Aquatopolis: The Future of Urban Agriculture

Aquatopolis, a thriving 150 year-old urban metropolis with over 900,000 residents of mixed ages and ethnicities, occupies 233 km$^2$ on the Guadalupe River in Central Texas (29.5744°N, 97.9653°W). The city harbors a large urban population, with an influx of younger families. Temperatures generally vary from 7°C to 25°C with an average annual rainfall of 75cm.

Due to urban growth, the amount of land available to raise cattle and grow crops became a problem. Engineers needed to find new ways to obtain sustainable food sources in small spaces. The first idea was aquaponics, a food growing method in which fish are grown in tanks, and the fish excrete nutrients into the water. This water is then used to grow plants hydroponically. This idea would work well due to the city’s close proximity to the Guadalupe River, a natural resource that can provide the needed water.

This food production process was efficient, but required great amounts of land for fish tanks and plant beds. The next idea was a configuration that involved placing the plant beds over the fish tanks so that plant roots can directly absorb the nutrients from the water. This system saved space, but made it more difficult to harvest the fish, and restricted the plant bed size to the surface area of the tank.

The final solution was a brand-new aquaponics design with alternately-spaced fish tanks located above the plants. The water is pumped into each fish tank at a constant flow. A computer-controlled valve at the bottom of the tank regulates the flow of water to the plant beds, ensuring the fish tanks are always full. Thus was born the Aquaponic Fountain: An innovative system that allows for a flexible ratio of fish and plant production in a small footprint.

An Aquaponic Fountain consists of a 30 meter high, 6 meter wide tower with fish tanks attached to it above the ground. There are two levels of
fish tanks, each level containing three 600,000 liter tanks. The tanks are composed of carbon-nanotubes, a strong and light-weight material that can easily hold the weight of the water. Underneath the fish tanks are hydroponically grown plant beds divided into sectors so that each sector is watered by one fish tank. The fish and plants are harvested using a robotic system. Covering the Aquaponic Fountain is an umbrella-like structure covered with transparent, photovoltaic cells, that will keep out precipitation and generate electricity to power the Aquaponic Fountains and nearby buildings, making them an energy efficient system.

The city engineers had to take into account many key elements such as available light, air quality, and the need for water when designing this system. Aquatopolis has a sunny climate which helps the growth of plants and the production of energy through solar panels. The air quality is not negatively affected as aquaponics do not produce greenhouse gases. Aquaponics do not require soil and are unaffected by the traditional agricultural cycle.

The next question to consider involved a specific selection of fish and plant species. The fish would need to be protein-rich and low on fat. The plants needed to be rich in vitamins and nutrients, and able to be grown hydroponically. The final decision was to use bluegill, as the fish has 21 grams of protein and less than 1 gram of fat. The plant chosen was romaine lettuce, for it is full of nutrients such as vitamins K and A, fiber and minerals. The Aquaponic Fountains produce a large surplus of bluegill and romaine lettuce which is traded with neighboring cities for other types of food, such as grains and dairy, fulfilling the dietary needs of the citizens.

The key element of the Aquaponic Fountains is water, which is filtered and pumped from the Guadalupe River into the fish tanks. The fish add nutrients to the water; a parabolic filter is used to remove the solid fish waste as the water directly drains onto the plant beds. Finally the water is channeled back to the river.

The city engineers assessed the possible risks of the Aquaponic Fountains. These tall structures are susceptible to damage from natural disasters such as tornadoes and may attract the attention of terrorists. Thus, a decentralized system was utilized. Sixty Aquaponic Fountains were built in different locations around the city. Therefore, if one was unable to function, only a small portion of the city’s food source would be affected. Since the Fountains’ electrical system is self-contained, power outages are not a concern. Additionally, the local aquifer provides a backup water supply, should the Guadalupe River dry up.
Another major risk factor identified was disease from bacteria or fungi. To contain the fallout from disease, Aquatopolis engineers designed a partitioned system. Each fish tank in an Aquaponic Fountain only fertilizes a certain sector of vegetation, which is isolated from the other sectors. Therefore, if one tank is infected, only the fish in that tank and the corresponding vegetation sector would be lost.

The Aquaponic Fountains have several trade-offs. The fountains are complex systems that require regular maintenance and cost more than traditional farming, and they require a large quantity of water that is supplied by the river. However, they take up less space and allow for a cleaner environment. The fish and plants are grown organically, making them an incredibly healthy food source.

The design of Aquaponic Fountains required a large team of individuals from many disciplines. The most crucial role was performed by civil engineers who designed and constructed the complex Aquaponic Fountain structure. The second most crucial role was performed by robotics engineers who developed the system that harvests and processes the fish and plants. In addition, electrical engineers designed the photovoltaic cells and power systems.

The Aquatopolis city leaders effectively solved the problem of feeding its population with a unique form of urban agriculture. The Aquaponic Fountains provide a reliable and healthy food source, while maintaining a tiny environmental footprint. This makes Aquatopolis a fantastic place to live and eat.

Word Count: 999

Works Cited


Waite, Jack. "Agua Dulce Farm." Personal interview. 7 Nov. 2014. President and Founder