Section 3: The Perspective of the Scientific Community

Digest #1

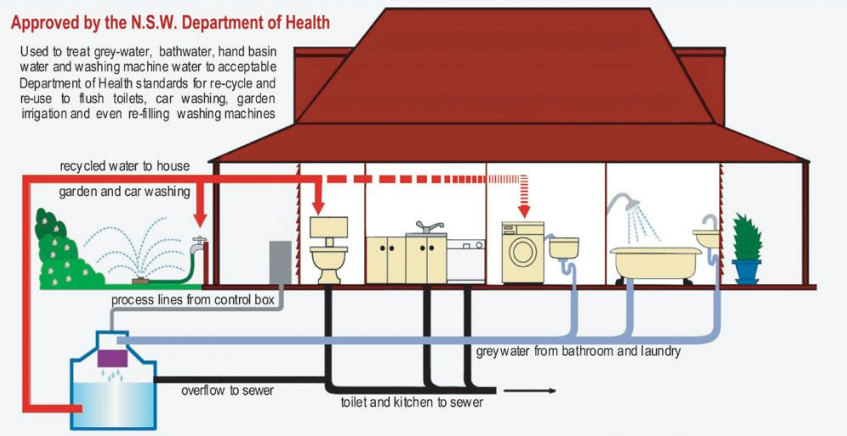
People always ask how did we get into this crisis, what are we doing now to combat it and what more can we do to change our present situation. From years of studying our current water crisis, I know that there is no one simple answer to any of these questions. All of these questions have layers upon layers of technical data, complex events, and various factors that go into their answers.

Starting at the beginning of the crisis does not paint a clear enough picture for a true understanding of what is going on. The water crisis is rooted deep within human nature and traditional water practices. From early on, the scientific community defined water as a renewable resource. For those without a scientific background, a renewable resource is a resource that once used, is not destroyed. For example, you wash your dishes or clothes with water, but after the process ends, the water can be taken and cleaned returning to its original clean state. Likewise, when runoff water soaks into the ground or collects in a body of water, it can evaporate and go throughout the water cycle to be, in a sense, "reborn" into the fresh water falling from the sky or joining a natural spring or reservoir.

This is all acceptable, but what humans often underestimate is the amount of time that this process takes to occur. Since humans developed habits of using fresh water as it is in infinite supply, they also developed a serious fresh water shortage. We irrigated with a lack of planning and execution, wasting crucial water that could have been the difference between constantly running on empty or having reserves to go to in the case of disaster. This attitude and approach of constant usage has left our fresh water systems extra vulnerable to drought and disaster. As seen in California during the first two decades of the 21st century, a drought can be devastating to a population already short on water. From 2011-2016, California experienced a drought like no other. With little access to fresh water from overtapped reservoirs and wells, farms suffered, the housing market suffered, and most of all the people of California suffered. In order for these people to survive, scientists determined that a limit must be placed on the amount of water that each household may use over a given period of time. Following this temporary adjustment, scientists worked to determine a better way to manage the extreme water shortage faced by the citizens of California.

The answer that scientists found was simple but proved to be a revolutionary technique in water reuse and management. Scientists determined that approximately two-thirds of a household's water could easily be recycled using a gray water recycling system. Gray water is defined as the relatively clean waste water from baths, sinks, washing machines, and other kitchen appliances. So starting in 2016 near the tail end of the worst drought in years in California, a new technology was mandatorily implemented into all new housing development projects. This technology was a gray water reuse system, it took the relatively minor wastewater from the baths, sinks, and appliances of a house and cleaned it so that it could be reused in the house without having to be sent out to the water treatment plants miles away from the housing

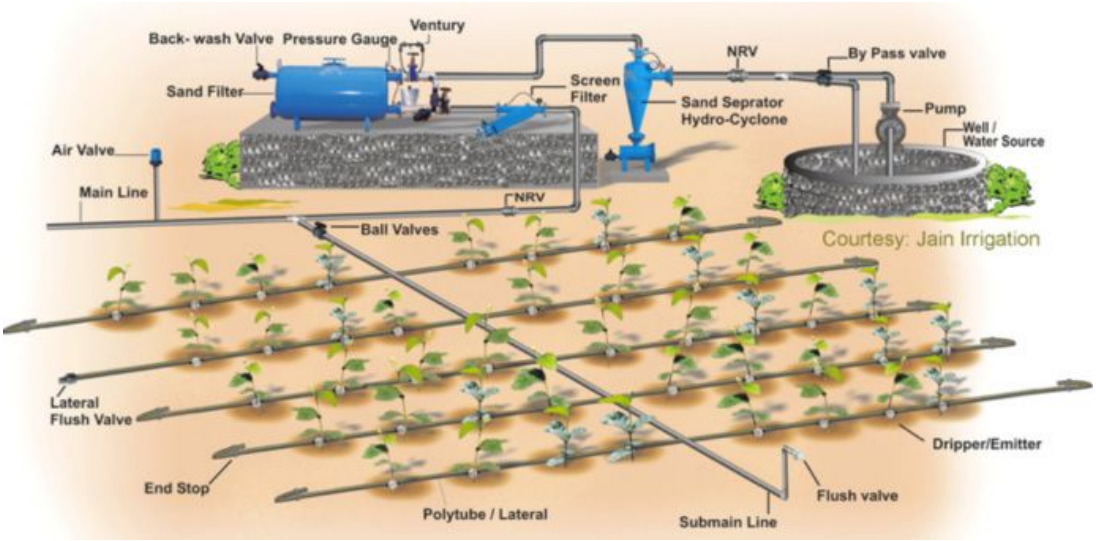
developments. This system provided a multitude of benefits to society. For example, since it allowed for water reuse, it provided the opportunity for houses to get more water usage out of their rationed amount of water per month. In fact, this technology became so successful at saving up to two-thirds of a house's water for reuse that by 2020 it was state mandated that not only all



new housing projects, but also all new commercial projects, must include a grey water reuse system. Along with this, less dangerous chemicals had to be used to treat the wastewater at large scale plants to decrease the chance that a dangerous chlorine chemical would leake in the surrounding natural areas. The picture below depicts the functioning of a average household gray water reuse system.

This new technology proved effective for the following decade, but as the large scale population growth of the state of California continued, the need for more water recycling increased and by the late 2020's, a new change was needed. With a need for more effective water reuse, scientists turned to what could possibly recycle the remaining one-third of household water usage, also known as heavy waste water. Heavy waste water is sewage along with the water used in manufacturing of goods. Scientists developed more effective large scale water recycling plants that were safer and more efficient than past water recycling processes. These could be implemented in a variety of locations from cities to the suburbs to deal with the recycling of heavy waste water. After tackling the commercial and residential sides of water reuse, it came time to address the elephant in the room that was agricultural water usage. Though periods of heavy rain followed the extensive droughts of 2011 through 2016, the underground reservoirs and aquifers remained at a dangerously low level. This was a monumental problem because with a growing population, more food production was needed, and not only for the state of California, but also for the United States as a whole. California is the leader in the production of many foods throughout the continental United States and thus must be able to produce, otherwise a shortage might occur. The scientific community spent years researching and eventually deduced a micro irrigation system that was extremely effective in conserving water

and increasing plant growth. An example of one of these revolutionary devices is pictured below.



The advantage of these systems was that they could also use a rain barrel in order to conserve extra water from rainfall and save it for further irrigation. This way, instead of heavy rainfall creating runoff, it created a bountiful reservoir to draw from for irrigation. The final change that has been implemented thus far in the year 2040 is a water limit per household based on the number of occupants, instead of just a flat rate per household. Scientists discerned by structuring the system this way it would create equity and those with larger families would not be punished over those with smaller families.

For now, the scientists believe the state of California is doing just enough to survive, but in order to thrive more changes and innovation must occur. Examples of these range from water desalination plants, to an in-depth look into aging water pipelines and systems. Water desalination plants harness the power of the most abundant source of water on Earth, the oceans. By taking water from the vast nearby Pacific Ocean and desalinating it, scientists are able to produce excess fresh water for usage in farming and everyday life, taking some of the strain out of mandatory limits and systems. Possibly the easiest solution that scientists such as myself are beginning to look into is a thorough check of the existing water systems. An aging system can lead to leaks and cracks, essentially wasting precious water that can be utilized to help our people. If we are able to locate and fix these cracks can save crucial amounts of water. Amounts that very well can be the difference between the survival or collapse of California's infrastructure in the future.

Digest #2

Since the year 2018, the water recycling systems available to us have changed dramatically. After California's worst drought in history from 2011 through 2016, scientists and engineers like myself proposed the idea of limiting the amount of freshwater intake per month

for each citizen. 2,000 gallons of water would be the maximum amount available for any one person for each month. However, this could not be the only way to manage how we use our water and how much of that is fresh versus gray. Earlier in this century, small scale waste water recycling systems were researched. After California's long, severe drought, these were implemented as a mandatory recycling method. This system was a great way of managing water reuse at the time because it took grey water from appliances in bathrooms and laundry rooms like sinks, washing machines, and showers, and channeled it into a treatment system on the homeowner's property in order to clean it and bring it back into the house to be reused. This system made it possible for reused water to be put to use for many different things. However, the wastewater from toilets would be brought to the sewer, as well as any overflow from the wastewater system, meaning that this water would not be reused at all.

Since the late 2020s, the global population as well as within the state of California has grown drastically causing the need for more effective ways of reusing water. Scientists and engineers came together to research how to provide an option that reuses all of the water in every household, including grey water as well as heavy wastewater. Our goal was to have this new system be very safe and require as little chemicals as possible to treat the water. Less than five years ago, we developed large scale water recycling plants in Los Angeles which have since been implemented in a few other cities such as New York and will soon be brought to more areas as well. Wastewater treatment plants remove a lot of the pollutants from the water before releasing it to local waterways. "At the plants, physical and biological processes closely duplicate how wetlands, rivers, streams and lakes naturally purify water. Treatment at these plants is quick, taking only about seven hours to remove most of the pollutants from the wastewater" (NYCEP). The wastewater gets treated in five stages. The first, preliminary treatment, is where the water from the sewers flows into the plants through several upright bars which aim to remove large pieces of trash. In the next process, called primary treatment, the wastewater goes into sedimentation tanks where light and heavy solids either float to the top or settle to the bottom. These solids are then taken off of the surface or if they are at the bottom, this primary "sludge" is then pumped through degritters. The water flows to the secondary treatment system where air is pumped into the tanks in an effort to stimulate "the growth of oxygen-using bacteria and other tiny organisms that are naturally present in the sewage" to consume the remaining pollutants (NYCEP). Next, the water flows to more tanks to have its solids separated once again and the sludge that is present gets processed further elsewhere. The wastewater goes to "chlorine-contact tanks mixing with sodium hypochlorite" which further disinfect the water, an essential step (NYCEP). The water is released to local waterways after going through this treatment process.

With "much of the demand [for water] driven by agriculture, which accounts for 70% of global freshwater use," scientists saw that systems were necessary in reusing water when growing crops and producing food (Smedley, 2017). In 2035, "food production [had grown] by 69% to feed the growing population" in California (Smedley, 2017). This increase has required more water to be used, so why not utilize recycled water that could serve the same purpose as

fresh water while still being a safe and clean option? Telling farmers to look at possible leaks and faulty pipes in their irrigation systems did not do enough. Micro irrigation systems, the latest and best system to date, not only use lower pressure, but also less flow than other systems. Also known as drip irrigation, this system has small drip emitters close to the roots of the crops, which allows for more efficiency and control. Water is released from the very small sized emitter slowly. The "emitters are directly connected to the water source by feeder hoses" (McFadden, 2017). Several engineers believe this system will be used by more and more farmers because its benefits outweigh its costs.

In thinking about the future, engineers have been generating ideas about even more ways of recycling and reusing water. I think water desalination plants will be next on our list of things to tackle, but for now, we must encourage and maybe even require, everyone in California to recycle water in the ways that have already been implemented. We must also bring the large scale wastewater treatment plants to cities and regions around the country and world to make an even larger impact in reusing water. Us engineers and scientists have already created these methods, but it is up to the citizens to follow through and practice them.

Explanation:

As seen in the above pieces from the scientific community, the transition from practicing dominating nature to managing nature lies heavily in the technologies available to the people of California, specifically the farmers. The scientific community both recognized and assessed the damage being done to the environment of California and then developed solutions to the issues. Years of water overuse from large scale farming with improper irrigation lead to disastrous effects on the water tables and aquifers in the region. To combat the escalation of these issues, the scientific community came together to engineer systems such as greywater recycling systems and micro irrigation techniques that properly reuse and save water to take the strain off of nature. The keys that made the difference between humans dominating nature and managing nature were the development of technologies that supported the environment and the practice of taking the strain away from nature and putting it on humans to be more sustainable.