Belize Aquaponics Service Project

James J. Holt

Capstone for Minor in Sustainability

University of Arkansas College of Engineering

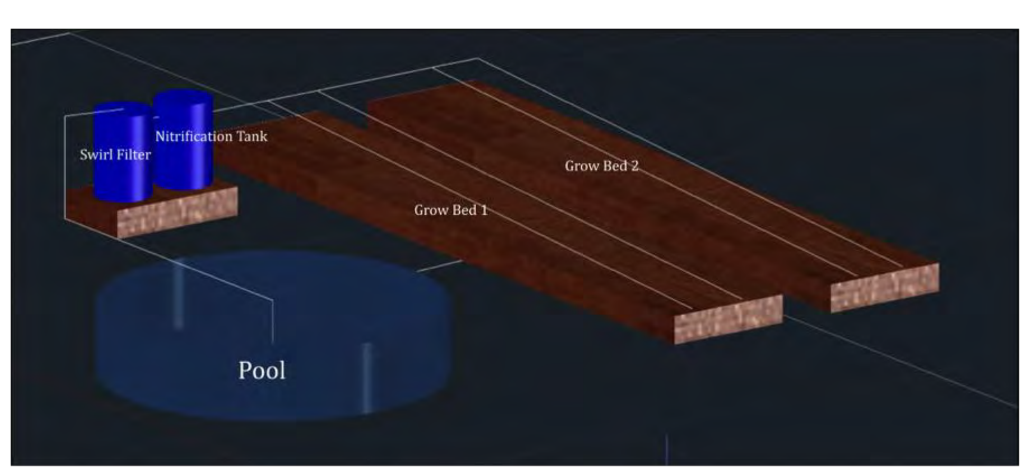
ABSTRACT

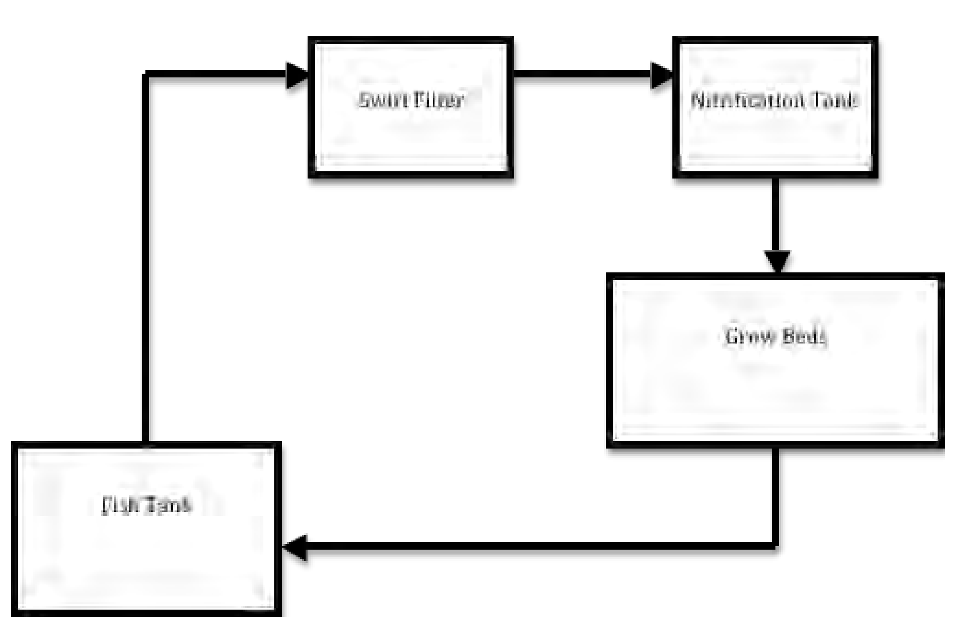
In the University of Arkansas (UA) Community Development in Dangriga, Belize program, teams of students work with community members on projects to address a specific need. For three weeks, the engineering team designed and planned a sustainable aquaponics system with faculty at the Ecumenical High School. Aquaponics utilizes ammonia naturally produced by fish by filtering and converting it into a fertilizer for plants. If designed correctly, a sustainable system could be used as part of the agriculture curriculum while generating some level of food and income for the school. The project would address the system of built sustainability by utilizing recycled and repurposed, low cost material for the design. The project would also address natural sustainability, by utilizing the process where bacteria naturally convert toxic waste material produced by fish to serve as an energy source for plants.

OBJECTIVES

The objectives of this project where to:

- Collaborate with Ecumenical High School students and faculty to design an aquaponics system that
  - meets built and natural system sustainability criteria, and
  - could be used as a teaching tool both at the high school and for community members interested in constructing their own systems.
- Demonstrate the ability to recycle waste as a fertilizer, allowing for a low impact solution to food needs
- Create a design plan that was culturally appropriate and create an environment of sustainable practices that would continue to develop in future projects

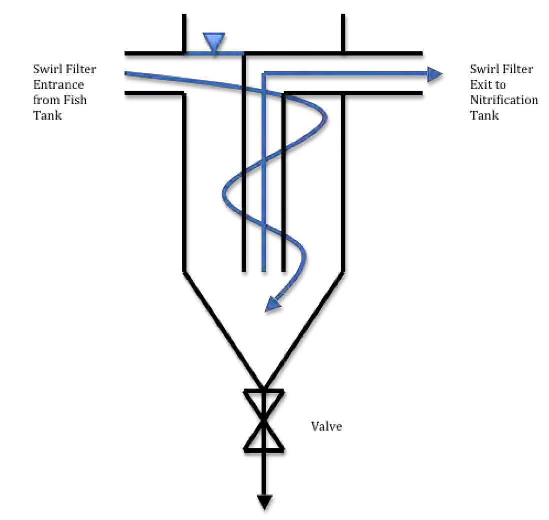




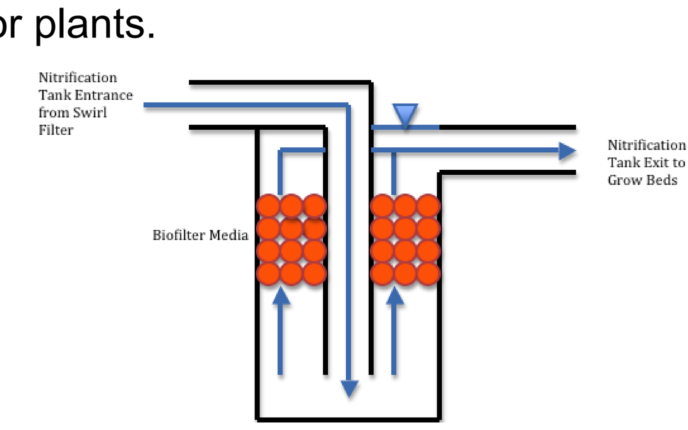
SYSTEM DESIGN

The system would operate through several stages necessary to circulate all materials in equilibrium, filtering and transforming nutrients at each stage.

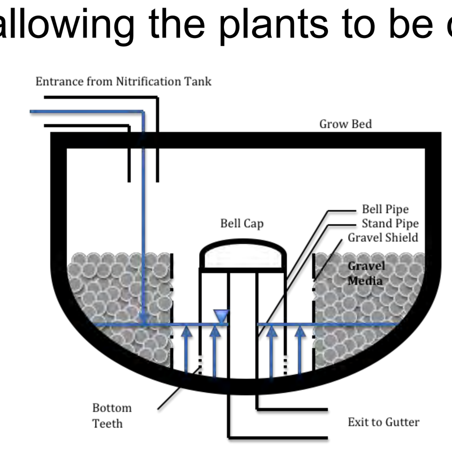
The water from the pool first enters a swirl filter via a water pump from the fish tank. This stage allows for larger pollutant particles to undergo a filtering process utilizing the differing densities of particles in a centrifuge to separate material. Heavier, pollutant particles will contact the concrete wall of the swirl filter and collect at the bottom. This material may be collected and used as organic fertilizer.



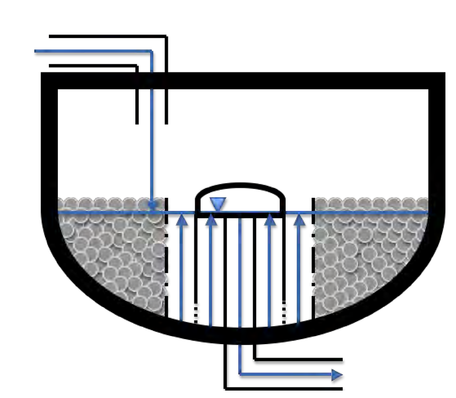
The water is then sent to an nitrification tank by gravity. This environment consists of bacteria called nitrosomas, which convert the ammonia rich water into nitrite, and nitrobacters, which convert the nitrite into nitrate. Nitrate is a natural fertilizer for plants.



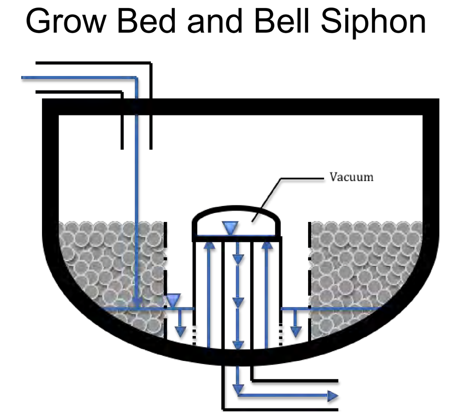
The nutrient rich water is sent to one of twenty grow beds via gravity. Nitrate will be taken up with the water by the plant roots. Inside each grow bed is a bell siphon.This allows for the grow bed to quickly fill with water and then be drained, allowing the plants to be oxygenated.



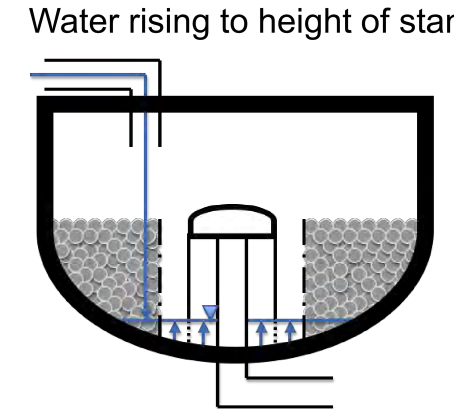
Grow Bed and Bell Siphon



Water rising to height of stand pipe



Siphon created and water is forced from the grow bed to drain out to fish tank

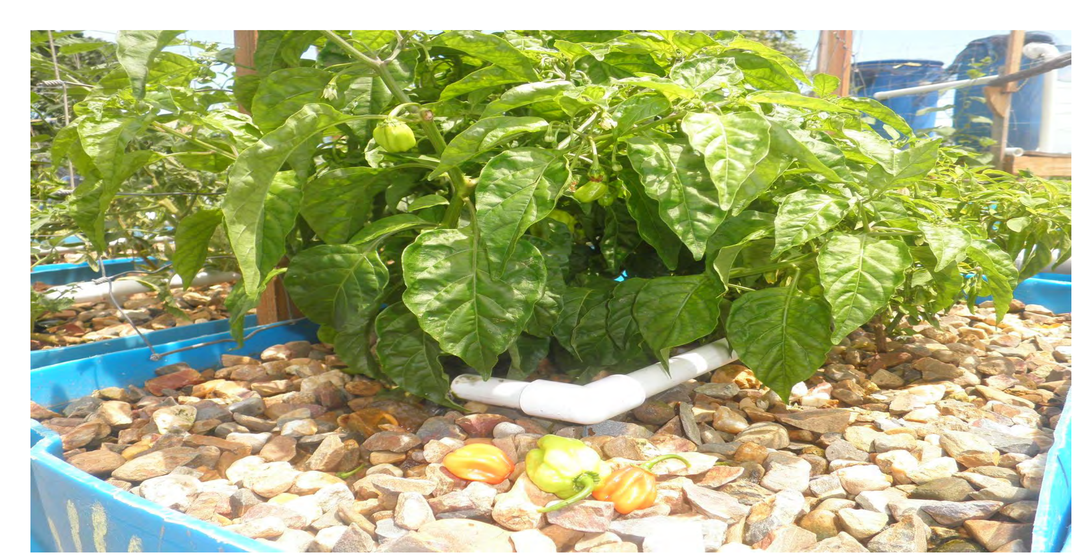


Water reaches bottom level and begins to fill up with water, repeating the process

RESULTS

The system was completed on the high school grounds.

Ecumenical High School faculty member Derek Jones and his students were left in charge of the system. The system is now producing crops. The fish are thriving and continue to grow and increase in population. Steps are underway to integrate the program into the school's agricultural curriculum.The University of Arkansas will continue to visit Dangriga for the study abroad program and update the system



SUSTAINABILITY

Built- The team set out to work with materials and tools that were available to the Belizeans. No items were chosen if not available to Belizeans, and materials were donated and recycled when possible. This lends the ability for this project to be potentially replicated by citizens as well as reducing the need for material production or materials to be shipped in. The system would serve as a model to build one's own system using what materials are available with varying budgets and ingenuity. Belize is a developing country with many struggling citizens, the incentive to repurpose used material is heightened greatly based on its cost effectiveness.

Natural- Aquaponics is a model of the natural process involved in the recycling of energy in any environment. This process has been utilized here to create a more efficient and self sustaining system where food can be created. Water reuse allows for energy and water wastes to be diminished. The aquaponics system operates using only 1-3% of water normally used in farming. Water purification can occur naturally without the addition of harmful chemicals. The aquaponics system also operates using gravel media to produce food. This means the problem of soil runoff and its effect on water quality is minimized since all pollutants and nutrients are maintained in a closed system and gravel media is in use. There are also no weeds, burrowing pests, or other common issues involved with soil farming.

FUTURE OF THE PROJECT

All unused material will be used in additional aquaponics projects as plans are underway to build more systems at the school on different scales.

The system will take close monitoring to ensure its success. Ecumenical High School has begun teaching students about operating the system and the science involved as the system operates.

ACKNOWLEDGEMENTS

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