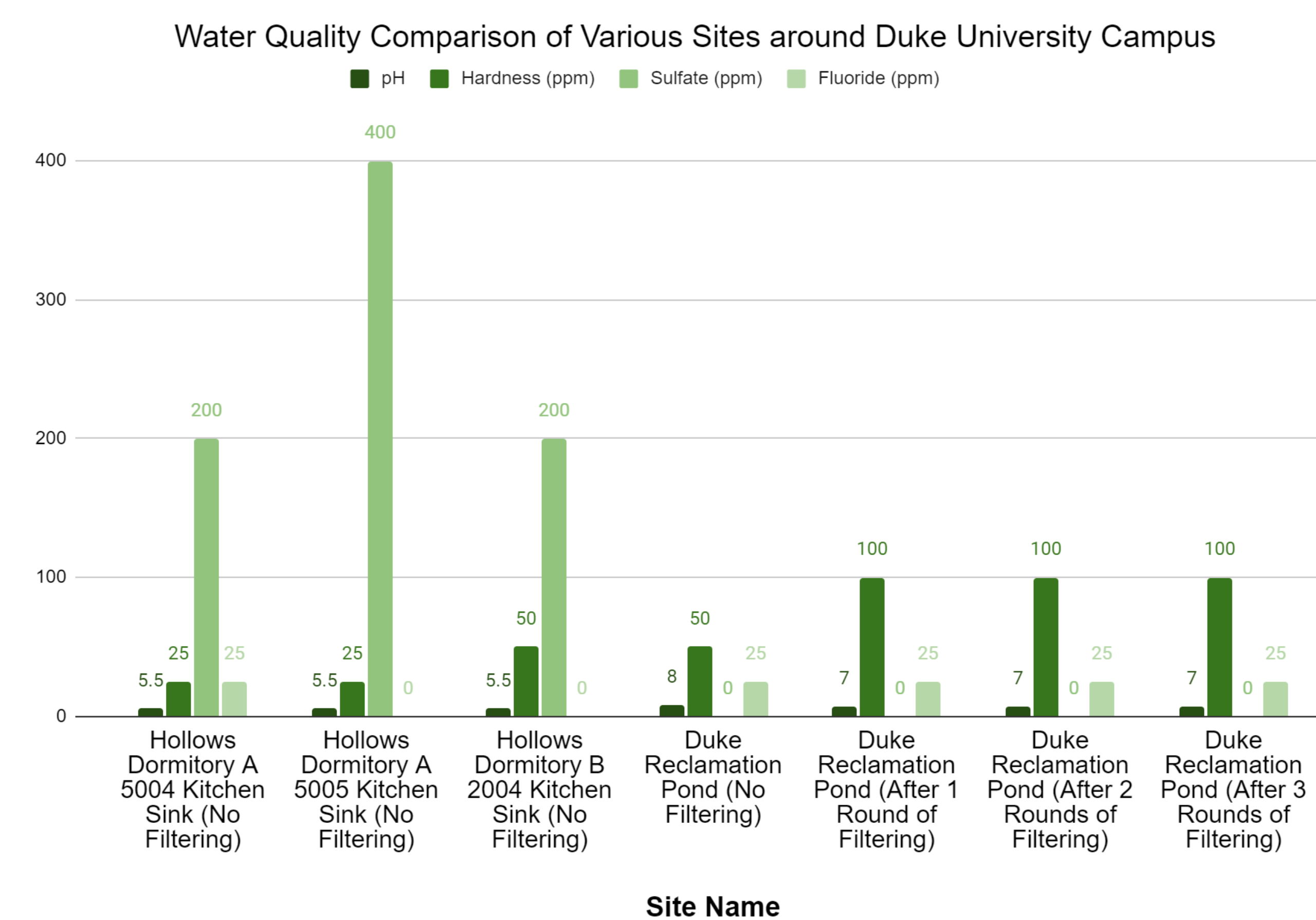
- Focused on creating method of **mechanical integration** for existing turbine designs and water purification systems.
- Selected to use **Pelton wheel turbine** design and **MSR Miniworks EX Purifier System** for water purification.
- Designed gear system to increase the torque produced by turbine three times.
- Designed **slider-crank mechanism** to convert rotational motion from the gears to linear motion to pump the crank.
- Used bearings, housings, collars, and rod ends to reduce friction and integrate various components.

Final Prototype Design & Results



- Our prototype can purify 580 ml of water per minute, or over **300,000 liters per year**, the equivalent of over **600,000 standard sized water bottles**.
- The **optimal performance** of the system occurs at a turbine rotation speed of 2 revolutions per second, which correlates to **2 meters of head**.
- The prototype costed approximately **\$745**.

Water Testing Results



The EPA recommends a pH between 6.5 and 8.5, sulfate below 250 ppm, and fluoride below 2 ppm. Filtering did not significantly affect indicators, but significant particulate matter (ex. dirt, debris) was removed via filtering.

Social & Environmental Benefit Analysis

- Prototype can eliminate the estimated 450,000 plastic water bottles used in the park annually
- Potential source of income for locals from sale of reusable water bottles or purified water fee
- Regional deforestation, tourism, illegal mining, and climate change lead to pollution, habitat loss, and ecological disruption.
- Plastic waste is pervasive – microplastics and associated toxins contaminate freshwater habitats.
- Our modular water purification device helps tackle plastic pollution in the region by providing a renewable, decentralized clean water source
- The prototype eliminates the need for thousands of single-use plastic bottles annually, which aligns with Colombia's sustainable infrastructure goals.

Conclusion

Our prototype could reduce **all of the plastic water bottle waste** currently in the park **without carbon emissions**, and scaling the size or number of systems could further reduce its impact.

Our module filters out particulate matter and bacteria, but not viruses and sulfates—however, this is a relatively rudimentary filter, so more advanced filter devices attached to our module could enhance its effectiveness.

Recommendations

- Scale the system to meet park visitor needs
- Host workshops to train the client on proper use and maintenance of the system
- Test prototype on cascades of Buritaca River to quantify efficiency of the system as a whole.
- Integrate prototype with more advanced filter
- Market prototype to similar national/state parks with annual visitors in the 10,000s