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Understanding Wastewater Treatment and its Significance in California

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Abstract: **The average Californian uses 48 gallons of water per day. This can be from your morning shower, your toilet flushes, or you washing your hands. When using this water, many do not think about where this water goes or comes from. Many believe that the wastewater goes straight to the ocean, however this is untrue. Instead, wastewater undergoes an extensive process of filtration and treatment before it is released back into a body of water like the ocean or reservoirs so that it can return to the natural water cycle. California has a harsh history with water supply with its residents often facing constant drought. Therefore, it is vital that the wastewater treatment process is made as effective and efficient as possible to make the best use of the water that is available.**

Keywords: **wastewater, recharge, sludge, groundwater, sustainability.**

I. INTRODUCTION

Our Earth, known as the Blue Planet, is 71% water, hence its nickname[1]. Although this may seem like a lot, only a mere 2.5% of this water is freshwater and of this freshwater, only 31.3% is found on the surface and in the ground[2]. The other 68.7% is located in glaciers and ice caps and therefore, difficult to harness[2]. The good news is that water is a renewable resource due to the water cycle in which these water sources are replenished. In order to make use of this cycle and reuse water, we treat our wastewater in wastewater treatment facilities and replenish surface and groundwater in a process known as recharging. The process also ensures that no toxic elements and microorganisms are released back into the cycle, which could endanger people, animals, and the environment.

California is the most populated state in the U.S. and consequently uses the most water[3]. Constantly in droughts, California does not have nearly as much natural access to water as some other states, especially in proportion to the demand. Since wastewater treatment is such a critical process not only for our supply to freshwater, but also for our health, we must ensure that wastewater treatment methods are not only efficient, but sustainable.

II. CALIFORNIA'S CURRENT WATER SUPPLY

The California Water System is a series of dams, aqueducts, reservoirs, and pumping plants that provides California with its water. The system consists of three major sources. The Central Valley Project, built in 1937 by the federal government, is a network of various man-made water sources like dams and reservoirs spanning about 400 miles[4] (Figure 1). This system provides about seven million acre-feet of water that is used for agricultural, urban, and wildlife uses including agricultural counties that are critical to California's economy. The second source is the California State Water Project, developed in 1960 (Figure 2). Extending 705 miles, the California State Water Project is the largest water storage and delivery system, providing water for almost 70% of California's population as well as for farmland and businesses[5]. The system also generates hydroelectric power in its five hydroelectric power plants[5]. Lastly, the Colorado River Aqueduct is also a major source of water in California (Figure 3). This channel spans 242 miles and transports more than 1.2 million acre-feet of water a year[6]. While these systems may seem abundant and dependable, California's high demand and lack of surface water continues to pose a constant threat to residents.

A. The San Joaquin Valley

Our water also comes from streams, reservoirs, and groundwater reserves. The most notable groundwater reserves are found in the San Joaquin Valley, which is located in the middle region of California. During times of drought, we often turn to the San Joaquin Valley for water stored deep in groundwater reserves which is extracted by drilling wells into the ground where water is then pumped out. However, repeated water extraction has caused land subsidence in the area[7]. This occurs when groundwater is extensively extracted, gradually weakening the foundation of the ground and causing the land to sink in. Not only does this sinking cause damage to infrastructure, but it also calls for expensive repairs.

We also depend on the San Joaquin Valley to provide water for a majority of California's agricultural projects. This results in higher levels of groundwater contamination from agricultural materials like fertilizers, animal manure, and pesticides[8]. For residents that live near the area, this means that their water is more likely to contain high levels of contaminants like nitrates which can pose adverse health effects[8]. The residents that feel these adverse effects are also often members of minority communities such as Latino or Hispanic communities. The effects of high levels of nitrates in water include higher risk of certain cancers as well as birth defects[9] like blue baby syndrome[9]. In addition, while these residents face high risk of illness, they are also paying higher prices for their water due to the high expenses required to treat such contaminated water. So, not only are these residents paying more money for their water, but for water that is causing harm. Another study reports on this issue, focusing on how the disparities between nitrate contamination and its effects on Latino communities. The study found that "[California Water Services]s that served higher fractions of Latinos and lower fractions of homeowners (i.e., more renters) had higher average nitrate levels"[9]. The study puts stress on how the uneven access to healthcare and social action acts to worsen the situation and prevent change. Discouragement from political action as a result of language barriers and citizenship status results in people in these communities are discouraged from bringing this issue to their government's attention. In addition, the aspect of these communities being renter-based and not homeowner-based is that renter-based communities are more likely not to have the ability to pay for improvements in water service[9]. This situation proves that the issue of water provision goes beyond having access to water, but also extends to protecting those who are already feeling the effects of California's poor water. This issue would only worsen if no change is enacted due to the lowering water table which would increase California's reliance on groundwater in reservoirs like the San Joaquin Valley. It becomes clear that it is dangerous for California to continue to depend on this water source, and that some solution must be set in place.

B. California's History of Water Shortage

California has a notorious history of drought and water shortages. It is important to take into consideration how these shortages and demand for water play into water reclamation. As of July 1, 2022, California's population was 39,029,342, according to the Census Bureau[10]. With California being the most populated state in the US as well as the most economically active, it naturally has a high demand for water, especially in Southern California which demands 80% of California's water[11]. However, California has been struggling for many years to meet this demand.

California consists of five major climate types: desert, cool interior, highland, steppe, and Mediterranean[12]. Figure 4 is a map that shows the average annual precipitation in the different regions of California. Because of the different climate types that are present in California, some southern regions will get less than 5 inches of rain in one year while a northern region will get as much as 120 inches of rain. However, it is clear that a large part of California does not receive much precipitation which means that there is not a steady supply of surface water, which refers to water found in bodies of water like streams, creeks, lakes, and rivers. This lack of precipitation is further emphasized by the long droughts that have deprived California of water. Figure 5 shows water distribution by source in New Jersey, Pennsylvania, Missouri, Illinois, and California. For New Jersey, Pennsylvania, Missouri, and Illinois, the majority of water is sourced from surface water, then groundwater and lastly, purchased water. Meanwhile, California's water is largely sourced from groundwater and purchased water, highlighting California's dependency on groundwater and utter lack of surface water.

This lack of consistent water supply is why wastewater treatment processes must be operating at optimal efficiency. While California's water system is well-established, as the population and demand continue to grow and droughts threaten these water sources, we are faced with an increasingly urgent problem of how to provide California with clean water.

III. WASTEWATER TREATMENT

Current wastewater treatment processes consist of about four main treatment stages[12]. When sewage wastewater enters a facility, it enters primary treatment where the water passes through a screen so that large objects can be disposed of. Then, the water undergoes primary treatment, where water is pumped into sedimentation tanks. In these tanks, sediments sink to the bottom of the tank while lighter substances like grease are skimmed off the top. In secondary treatment, microorganisms are pumped into the water that consume contaminants. In the disinfection process, chemicals like chlorine are added to kill protozoa, bacteria, and viruses. Finally, tertiary treatment consists of additional filtration, distillation, or other methods to further clean the water. This can be to remove any biological components. One method used is ultraviolet disinfection which kills any additional bacteria.

According to a video by the Orange County Sanitation District outlining the water treatment process in Orange County, located in Southern California, this same basic wastewater treatment process is used. However, chemicals are added to the water to allow sludge to clump together. The benefit of this process is that it increases the efficiency in which sludge is collected. The sludge is also used to create biosolids that can be used in farms as compost, instead of being disposed of which can result in the release of carbon dioxide into the atmosphere, contributing to the greenhouse gas effect. Methane, a common greenhouse gas, from the sludge is also used as energy. Another additional process used is co-generation, which is when energy generated from such processes are used to heat nearby homes.

A. GWRS: Groundwater Replenishment System

The GWRS system is the Groundwater Replenishment System used by the Orange County Water District. As of 2015, the GWRS facility produces about 100 million gallons of water per day after its expansion. It is also expected to expand even further to produce 130 million gallons of water per day for 2023. After treatment, the water is sent to recharge facilities as well as seawater barriers. This prevents saltwater intrusion, which is when saltwater from the sea seeps into our freshwater supply, thereby contaminating it and making it unusable. To prevent this, water is pumped to maintain the freshwater supply and keep saltwater out.

IV. CONCLUSION

The water treatment process is a complicated one with many steps and substances used in order to provide the clean water that we have the privilege of accessing. There are those cities and communities such as those near the San Joaquin Valley that are already facing the effects of California's struggling water table. The issues that these communities are facing spread far beyond the fact that they do not have access to safe drinking water, but link back to issues of healthcare and climate change. Therefore, the solutions for these issues are also broader, requiring the actions of many rather than one single change. However, there are changes that can be made to at least improve the conditions in smaller areas. For example, as Orange County does with its waste and bioproducts like sludge, methane, and carbon dioxide, other counties and cities can put these substances to use rather than simply disposing of them. This can increase our use of sustainable energy while reducing our output of greenhouse gasses.

Figure 1: The Central Valley Project

Figure 2: The State Water Project

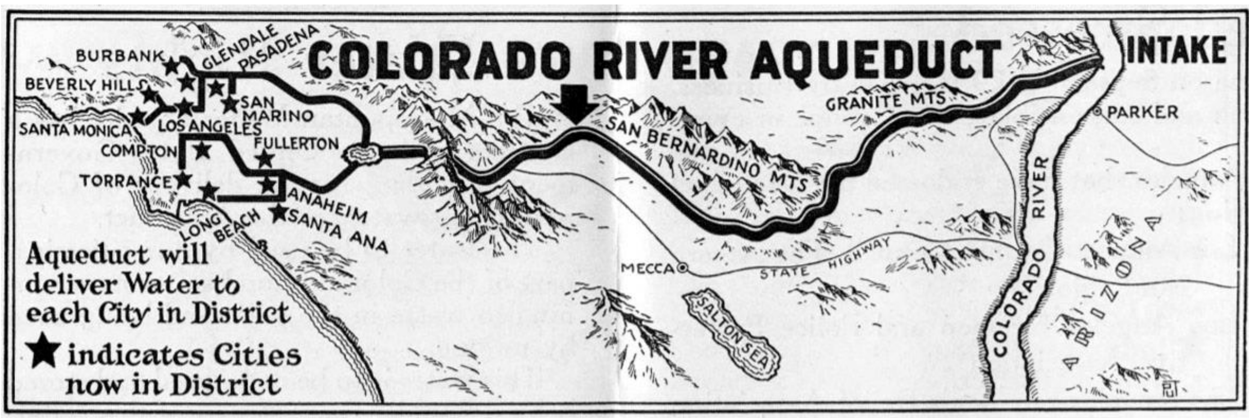
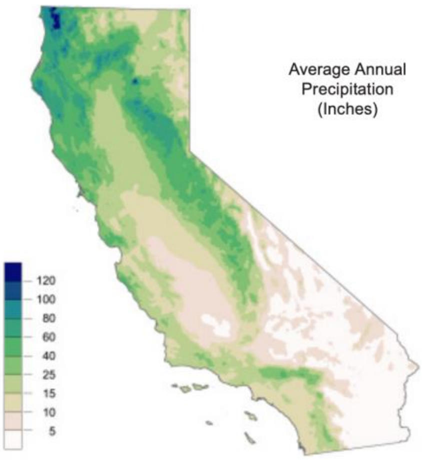


Figure 3: The Colorado River Aqueduct



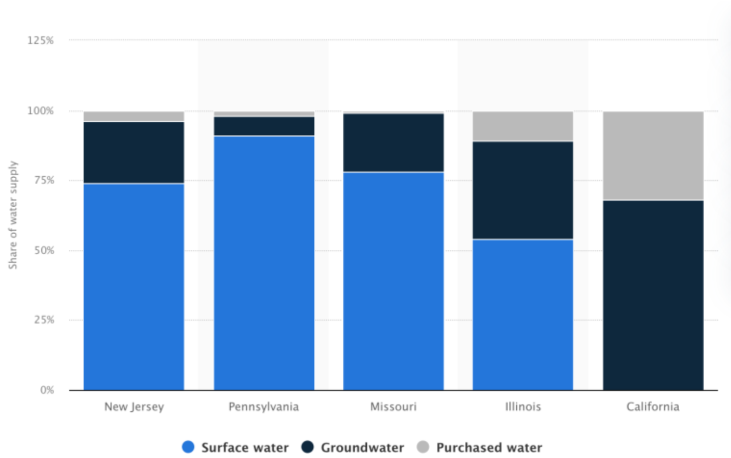


Figure 4: Average annual precipitation in California Figure 5: Water Supply Distribution in FY 2022 by Source and State

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