VAPOR HARVEST SYSTEM

Water Harvesting & Nanotechnology

Colette Bazirgan

My focus for this project was to improve agricultural systems in arid/semi-arid lands, utilizing nanotechonolgies to do so. Specifically, I was investigating a means of harvesting water for dry lands, from more than just precipitation.

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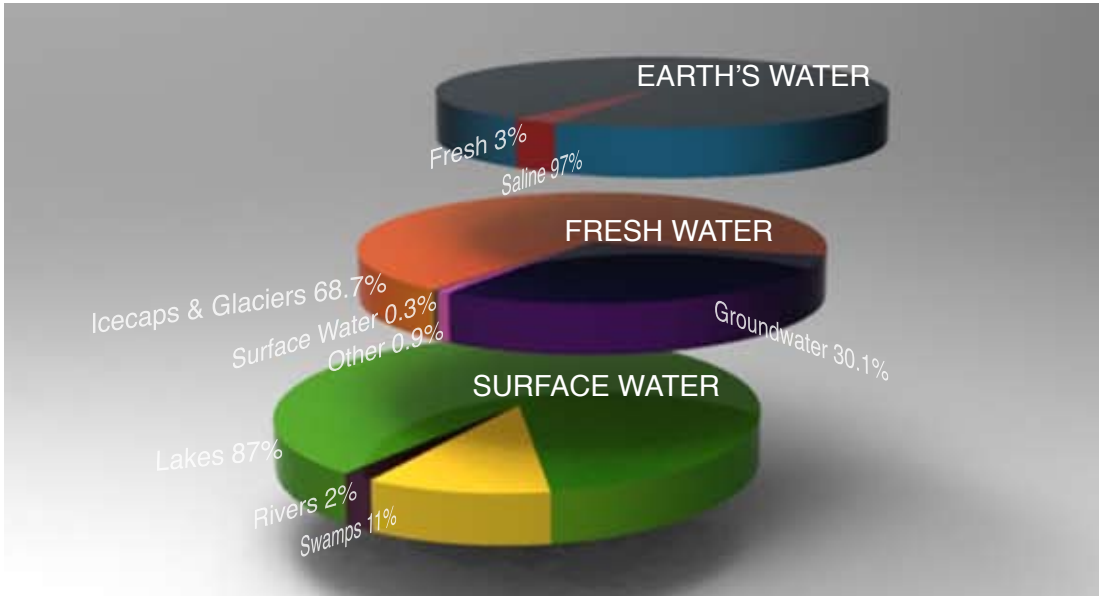
THE PROBLEM

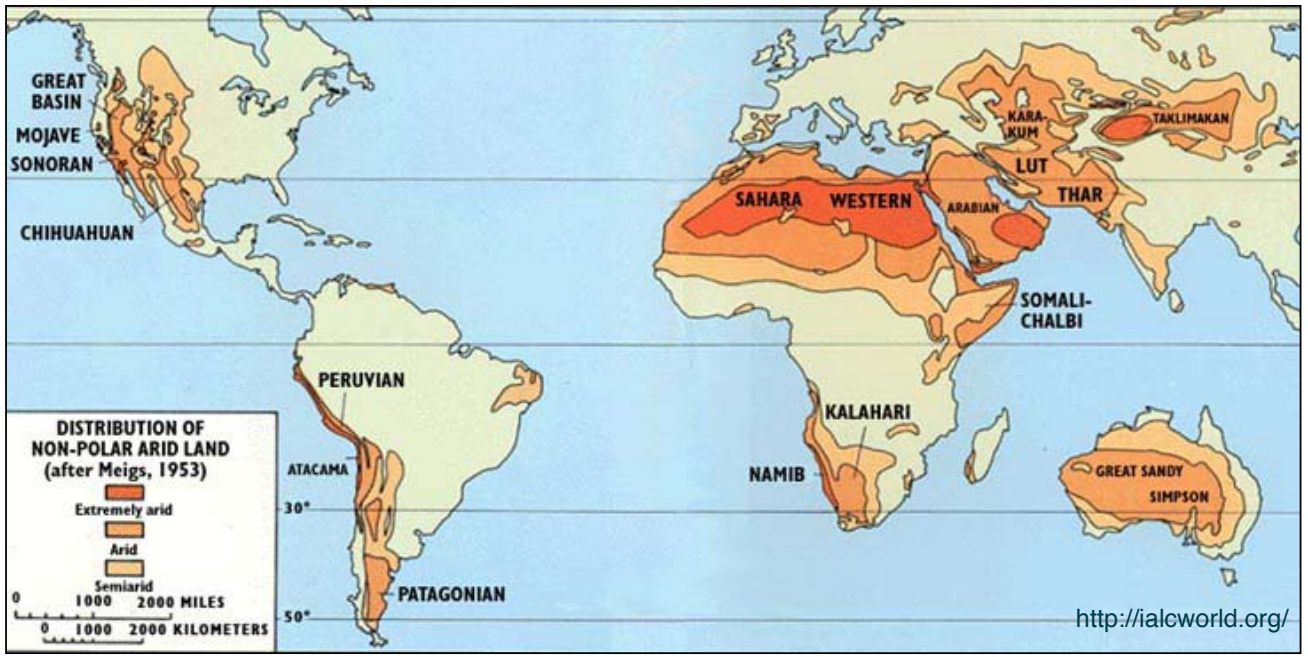
WHERE IS OUR WATER?



One factor of agriculture to consider is water. Only 0.3% of the 3% of freshwater is available as surface water. Currently, 70-80% of our country's water consumption is for agriculture.

AND OUR LAND?

Another considerable factor is land. Approximately 45% of the earth's land is arid/semi-arid. About 40% of US land is used for agriculture.



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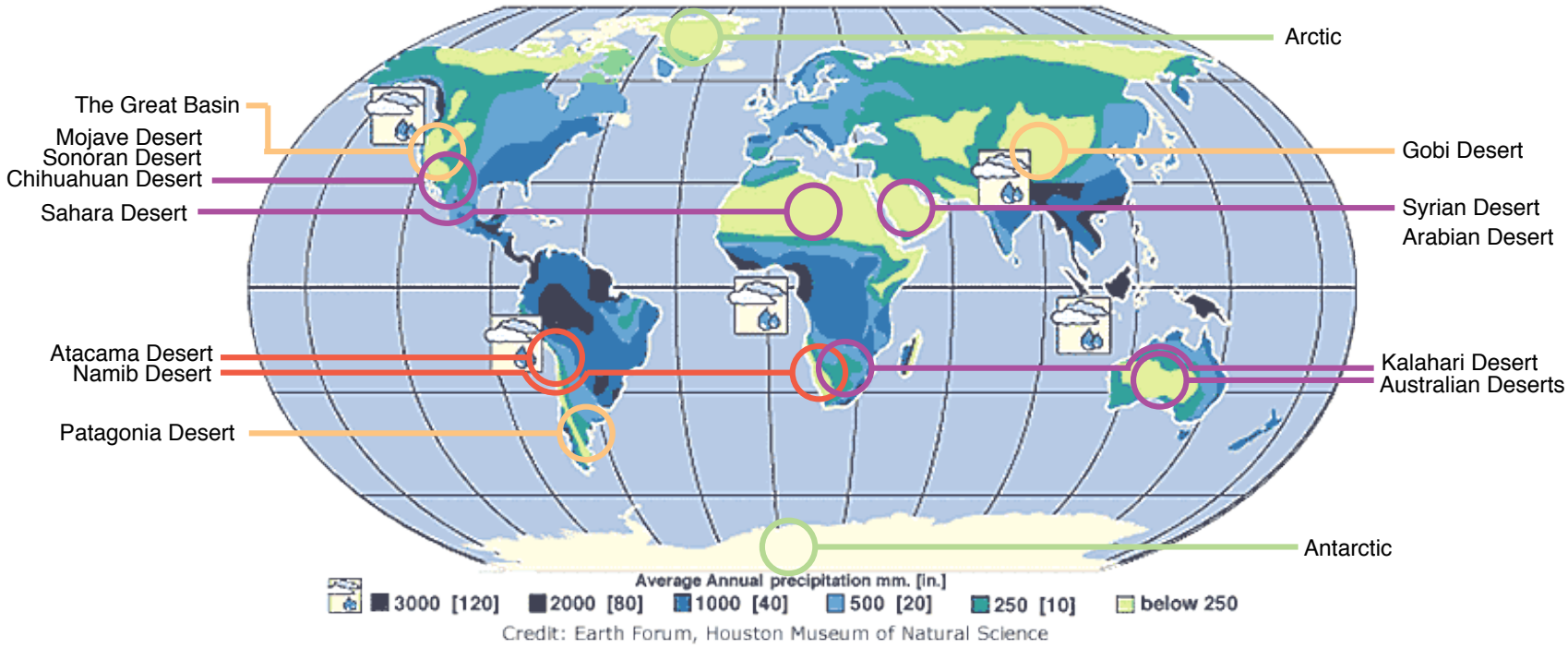
THE LOCATIONS

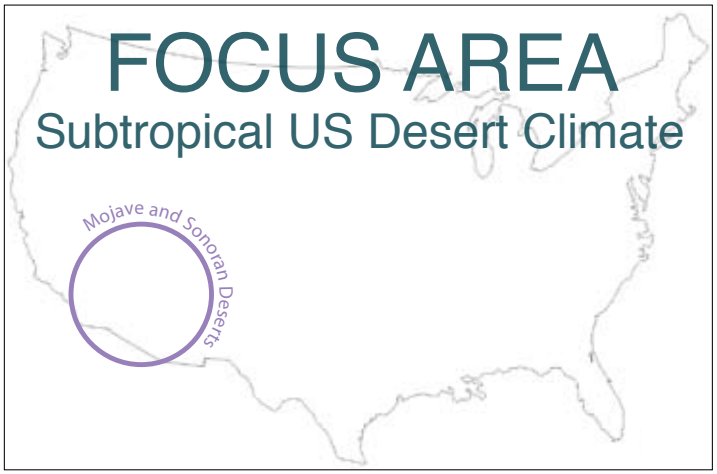
Desert Locations & Annual Precipitation

All deserts experience extreme weather conditions and receive 1-15” of rain annually.



FOCUS AREA

Subtropical US Desert Climate

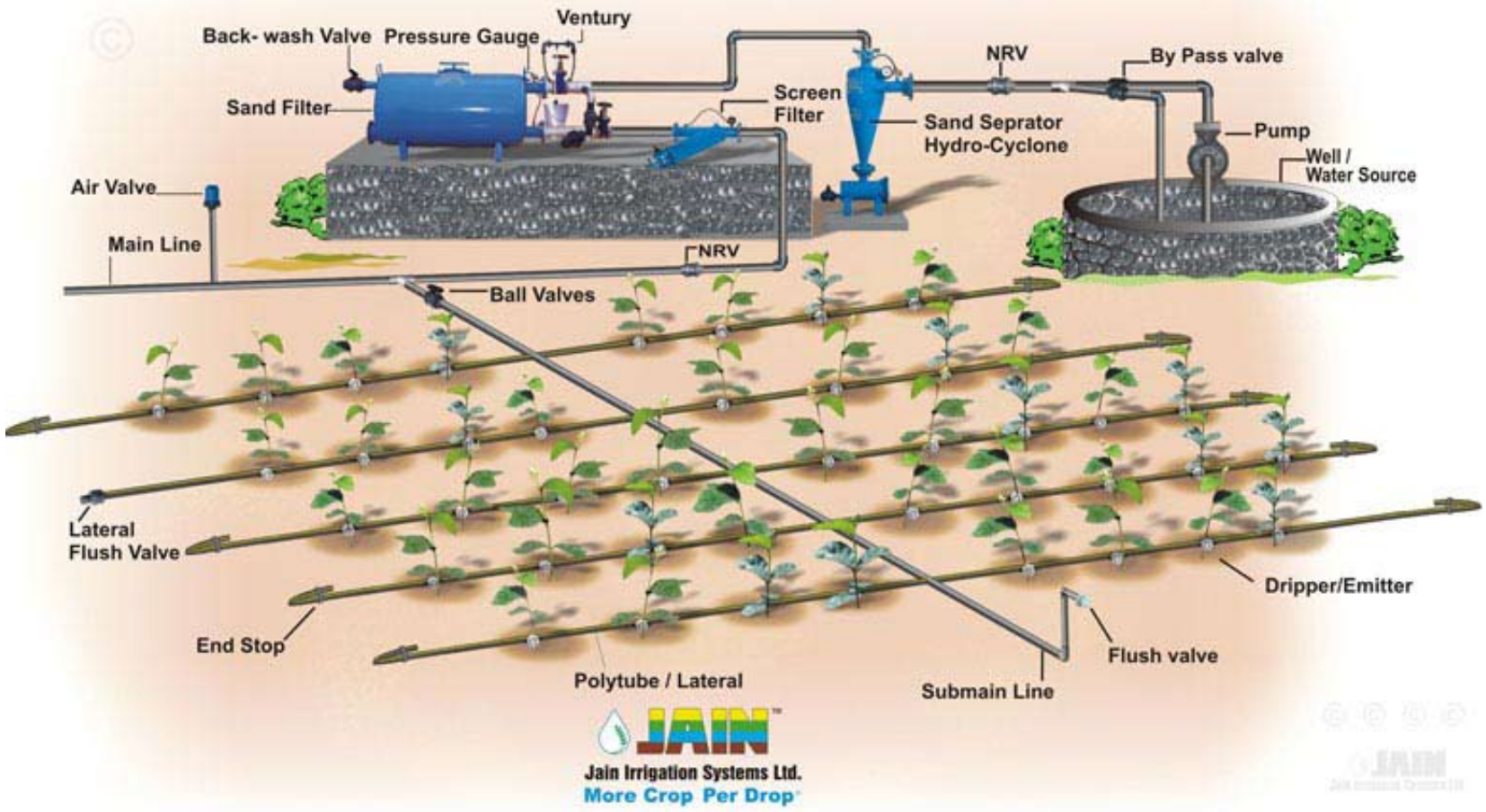


I focused on the subtropical deserts in the US, the Mojave and Sonoran Deserts in the southwest. The climate here is hot and dry year round, rainfall is 10” or less annually, and humidity is usually between 10-30%. Sometimes it can be so hot that the rainwater evaporates before it hits the ground. Dry areas are also prone to salinity in the soils and aquifers.

http://ga.water.usgs.gov/

CURRENT SYSTEMS

Drip Irrigation System



Drip Irrigation Systems are used to conserve water in irrigating crops. It prevents soil erosion, evaporation, and runoffs, supplying water and nutrients directly to the roots.

Drip Irrigation began development in 1866 in Afganistan. Modern systems were developed in Israel in 1959.

Systems are currently used in 112 coutntries, and on 5 continents.

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MY DESIGN

My design is based on this system of irrigation, focusing on water storage, reducing wasted water, and other ways of obtaining water. For example, rain, fog, and humidity. Although my areas of focus are some of the driest lands, there is always some moisture in the air. My design uses two nanomaterials that work in collecting water out of the air and storing it without a risk of evaporation. One material gathers the water from the air and the other controls the path of the water.

The Vapor Harvester is about 11.5’ tall and has a footprint of about 5.5’.

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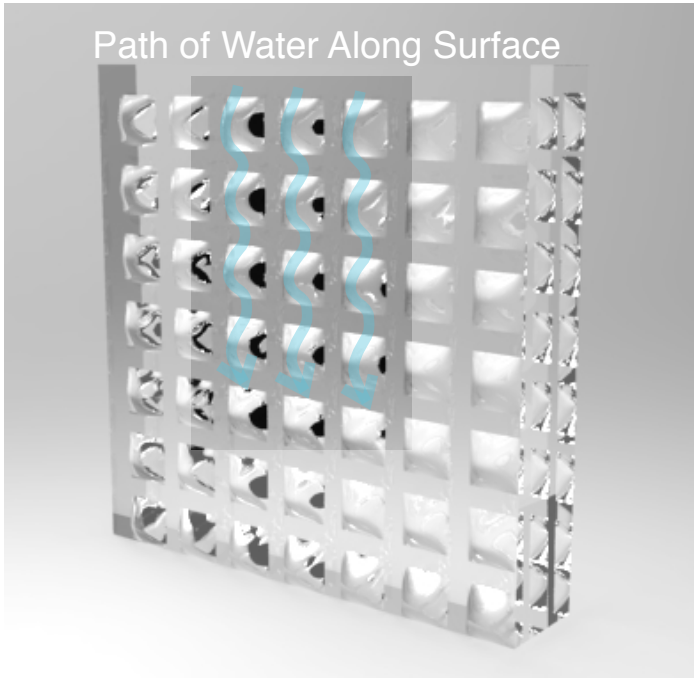
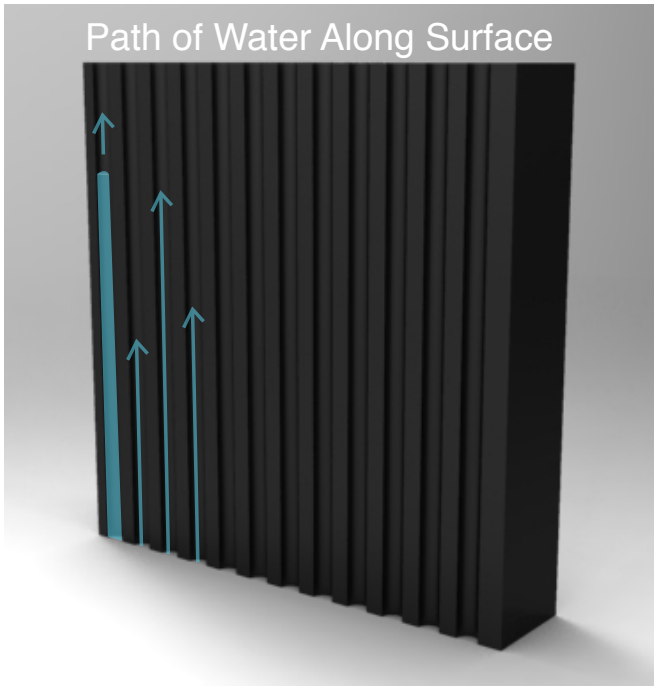
THE MATERIALS

HYDROPHOBIC/PHILIC

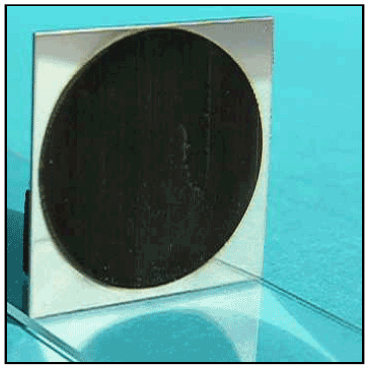


My first material is a superhydrophobic/philic surface created by researchers at MIT. It is based on the Stenocara beetle located on the coastal dsert of Namibia, who collects water on its back from the heavy fogs that come in off the ocean. It works by have hydrophilic raised surfaces that attract water vapor which beads up and becomes heavy enough to roll down into the hydrophobic recesses.

WICKING METAL



Click Me!



My second material is a nanostructured wicking metal that can carry water passively uphill. It is being researched at the University of Rochester by altering the metal with a femtosecond laser which creates nanosized pits and channels. This causes the water molecules to climb over each other. being more attracted to the material than themselves. The water can travel at 1cm/sec against gravity.

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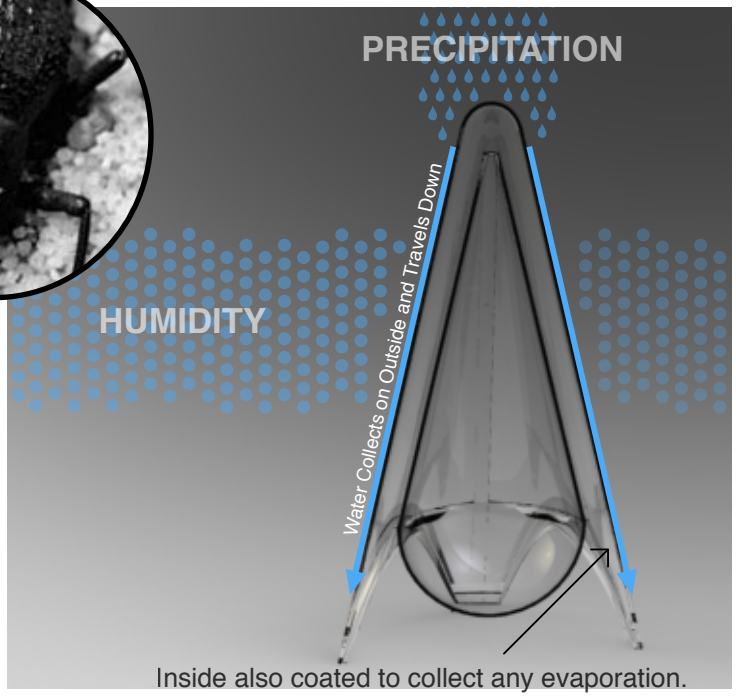
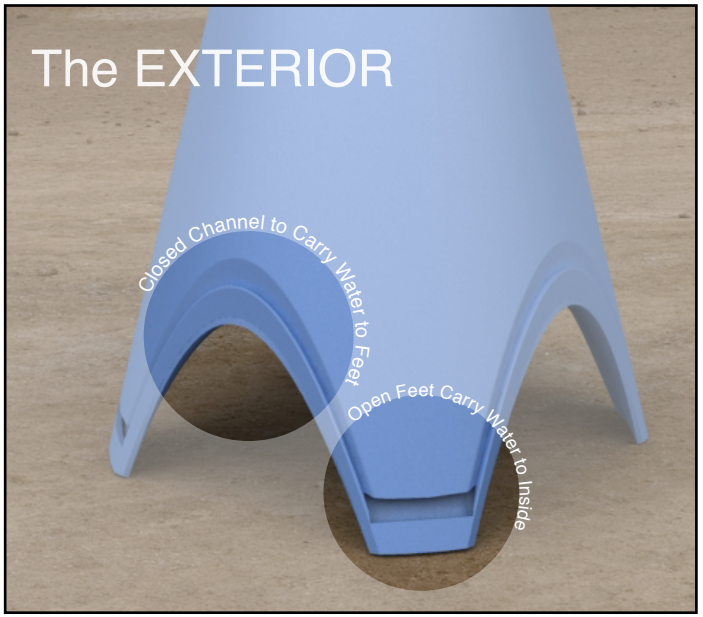
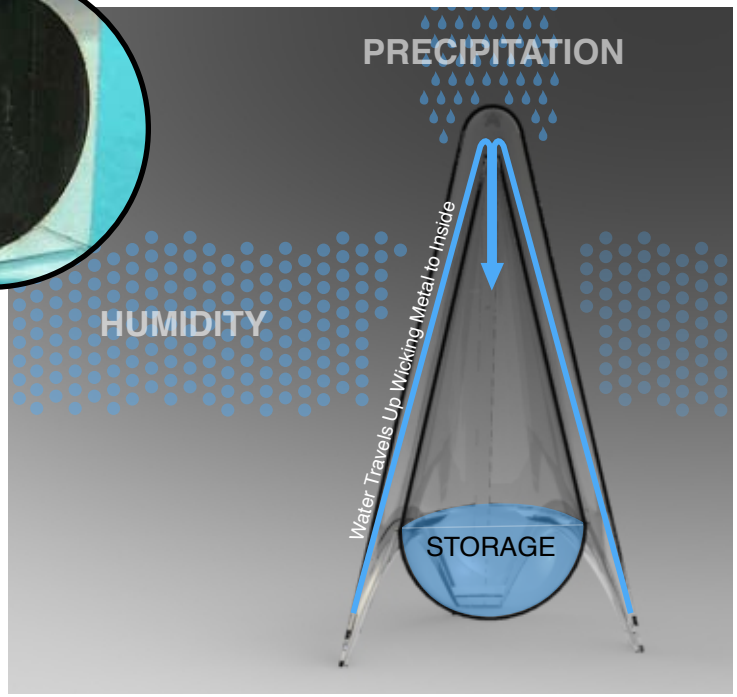
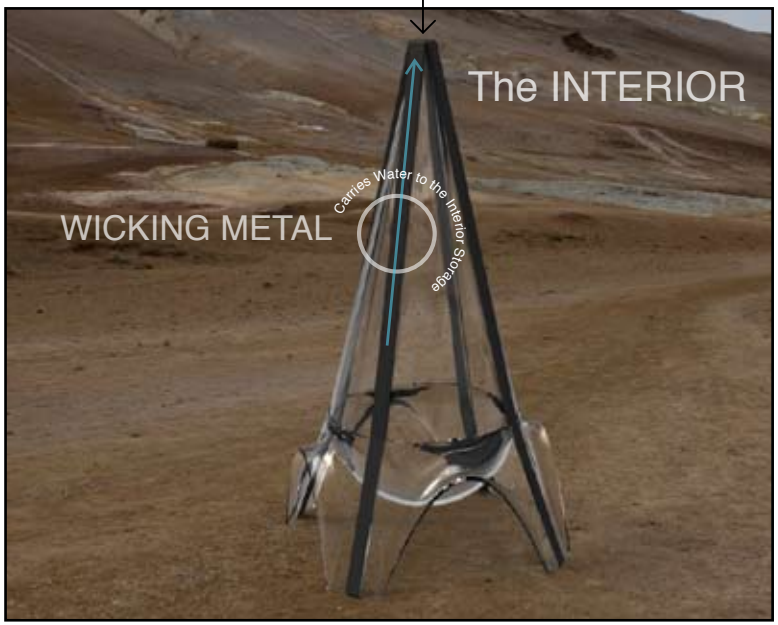
THE FUNCTION







Nanosized opening to prevent evaporation.



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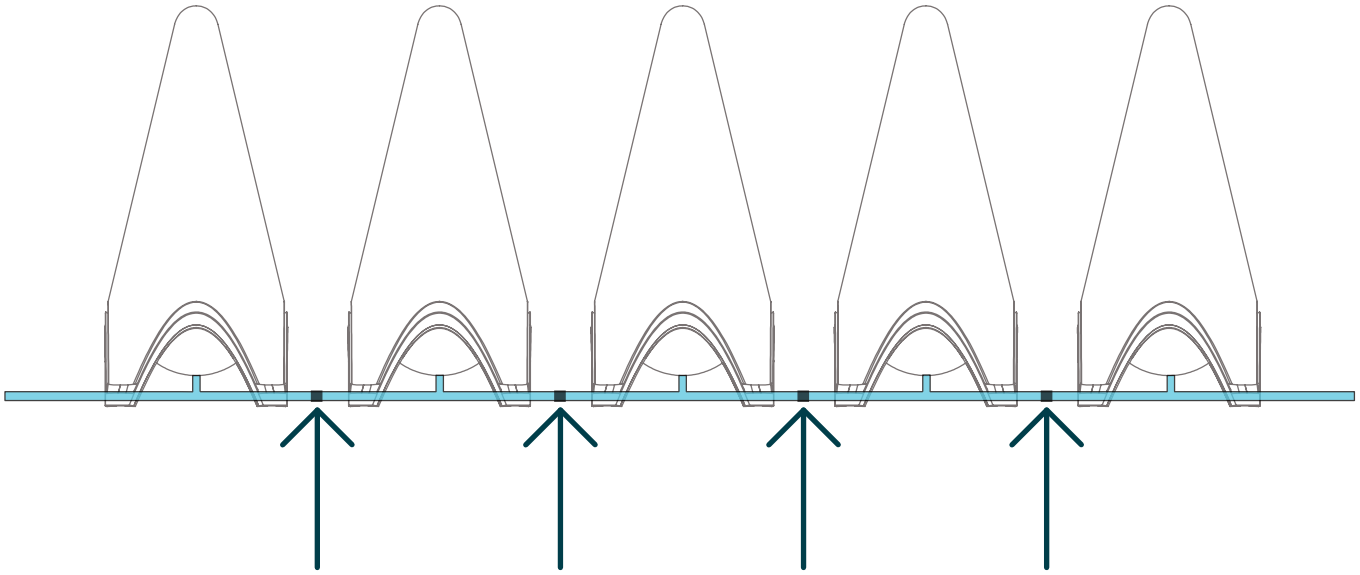
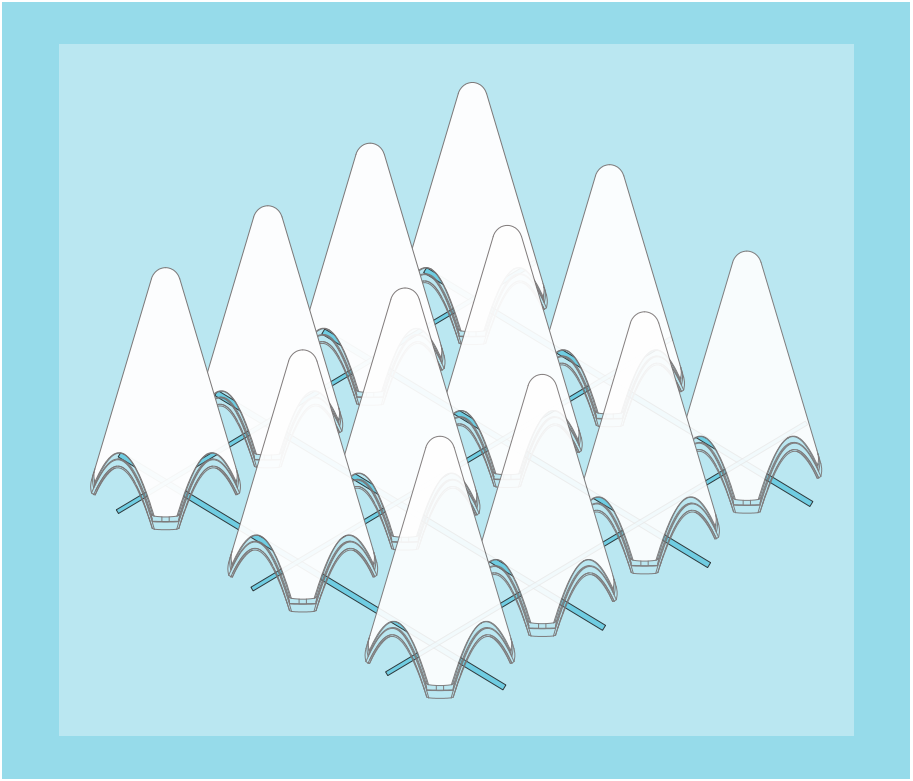
THE SYSTEM





The size of my design is fairly small in order to be used for more applications. A single unit may be used for a home, or small garden. Or multiple units may be attached together to collect more water for larger crops. These would be implemented in a similar way to the Drip Irrigation System.

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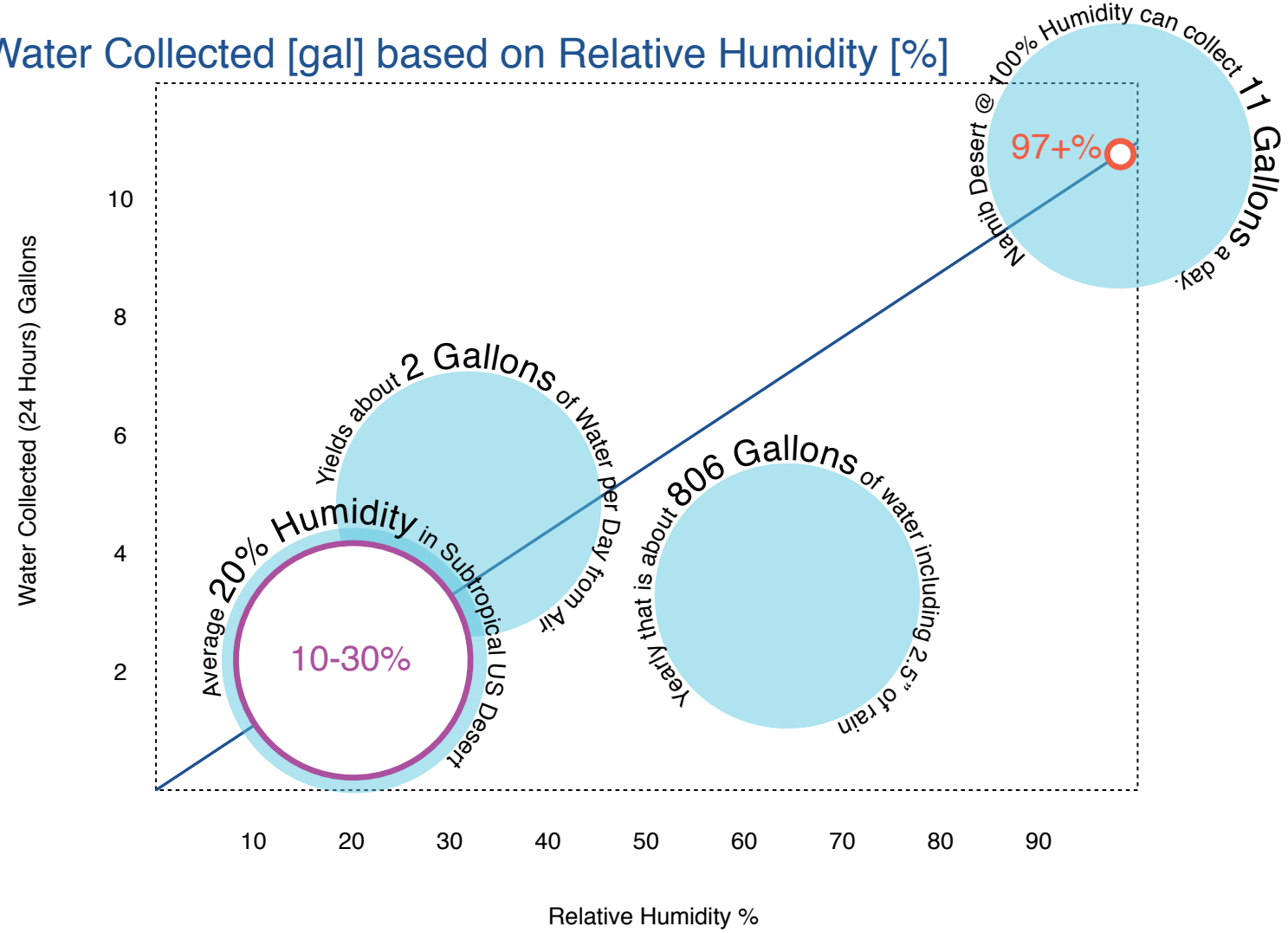
THE COLLECTION

Using research gathered from the beetles, I calculated how much water I could collect based on the humidity in the area.



NOTE: Actual relative humidity numbers change over 24 hours. These are approximate calculations. Actual numbers may be higher or lower depending on the specific weather.

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THE BENEFITS

Compared to current water harvesting and irrigation systems, my design has a lot of benefits. By passively collecting water in areas where precipitation is little to none, and sometimes evaporation steals what little moisture is available, it has the potential to make better use of arid areas and increase their growth potential. It could increase food supply without increasing groundwater extraction. It could enable areas to grow more food locally. Also, it could eliminate the need and expense for desalination processes.