PANGEA

4/18/19

Emergency and Contingency Plan

Pangea is a three-season outdoor hydroponic garden system that harvests food, water, and energy situated in downtown Houston, Texas at the University of Houston-Downtown's garden. Water collection with solar, and wind power capture technologies sustain the hydroponic garden with enough resources to naturally replenishes itself. Pangea's name derives from the hymn (Pange) of St. Thomas Aquinas in celebration of Good Friday and, the supercontinent Pangea. With a strong global interest to increase urban food production while reducing energy consumption to lessen stress on the modern food production system, the Pangea system intends to address these global needs by bridging the gap between food, water, and energy to an individual or community. This paper’s objective is to analyze the potential hazards, inefficiencies, and vulnerabilities with the technology used. Upon completion, this study will examine the needs for improvements and further modifications in commercialization efforts.

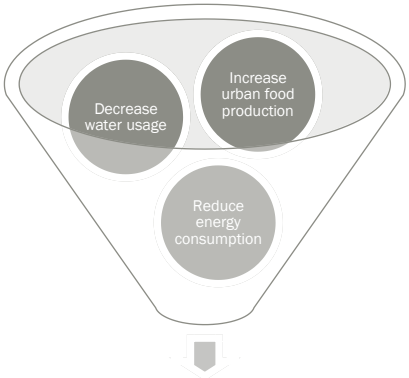
PANGEA

Contingency Plan

WHAT?

Pangea is a three-season outdoor hydroponic garden system that harvests food, water, and energy situated in downtown Houston, Texas at the University of Houston-Downtown's garden. Water collection with solar, and wind power capture technologies sustain the hydroponic garden with enough resources to naturally replenishes itself.

- Equation, formulas, software, systems, etc. used in project
    - Raspberry Pi and Arduino microcontrollers were used to power programs for an assortment of sensors from temperature to sun hours. Weather vane and rainfall collector with running programs were used to determine water production, energy usage, and monitor and control the plant growth and health. Pumps added nutrients to water plants and were repurposed into system or purified into potable water in continuous and timed intervals,
- What interested me about project (mission statement)
    - We come to associate natural disasters and catastrophes as a negative or a cost. Leading to a loss of life or the necessities for life like food, water, and energy. Catastrophes can turn major global challenges into benefits. The implementation of microgrids that produces food, water, waste, and energy shares the potential to minimize consumption rates through annual returns.



Conservational techniques can turn costs into potential benefits.

Figure 1. Mission Statement

MISSION

Future global population estimated to be 6.8 to 28.6 billion people by 2100 depending on the fertility scenario models used. (Sachs, 2015). 68% of which in urban areas by 2050 (UN, 2018). Our population directly corresponds to general consumption rates from food, energy, and water. With increased populations, we know that food consumption rate will need to increase by 50% by 2050 (World Bank Institute, 2018). The case of our global population and consumption rates suggest a need to innovate the current agricultural and energy infrastructure. While growing food we need to enhance biodiversity and maintain economic gains which support a carbon neutral future.

Henry Thoreau first sparked public discussion, questioning the effects of Industrialization and Urbanization through his literary work, Walden (Thoreau, 1854). Garrett Hardin extended Thoreau's observations publishing the Tragedy of the Commons, inferred that shared resources like water or air, humans tend to take more than their share and the commons becomes degraded (Hardin, 1968). Elinor Ostrom, who won the Nobel Prize in Economics in 2009 publishing, Governing the Commons, showed the only way to protect the commons is to have grass-roots and small scale stake-holders (Ostrom, 2015). Pangea's system supports urban food production while producing electricity and capturing water and solves the philosophical challenge of protecting a common through local stakeholders. The goal is to grow food efficiently where you live with urban hydroponic micro-grid farms backing sustainable development.

APPLICATION AREAS

- Urban farming and microgrids for food, water, waste, and energy
- Community organizations, government, and utility
- B2B and B2C (chefs, restaurants, eatery’s, grocers, farmer markets, and hospitality)

PREVIOUS WORK

Personal

- Develop small scale model displaying initial concept
- Develop rough draft of an ESG metric database measuring economic, environment, and social cost and benefits called, Sustainability Pro Forma
- Develop proof of concept / prototype of system concept
- Develop programs to interact with sensors and technology to monitor, record, store, and automate
- Conduct comparative statistical research comparing system to industry standards
    - No significant statistical difference between plants grown in Pangea system and classic soil

The wind turbine favors an eastern wind. Further engineering design plus the placement of the system can solve this challenge. Water evaporation and leakage was found in the tank that repurposes water. Proper container coloring, sealing, air, and heat fixtures can maximize this found inefficiency. More computer programming can automate and optimize the total efficiency of the system. Developing a database collecting and storing all data will aid efficiency efforts. Redesigning the system by modifying an existing greenhouse will increase food, water, and energy production.

Figure 2. Traditional Garden Bed –

8 bareroot chandler strawberry plants grown in soil and peat moss with a 4 inch spread in 3 rows of 4 plants. Maintained by manual water and soil treatment. Photo shown after planting. Plants grown for 4 weeks

Figure 3. Pangea Garden Bed – 8 bareroot chandler strawberry plants grown in hydroton and rockwool 4 inches apart. Water was treated with Ph down solution. This system is classified as a deep water culture outdoor hydroponic system.

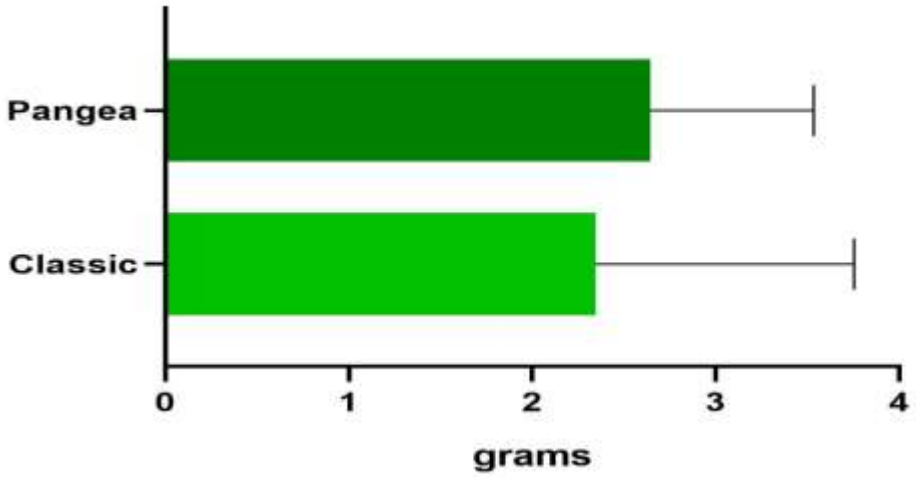


Figure 4: The shoot weight was recorded for each of the 8 plants grown in the classic and Pangea garden beds after 4 weeks. A t-test indicated no significant statistical differences between strawberries grown in either the classic of Pangea system (P=0.6).

Industry

- Urban, rooftop, vertical farms for all farming techniques
- Battery storage and integration (work remaining)
- Bacteria usage to stimulate plant growth and yield
- Energy cell efficiencies
- Water, wind, and sun capture technologies

Urban rooftop farming exposes plants to less harmful pollutants. It also opens more power production for solar and wind with less obstructions. Vertical farming maximizes space to increase crop yields in a given area. Beefing battery storage and integration leads to higher power storage capacity for electricity demand. Bacteria and microbial life are known to better treat plant health and growth.

WORK REMAINING

Personal

- Conduct human behavior and interaction study
- ESG-Metric Database
- Commercialize concept on larger scale to validate market fit
- Consolidate microcontrollers running programs and technology into remote web-based database
- Develop interface for database and system optimization efforts
- Fully automate system operations
- Implement other renewable practices like bioswales, animal farming, and other energy production

Garden Bed Production	**Classic Soil**	**PANGEA**
Water Produced	0 gal	In-progress
Water Consumed	In-progress	In-progress
Water Differntial	In-progress	In-progress
Energy Produced	0 w	In-progress
Energy Consumed	0 w	In-progress
Energy Differntial	0 w	In-progress
Plant Weight (Sum of 8 plants)	16.46 g	18.5 g

Table 1: Water and energy needs for each system along with biomass produced.

technology based on climate and location

Understanding how humans behave and interact with this system is necessary. It will determine how the system can best operate and adapt to human activity. An Economic Social Governance (ESG) metric database will provide information detailing the economic/financial, social/human, and environmental impacts of such a system, product, or service. Developing a small-scale commercial concept will lead to a better understanding of food, water, and energy studies with comparative systems. A commercial concept can determine future customer relationships and demands. The creation of a database will improve efficiencies and performance for the system leading to automation and optimization efforts. Examining how this system will interact in other climates will determine other renewable practices dependent on location and climate.

Industry

- Micro bacteria and fungi interactions and behavioral research
- Human behavior and interaction research
- Commercial scale of microgrid capabilities
- Vertical Axis Wind Turbine (VAWT) research
- Water treatment innovation and adaptation
- Waste treatment mitigation and adaptation research

WHY?

Pangea's name derives from the hymn (Pange) of St. Thomas Aquinas in celebration of Good Friday and, the supercontinent Pangea. With a strong global interest to increase urban food production while reducing energy consumption to lessen stress on the modern food production system, the Pangea system intends to address these global needs by bridging the gap between food, water, and energy to an individual or community.

- Global population growth is expected to lead to a proportional increase in food demand of about 50% by 2050 – World Bank, Food Security – Overview, 2016 & World Bank, Global Economic Monitor (GEM) Commodities, 2016.

HOW?

This paper’s objective is to analyze the potential hazards, inefficiencies, and vulnerabilities with the technology used relative to the potential crop yield of eight chandler strawberry plants through a climate station equipped with a raspberry pi, sensors, and visual analysts. Upon completion, this study will examine the hazards, inefficiencies, and vulnerabilities with the technology used. Upon completion, this study will examine the needs for improvements and further modifications in commercialization efforts.

- How was this project planned?
    - Evaluate the pain statement and mission
    - Consult with professionals throughout project
    - Brainstorm and research applications, concepts, designs, functions, and technology continued throughout project
    - Develop small-scale model and evaluate

- Find resources, producers, and suppliers
- Record findings and consolidate into a proposal and budget
- Ascertain funds and begin development
- Complete proof of concept and prototype
- Evaluate, record, and monitor results
- Conduct feasibility report, business plan, and research from project findings and results
- Create SWAT analysis and repeat steps above for commercial scale model

Figure 5. Community Engagement

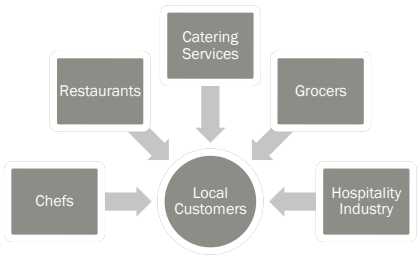


Figure 6. Potential Customers

SUMMARY

Natural disasters are commonly known to negatively impact a community. Pangea can harness the energy from the negative effects of naturally occurring events and successfully create food, water, and energy. There is no significant statistical difference between food grown in a Pangea system and classic soil garden. The system will produce up to 65 gallons of water and charge a 12-volt battery using sun and wind capture technology. Further research and development will determine the viability and feasibility of commercialized Pangea system. It will help understand market fit, demands, and behaviors.

REFERENCES

Hardin, G. (1968). The Tragedy of the Commons. *Science*, 1243-1248.

NCDC/NOAA. (2018). *National Climatic Data Center, National Oceanic and Atmsopheric Adminstration.* Retrieved from ncdc.noaa.gov: https://www.ncdc.noaa.gov/sotc/global/201805

Ostrom, E. (2015). *Governing the Commons.* Cambridge: Cambridge University press.

Sachs, J. D. (2015). *The Age of Sustainable Development.* New York, Chichester, West Sussex: Columbia University Press.

Thoreau, H. D. (1854). *Walden, or Life in the Woods.* Boston: Ticknor & Fields.

World Bank Institute. (2018, December 5). *How to Sustainably Feed 10 Billion People by 2050, in 21 Charts.* Retrieved from wri.org: https://www.wri.org/blog/2018/12/how-sustainably-feed-10-billion-people-2050-21-charts