No hay agua:  
Water Scarcity Affecting Farmers in Ensenada BC, Mexico Catalyzing the Requirement for Adaptation Methods to be Implemented
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Abstract

Farmers in the Ejido of Maneadero wake up to the recurring nightmare of the phrase “no hay agua” (there is no water). Maneadero, a coastal town part of the municipality of Ensenada Baja California Mexico, is composed of land that is primarily used for agricultural production and relies on water from the Maneadero aquifer. Due to increasing population, water demand has increased drastically. Most of the water that is extracted from the aquifer is not used for agricultural practice in the area, rather it is sent to the city of Ensenada for domestic purposes. This causes water levels to plummet in the aquifer and forces farmers to continue extracting water to irrigate their crops although levels are low. Furthermore, due to climate change and drought, the aquifers have not been properly recharged in years. This exploitation has caused extreme low water levels causing sea water intrusions into the aquifer and private wells of many farmers in Maneadero. Therefore, farmers who irrigate their crops using the available water with high levels of seawater contaminate the soil, leading to decreases in production and the decrease of the agricultural industry in the area. This study addresses the various methods that farmers, researchers, and stakeholders have thought to implement in order to adapt to changes in the climate, mitigate the harm done to the Maneadero aquifer, and find better methods of water management to support farmers.
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Introduction

“No hay agua”

My grandfather, Chuy Olmos, moved to Ensenada in 1974, two years after my mom was born. He managed to make connections with the farmers who were producing in the area at the time and started buying land to farm for export to the United States. After his death in the year 2000, my mom had to take over the company and excel as a farmer and vegetable exporter. I would always be right next to her while she worked at her desk, went to the fields, went to the packing house, and during the conversations she had with farmers. When I listened to the conversations she regularly had with other family members and farmers, the same phrase would come up again and again, “no hay agua.” This is a phrase that only haunted her before, but now haunts us both.

My mother is now only exporting vegetables and spices she buys from other farmers, but still considers herself part of the farming community, because without farmers and their support she wouldn’t be able to provide for the family, or as she would say, “yo dependo de la agricultura, si no hay agua no hay siembras, y no hay negocio.” (“I depend on agriculture, if there is no water, and there’s no business.”) When I finally conceptualized the issues regarding water access in Maneadero, and the effects not only towards my mother, but the rest of my family who also come from a long line of farmers, I felt inspired to learn more and identify the problem behind water inaccessibility in Maneadero.

I went into this project thinking that the drought and climate change affecting Ensenada were the sole reason why farmers were struggling to prosper in their
agricultural production. I idealized the reason for the lack of water to be connected with change in climate and drought. As I went about conducting the interviews with my uncles, I realized that many local farmers in Maneadero are doing everything they can to protect their crops from the drastically changing climate, and to reduce the amount of water needed. They are gradually adopting new technologies that allow crops to become less vulnerable to freezing temperature drops and dehydrating temperature increases, and new methods of irrigation that decrease the amount of water being wasted. Now, I noticed that when I conceived of this research, I completely overlooked a very important aspect regarding agricultural production in Maneadero from the very beginning; polluted water. Water became the key theme when referring to farmers struggling to maintain agricultural production.

The struggle for farmers and food producers indeed stem from the lack of water, but water scarcity does not look the way I imagined it. Some people have water wells that are connected to the aquifers that are full of water, but they are also highly tainted by sea water. Due to aquifer exploitation and drought-related low water levels in local aquifers has caused sea water intrusions to completely contaminate many wells. This water cannot be used for agricultural, industrial or domestic purposes because it is too salty. The water is also not suitable for human consumption, which adds another level of water inaccessibility for the community and even for those who have private wells at home. And, if farmers use the water from a well that has high levels of salinity to irrigate their crops, over time the soil will become contaminated with high levels of salinity, making the land completely unsuitable for farming. The decreasing levels of production are not led directly by the effects of ambient change in temperature on the crops, although heat
can play a part. Rather, it is the availability of unpolluted water, or lack thereof that is the crucial factor. The many roles and factors that play into the inaccessibility of clean water for agricultural use in Ensenada is the main issue addressed in this research.
Literature Review

The purpose of this literature review is to provide context of how the ongoing drought is affecting farmers in the community of Maneadero and the adaptations that have been adopted through legislative, social, and academic initiatives. This piece will also present suggestions for future considerations with regard to the means in finding methods of adaptation to the current posture.

Drought Affecting Farmers and Ground Water Supply

Ensenada has suffered an ongoing drought for the past decades, and is currently bearing a furthered decrease in precipitation. After crossing the San Ysidro-Tijuana US/Mexican border into Mexico, Ensenada is located 100km south of Tijuana (Medellín-Azuara et al. 2007). It is important to recognize that Ensenada relies completely on groundwater as its potable water source (Medellín-Azuara et al. 2007). This is a crucial issue because the area, which is suffering through strenuous drought, is a leading producer and exporter of agricultural goods (Mendoza-Espinosa and Daesslé 2018). In the case of this study, the Maneadero Valley (also known as Rodolfo Sanches Taboada), located 10 km south from the city of Ensenada (Elizondo and Mendoza-Espinosa 2020), is specifically analyzed.

The weather cycle and conditions in Ensenada mostly consist of “Mediterranean climate, dry summers and winter rainfall” (Elizondo and Mendoza-Espinosa 2020). To get a quantitative idea of Ensenada’s precipitation, the study by Daesslé et al. (2005) mentions that the annual rainfall from 1948 to 2002 was 248 mm. Most of Baja California relies on groundwater which makes BC extremely vulnerable to droughts (Villada-Canela et al. 2021). In Baja California, agriculture accounts for 87% of the total
water consumption (Cortés-Ruiz and Azuz-Adeath 2021). Mendoza-Espinosa, Victoria Orozco-Borbón, and Silva-Nava (2004) referred to a study done in 2002 and mentioned that Ensenada extracts 71% of water from the aquifers for agricultural purposes. Daesslé et al. also shared data from 1937 to 1997 in order to get an understanding of the overexploitation of the aquifers of Maneadero:

"Water extraction from the Maneadero aquifer started with \(2.5 \times 10^6\) m\(^3\) in 1937, increasing up to \(25.7 \times 10^6\) m\(^3\) in 1997. Of this extraction, about 70% has historically been used to sustain extensive agriculture in the Maneadero Valley (Comisión Nacional del Agua 1997a). Recharge rates, however, have not kept pace with extraction and have generally been less than the total discharge of the aquifer (i.e., extraction, evaporation and losses to the ocean) since 1960 (Fig. 2)" (Daesslé et al. 2005).

The over exploitation and the improper rechargement of the aquifers of Maneadero can lead to detrimental effects for the community and agriculture. Daessle et al.(2005)

![Graph showing water extraction and recharge over years](image)

**Figure 1.** Image taken from Daesslé et al. 2005. The graph presents the total amount of water extracted, the amount that was extracted for agricultural use, and the recharge-
discharge balance. This is a yearly analysis from 1948 to 2000, reported by the National Waters Commission.

provides a graph (Fig.1) that represents the total extraction, the amount of water that was extracted for agricultural purposes, and the recharge-discharge balance of an aquifer in Maneadero. In the graph, not only do we see that total extraction has increased throughout the decades, we also notice that the recharge and discharge levels decrease throughout time as well. If we look closely, we also notice the increased amount of water extracted for purposes not being for agriculture. This allows us to see the levels of extraction and recharging that has happened in the past, and helps us to further understand what steps need to be taken for the future, such as finding methods to recharge the aquifer.

Most of the population in Maneadero is aware of the current drought affecting the town’s community and the agricultural production of the area. Villada-Canela et al.(2021) mentions that ninety percent of the land in Maneadero Valley is oriented for agricultural purposes which demand water from the aquifers, demonstrated in Figure 2. Water demand has been elevating, but the water availability has not been enough to fulfill agricultural demands. Cortés-Ruiz and Azuz-Adeath (2021) have mentioned from a United Nations Water report that water demand has increased “by about 1% yearly since the 1980’s mainly due to population growth, socio-economic development and evolving consumption.” They also claimed that “the increase of population and water consumption (overall and per capita) has led to the rise of water shortages” (Cortés-Ruiz and Azuz-Adeath, 2021). Elizondo and Mendoza-Espinosa (2021) therefore discuss how intensive extraction of the aquifers has been taking place, causing aquifer water levels to decrease, which is in turn furthering water scarcity in the area. Intensive extraction of water in the
aquifers has caused marine water intrusion to seep into the Maneadero aquifers (Villada-Canela et al. 2021) causing salinated wells and abandoned farmland (Mendoza-Espinosa and Daesslé 2018). Mendoza-Espinosa and Daesslé (2018) state

*Figure 2.* Map showing that 90% of the area of Maneadero is used for agricultural use as “growing area” as compared to “urban”. Image taken from Villada-Canela et al. 2021.

“that seawater intrusion has severely contaminated the Maneadero aquifer, causing farmland irrigated with this water to become polluted. Villada-Canela et al. (2021) also mentioned that due to marine intrusion, high salinization contamination is present in the Maneadero aquifers by stating that the “total dissolved solids (TDS) concentrations between 1.1 and 26.9 g L⁻¹, by far exceeding the maximum permissible limit of 1 g L⁻¹ (Official Mexican Standard NOM-127-SSA1-1994).” When Mendoza-Espinosa and Daesslé (2018) state that “Seawater intrusion has severely contaminated the Maneadero
aquifer and the soil irrigated by these waters close to the coast,” they make a very important observation. Daesslé et al. (2005) points out in their study that “water for urban consumption is extracted from five wells along or adjacent to the Arroyo San Carlos riverbed, and is managed by the State’s Public Services Commission (CESPE). Water quality in these wells has not been affected as severely as in the wells positioned along the coast.” All wells were tested and noticed that salinity levels were much higher in the ones that were closer to the coast, resulting in higher concentrations of seawater. Both of these studies, Mendoza-Espinosa and Daesslé (2018) and Daesslé et al. (2005), highlight the crucial need for underground analysis to understand the maintenance required to preserve aquifer conditions.

Although climate change is very noticeable from the outside, it is necessary to study climate change in regards to its effects underground. Andreas Winkler analyzed the book *Climate change effects on groundwater resources: a global synthesis of findings and recommendations* published in 2011 by Holger Triedel, Jose Luis Martin-Bordes and Jason Gurdak, a book that explains the vitality of analyzing underground climate change. Winkler mentions that “research has largely focused on the responses in surface water due to visibility and accessibility; unfortunately knowledge about the impact of climate change on groundwater quality and quantity is limited” (2013). For the town of Maneadero, which relies heavily on groundwater extraction, this means that there needs to be more analysis and understanding of the change happening underground, in the aquifers. More than half of the surface land in Maneadero is pumping water that is polluted with high salinity levels, which is affecting the soil quality due to the use of this water for irrigation (Mendoza-Espinosa, Victoria Orozco-Borbón, and Silva-Nava 2004).
Winkler states that “examining aspects of climate change underground is an essential topic when water scientists are discussing the effects of global change” (2013), and that “a better understanding of aquifers in the regional hydrologic cycles is the basis for a reliable judgment of climate change impacts and the necessary adaptation to new challenges” (Winkler 2013). This realization has allowed scientists and researchers to expand their horizons when envisioning climate change and the ways it affects the world, by shifting mentalities from mitigation to adaptation.

Many local scientists in Ensenada have decided to focus part of their research on groundwater and the evolving changes happening underground. An essential aspect regarding the aquifers of Maneadero is that the closer the aquifer is to the ocean, the higher the concentration of salinity is present, and as previously discussed, we know that this is caused in part by over extraction of the aquifers. Now, it is crucial that locations that are becoming increasingly vulnerable to drought find ways to adapt and mitigate the harm that has been done for decades, ultimately creating a sustainable method for water demand. Understanding the harm caused to the aquifers allows water officials and scientists to realize that “minimizing intensive groundwater extraction will reduce vulnerability of coastal areas” (Gurdak, Jose Luis Martin-Bordes, and Holger Treidel 2011). Winkler (2013) suggests that more inland areas should be used to extract from aquifers if possible. In order for farmers to keep agricultural production afloat in Maneadero, programs need to be put in place to secure water for irrigation, which requires large amounts of funding. Ríos Flores, José Luis, Miriam Torres Moreno, José Ruiz Torres, and Marco Antonio Torres Moreno argue that the cost of water obligates farmers to find cost effective crops that will achieve sustainable socioeconomic and
environmental integrity in regards to agricultural irrigation. This conclusion also ties to Elizondo and Mendoza-Espinosa expressing that “sustainable groundwater management in the future requires groundwater to be used in a manner that can be maintained for an indefinite time without having unacceptable environmental, economic or social consequences (Kløve et al., 2014)” (Elizondo and Mendoza-Espinosa 2020). Taking all of this into account, the farming community of Maneadero is enduring worsening water scarcity due to the combination of drought and over-exploitation of the aquifers on the coast and will require large amounts of investment in sustainable water infrastructures.

**Water Demand Exacerbating Water Scarcity: Water Governance and Adaptations**

Water demand has been steadily increasing over the years, and so have the effects of climate change on water supply. Villada-Canela et al. (2021) mention that groundwater withdrawal has been restricted since 1965 in Maneadero, leading to reduced land use and furthering the decrease in agricultural production. They also discuss how this created a shift in the water demand increasing from agricultural to urban. Elizondo and Mendez-Espinosa (2020) further this claim by stating:

“As in other places, some of the factors that are driving Ensenada to water scarcity are the increasing competition among the different water users, particularly agriculture and urban mismanagement of water resources from the authority responsible resulting from procrastination and failure to take actions. Aquifers have often been marginalized in water management by not being considered in water planning efforts and management” (Elizondo and Mendez-Espinosa 2020).

Elizondo and Mendez-Espinosa mention the significance of the competition for water in Ensenada. Further, they argue that there is mismanagement of water and marginalization
when it comes to the Maneadero aquifers. Consequently, they argue that water scarcity is not only due to drought and over extraction of the aquifers, it is also caused by mismanagement of water resources and the marginalization of local water management. Villada-Canela et al. (2021) also discuss hows the lack of knowledge about the “availability, quantity, and quality” of water sources is a historic conundrum in Ensenada.

![Graph showing population and water demand](image)

Figure 3. “Population and water demand for the city of Ensenada, Baja California, Mexico, 2015-2035. Source: Built with information from CEA (2017)”(Elizondo and Mendoza-Espinosa 2020). Image from Elizondo and Mendoza-Espinosa’s (2020) study to demonstrate water demand in Ensenada.

When it comes to water and the rights to water, the people who are responsible for these decisions are stakeholders in the government sector. Ensenada has been struggling to use all their aquifers but the state and federal government have failed to implement actions to protect the resources for managing abundant water sources (Elizondo and
Mendoza-Espinosa 2020). The resulting lack of fresh water has increased demand for desalination processes over the past 15 years, but the water still isn’t the best quality and has caused a dramatic decrease in hectares used for agriculture (Elizondo and Mendoza-Espinosa 2020). Winkler (2013) argues that the possibility of desalinating water, or using sea water in this regard, would be cost effective if costs were reduced to produce drinking water, but the cost would be exorbitant if used for irrigation. The city of Ensenada has also tried to work through the costs of implementing more desalination plants (Elizondo and Mendoza-Espinosa 2020).

As mentioned previously, Ensenada relies heavily on underground water, and when there is not enough, all alternatives need to be used to provide water for the community, and farmland in the Maneadero Valley (Medellin-Azuara et al., 2007). The use of treated water, also referred to as reclaimed water (RW), is being utilized more and has become more accessible, but the water needs to be certified since most of the agricultural produce is sent to California (Mendoza-Espinosa et al., 2004). This becomes an issue when farm owners themselves are expected to treat their own water and absorb the associated cost. Mendoza-Espinosa and Daesslé (2018) underwent a project to understand the issues pertaining to the use of treated residual water, they stated that:

“In spite of the need for reuse, the Baja California state water authority was reluctant to invest in the construction of the aqueduct that would carry RW from El Naranjo wastewater treatment plant (WWTP) to Maneadero unless written consent by farmers to accept RW for crops’ irrigation was provided. Such an agreement was reached in 2009 and the State Government built a 20-km-long pipeline from El Naranjo WWTP to the south of the Maneadero Valley, which ended at a 2,000 m³ distribution tank (Daesslé et al. 2014). These facilities, however, were never used, as farmers were expected to pay for each m³ of RW supplied and invest in their own infrastructure to connect to the distribution tank to receive RW for irrigation” (Mendoza-Espinosa and Daesslé 2018).
Both demonstrate how state government officials heavily interfere with their desires to put systems in place that would allow water abundance for the area. They further explain that there was a verbal agreement between farmers in Maneadero and CESPE, CESPE proposed a deal that farmers would receive treated water at no charge to encourage them and promote the awareness of its use, since most were hesitant of the idea of using wastewater for utility. But, according to recent research, “there is no written agreement between water authorities and farmers about the length of this deal to provide RW for free” (Mendoza-Espinosa and Daesslé 2018). This was done this way because it was expected that farmers would eventually pay the RW tariff, which is set by the State Government (Mendoza-Espinosa and Daesslé 2018). They also mention this issue as a cultural issue: “Developing operational water reuse programs around the world can be very challenging. There are a series of factors that have to be considered, many dealing with cultural issues” (Mendoza-Espinosa and Daesslé 2018), in this case referring to the acceptance of the use of treated or reclaimed waters.

As previously mentioned, the Mexican legislature, specifically in Ensenada, Baja California has failed to implement actions that demand proper water treatment, “which has led to the redesign and transition of management models of water resources” (Cortinas, 2019). Mendoza-Espinosa and Daesslé (2018) mention that for there to be consolidated water reuse in Maneadero, steps need to be taken for assessment that can be divided into five stages of action: “(1) RW quality; (2) groundwater quality; (3) water management options; (4) stakeholders negotiation and institutional arrangements; and (5) monitoring and impact on the environment” (Mendoza-Espinosa and Daesslé 2018). These steps include crucial aspects of creating the foundation for the use of reusable
water in Maneadero. A major issue with approving RW for agricultural use in Maneadero is its need to be further processed and the maintenance needed for treatment facilities to produce the clean water, Mendez-Espinosa and Daessle (2018) argue this by stating that,

Although the RW in Maneadero was usually below the maximum threshold, it was clear that the WWTP (wastewater treatment plant) had problems that caused high levels of TSS, BOD5, and fecal coliforms some of the time. Other parameters that could be of concern are nitrates and helminth eggs. Nitrates are not considered a problem by Mexican legislation and are not included in legislation for RW. However, helminth eggs are considered a problem and should be below 1 egg per liter, according to Mexican legislation for treated wastewater. (Mendoza-Espinosa and Daesslé 2018)

This is a central part in the process to maintain a WasteWater Treatment Plant (WWTP) fully equipped and sustainable. There also needs to be proper maintenance due to the fact that wear can lead to treatment problems that can cause “high levels of TSS, BOD5, and fecal coliforms some of the time” (Mendoza-Espinosa et al., 2018) to be present in treated water. Contrastingly, Mendoza-Espinosa et al. (2008) claim that the natural residues from treated waste water are beneficial to grape vines, “The concentration of carbohydrates, organic acids and pH were similar in grapes from vines irrigated with wastewater to those irrigated with groundwater” (Mendoza-Espinosa et al., 2008). More leaves and more grape vines were actually sprouting due to the use of treated wastewater (Mendoza-Espinosa et al. 2008). Having a trustworthy WWTP would also allow for aquifer recharge in Maneadero as expressed by Mendoza-Espinosa, Victoria Orozco-Borbón, and Silva-Nava (2004): “Apart from reuse in crop irrigation, other potential reuse for the wastewater would be the injection to the Maneadero aquifer in order to maintain a balance between extractions and recharge. Nonetheless, starting on “June 29, 2014, approximately 200 lps (6.3 Mm³ y1) of disinfected secondary effluent from CESPE’s
wastewater treatment plants started to be delivered continuously to Maneadero Valley” (Mendoza-Espinosa and Daesslé 2018).

Other water management and irrigation systems have been put into analysis and consideration, and have been a prominent topic of study in Maneadero. For example, J. Medellín-Azuara et al. (2007) conducted a study that modeled a system of distributing treated waters all over the municipality of Ensenada using the CALVIN model, which is “an economic-engineering optimization model that jointly considers water management and economic performance, including water sources, storage and agricultural, environmental and urban water uses” (Medellín-Azuara et al., 2007). This system makes sure to use all of the available water sources to become the most efficient water management system to be put in place, receiving water from all sources and managing to allocate water to every community. This model is illustrated below.
Figure 2. General Schematics of the CALVIN model that is planned to be used for Ensenada’s region (Medellin-Azuara et al. 2007).

This could be a crucial system used in Ensenada that provides and distributes water to Maneadero and Valle de Guadalupe which are the two biggest agricultural producing areas (Medellin-Azuara et al., 2007).

Another water management solution that has been studied to pull water from the Colorado River aqueduct that runs through Mexicali. Ensenada is actually the only city in Northern Baja California that doesn’t receive water from this source (Mendoza-Espinosa and Daesslé 2018). This ‘solution’ also seems to present different challenges, mainly regarding costs to implementing the aqueduct which would be too high (Daesslé et al. 2005). This possibility was actually considered by “CESPE, the State of Baja California Water Commission (CEA), and the National Waters Commission (CNA)” (Daesslé et al. 2005). Another present issue is due to climate change, Elizondo and Mendoza-Espinosa (2020) mention that “the water allocation to Mexico from the Colorado River will vary depending on the water levels of lakes Mead and Powell in the USA, creating an uncertain future scenario for Mexico regarding water's allocation. It is expected that the use of water from the Colorado river will decrease by 8% by 2035 due to climate change” (CEA, 2017) (Elizondo and Mendoza-Espinosa 2020). The article by Jaweed Kaleem and Ian James states the current conditions of the colorado river and lake Mead, “the water woes on the Colorado River have gotten only worse as extremely hot, dry conditions have baked the watershed, dramatically reducing flows. Lake Mead, which was close to full in 2000 and at 41% of capacity when the 2019 deal was signed, is now at 34%” (Kaleem and James 2021).
Efficiency seems to be the major concern for these water management proposals to be put into place, specifically economic efficiency. Although Villada-Canela et al. (2021) discuss the various inefficiencies in Ensenada’s Government and water management systems, there is also a need to understand the amount of water consumption required to result in a certain amount of agronomic produce. Ríos Flores et al. (2016) published a study where they calculate efficiency in Ensenada and Mexicali for wheat farming to understand the relation between water consumption to final produce harvested and presented this as “water efficiency” (Ríos Flores et al. 2016). Ríos Flores et al. (2016) explain that:

“eficiencia del agua, propuesta por Mekonnen & Hoekstra (2011), como un cociente donde el numerador se encuentra la cantidad de agua empleada para la producción de de- terminado cultivo, y en el denominador se encuentra la cantidad de producto generado (físico, económico, social). La ecuación general para un número índice de eficiencia del uso del agua estará dada por:

\[ \text{Efficiency} = \frac{\text{Water Quantity}}{\text{Units of Product (físical, economic, or social)}} \] (Ríos Flores et al. 2016)

They present a formula that allows farmers and researchers to understand how much water is being used to produce a certain amount of produce from whatever crop they have planned. This would also allow researchers and farmers to understand which crops should be produced in certain areas during certain seasons for there to be the maximum water production efficiency. Speaking of efficiency, Villada-Canela et al. (2021) mention another perspective from which we can see inefficiencies in water management, notably, “the lack of an updated wells inventory, the lack of an updated integrated water management plan[...] and disinformation between users and authorities regarding the groundwater quantity and quality” (Villada-Canela et al. 2021). Altogether, these forms
of water management show possible ways of responding to the drought but also the
difficulties faced by farmers in implementing various solutions.

Methods

This is an autoethnographic qualitative research project where I write about and
describe my family's past in relation to farming and our relation to water scarcity. Water
is a vital and crucial resource for life. This may seem obvious, but many people have not
conceptualized the conundrum of water scarcity. With the ongoing drought in Baja
California, I was curious to know how the community and economy was being affected
by this water crisis, specifically land farming in Maneadero. For this research project, I
looked at the effects of water scarcity and water conditions affecting farmers in the
community of Maneadero. Maneadero has had to manage extended issues with water
availability and quality. And all farmers in Ensenada have needed to find ways to adapt to
the ongoing drought affecting Baja California.

Construction of Research Instrument

In regards to my research instrument, I started off by interviewing three different
groups of people who I thought would give me the best perspective and view towards the
water crisis in Ensenada. With this in mind, I initially thought of interviewing farmers
and field irrigators from Maneadero, along with researchers at the local higher education
institutions in Ensenada, but due to time restraints, I was only able to interview farmers,
researchers and a stakeholder.

As I was writing my research instrument, I made sure to write it all first in
Spanish. I did this strategically because I knew that all my participants were going to be
predominantly Spanish speakers. I wanted to make sure that my questions would be clearest in the language I was going to speak them in. After I finished writing the research instrument in Spanish, I went back to translate all of the questions and sub-questions. I had to make sure to word the questions strategically so that I could interview people with diverse opinions and views towards climate change. I also didn't want to make the assumption that climate change is the cause for the drought, so I sought to make my questions open-ended to make room for this potential diversity of opinions and perspectives.

Participants

I started off by interviewing my mother Janette Olmos in order to get an understanding of how our family started farming in Maneadero and why we are struggling with water accessibility. I then interviewed two of my uncles, Adrian Olmos and Hector Olmos, who are siblings that continued on with the practices and knowledge that they inherited from their father. I also interviewed the Maneadero Ejido President who is also a farmer: Lic. Raymundo Chávez. Additionally, I interviewed an irrigation engineer who is the Chief Operating Officer at the Technical Groundwater Committee (COTAS, acronym in Spanish) in Maneadero, Lic. Alejandro Guzmán. Then, I spoke with two local professors from the Autonomous University of Baja California Ensenada (UABC, acronym in Spanish) who have conducted experiments and are experts on aquifer conditions and water management: Dr. Mariana Villada-Canela and Dr. Leopoldo Espinoza-Mendoza. I further interviewed another local academic from Ensenada’s Center for Scientific Research and Higher Education (CICESE, acronym in Spanish) who specializes in water use efficiency at biological and plant levels for Mexican cultivators:
Dr. Rodrigo Mendez. Finally, I spoke with the head of the Rural Development District representing the agricultural sector who is the Secretary of Agriculture and Rural Development (SADER): Engineer Francisco Sánchez. I interviewed a total of nine (9) people in Ensenada.

**IRB Submission**

For this project, I needed to collect personal experiences from farmers and other local stakeholders and academics, meaning that I was going to be interviewing human subjects. Many risks can arise from interviewing human subjects when speaking about issues that make them vulnerable to social censure. Also, another risk that weighed heavily on the methods through which I conducted my interviews was the currently ongoing pandemic of SARS-COV-2. This pandemic has affected us all in various shapes and forms. I was mindful of the potential risk of conducting in-person interviews and the possibility of contracting or transmitting the deadly virus.

The submission of the Institutional Review Board application to Kalamazoo College was in May and it was approved on the 9th of June in 2021. Since I wanted to offer the participants the option to choose to use a pseudonym or their own name, this required thorough analysis of the application to make sure that their identity was kept confidential. Although I offered the option of using a pseudonym to all of them, they all signed the consent form without requesting a pseudonym. Meaning that they agreed on having their names be mentioned on this manuscript.

I also made sure to create three different questionnaires for the three different groups of people I had planned to interview: farmers, stakeholders and researchers. Only I had access to the audio recordings, transcriptions, and codes. The documents were
saved using an identifier code. The code began with the interview number, followed by a colon (:), and the initials of the name and last name they provided. The named files using the code would essentially look like this: 1:AB, this would potentially represent the name of a file if it were the first one conducted and the consented given name was “Anthony Brown.” This would either be the pseudonyms that the participants chose to use, or their real legal names. This would allow for further protection of identity and confidentiality. Documents will only be saved in the computer owned by Mauricio which will be used to process audio files and transcriptions filed under their code, and ultimately write the final report using the transcripts and use their preferred name.

**Recruiting**

When recruiting, convenience sampling was used to recruit family members to be interviewed, snowball sampling method was used to network with local academics and researchers, and, finally, I used purposive sampling to speak with specific types of local stakeholders in water management in Ensenada and Maneadero. When it came to contacting my family members for this project, I had to keep in mind that they do not use electronic mailing accounts. I had to consult my mother for their phone numbers. Neither of them answered the phone because they didn't recognize the number I called them from, so I had to call them using my mother’s phone. I started off with a personal conversation to catch up with them and then asked if they were willing to be interviewed for my project. They followed with the questions: “Why? What are you going to ask me? How am I going to help?” I answered by saying that my project was on the effects of drought on farmers and agricultural production, and that I just wanted to hear their evolving experiences with farming. After considering it, they felt that the interview was not going
to be putting them at any risk and they both agreed to participate. I also had to call other community members from Maneadero to recruit interviewees, along with arriving in person at governmental sector offices to find someone who could answer my questions. These conversations would consist of me introducing myself, explaining my project, and communicating why their input is crucial for my research. When it came to professors and academics, their contact information is available through departmental websites, which I had very easy access to. I emailed them hoping they would answer promptly, and if they did not answer the email I planned to call their offices as a last resort. Fortunately, they all answered within the same day or the following day. The email that I sent to professors and academics read:
Muy cordiales saludos [Nombre].

Espero y se encuentre bien y con mucha salud. Me llamo Mauricio Guillen Olmos, soy estudiante de Kalamazoo College en Michigan. Me comunico hoy con usted porque ahorita estoy recolectando datos para mi tesis cualitativa y me encantaría poder entrevistarlo.

Mi tesis trata sobre la sequía de Ensenada y los efectos hacia los agricultores y comunidad de Maneadero. Sera reportado en el departamento de antropología y sociología de mi Universidad como un proyecto de investigación cualitativa.

Me encantaría entrevistarlo para poder platicar sobre [menciona sus estudios publicados, sus campos de estudio y trata de conectarlo con mi estudio lo mejor posible]. Este proyecto significa mucho para mi ya que la mayoría de mi familia son agricultores en Maneadero, y quisiera seguir con esta investigación de cambios climáticos y los efectos hacia la agricultura.

¿Gustaría participar en mi estudio? La entrevista dura aproximadamente 45 minutos a 1 hora. Estaré en Ensenada hasta el 9 de septiembre si es que prefiere la entrevista en persona, o por Zoom si se siente mas cómodo por video llamada. Si gusta mas información, porfavor déjeme saber para mandar el consentimiento informado. Apreciaría mucho su tiempo y apoyo.

Espero su respuesta con emoción. Muchas gracias.

Greetings [NAME],

I hope this finds you well and with abundant health. My name is Mauricio Guillen Olmos and I am a students from Kalamazoo College in Michigan currently conducting ethnographic research under the supervision and advising of Dr. Adriana Garriga-Lopez. I am communicating with you today because I am currently collecting data for my qualitative research thesis and would love to interview you.

This ethnographic research project is for my senior thesis on the ongoing drought that Ensenada BC Mexico has endured and will continue suffering through. My research project will be turned in to my institutions department of anthropology and sociology as a qualitative ethnographic research project.

I would personally love to speak with you, specifically around the last paper you published [mentioned their prior published research, their fields of study and tried to connect it with my research as best as I could]. This research project is extremely important to me since most of my family are farmers in Maneadero, and would like to further the research on climate change and its effects on farming.
Would you like to participate in my project? The interview lasts approximately 45 minutes to 1 hour. I will be in Ensenada until September 9th if you prefer to have the interview in person, or we could also have it through Zoom if you feel more comfortable virtually. If you'd like more information, please let me know. Your time and support is very much appreciated.

I wait for your response with excitement. Thank you very much.

Cordially,

Mauricio Guillen Olmos

Interview Process

When collecting data and conducting interviews, I made sure to offer the choice to conduct the interview through a telecommunication medium or to conduct it in person if they preferred. This research experiment was conducted from June to September in 2021, while the COVID-19 pandemic was still actively affecting many communities around the globe. The biggest risks of conducting this research was the exposure during the in-person interviews and the possibility of contracting the deadly virus. This is why it was fundamentally necessary that I offer the option of virtual interviews by Zoom or other platform.

Telecommunication Mediums

When conducting the interviews online, I made sure to have my Zoom account ready to be used and send meeting invitations. Although I made sure to prepare my Zoom account, I never used it for this study. Every person who I interviewed through a video call suggested we use Google Meet instead. They had mentioned that Google Meet didn't have a time limit the same way Zoom did. And, they also mentioned that it was just much easier to access and navigate compared to Zoom. After talking through the consent form with them, I would turn on the recorder on my phone and initiate the interview.
**In-Person**

I was able to interview most of my participants in person. Mindful of the ongoing pandemic, I made sure that all safety measures were taken for the participants' comfort and my own. The safety protocol that I established was, 1) asking them what setting would make them feel the safest, 2) always kept my mask on covering both my nose and mouth, 3) I made sure that we were 6 feet apart, and that 4) windows were opened if possible. And once we were seated in a comfortable position, I discussed the consent form, had them sign it, turned on the recorder on my phone and started the interview.

**Analysis**

When it came to analyzing and processing my data, since I had funds for this project, I transcribed my Spanish language audio recordings using the transcription service GoTranscript (www.gotranscript.com). After I received the transcriptions, I read them and considered what patterns emerged. I also considered the recurring themes in the interviews and created a list of codes. I then went through and coded them for common themes. I realized that the major themes in terms of understanding water scarcity in Maneadero affecting farmers consisted of water management, stakeholders holding power over water, change in climate, adaptation to climate and aquifer conditions, and methods to mitigate harm caused to the aquifers. I started off by analyzing the observations mentioned by the farmers and the issues they see in regards to water scarcity. After mapping out what the farmers considered to be the factors leading to the lack of water accessibility, I went on to analyze the answers of the stakeholders and researchers I interviewed. This allowed me to compare answers and try to bridge connections with the farmers' experience and the answers that the stakeholders and
researchers mentioned. Ultimately, I was able to map out as many factors possible that leads to water scarcity, but only focused on the right of water, aquifer conditions, climate change, and how these affect farmers and the farming industry.

RESULTS AND ANALYSIS

CHAPTER 1:

Evolving Drought in Ensenada Catalyzing Agricultural Adaptations Requiring Accountability from Stakeholders for Water Management.

In this chapter, the ways in which farmers are being affected by water scarcity due to drought and poor water management will be analyzed. I initially imagined the issues of farmers enduring lack of water access due to the drought, but later realized that the problems concerning farmers and their ability to produce efficiently is not solely dependent on climate change and drought, rather the issue also constitutes water mismanagement and marginalization of the Maneadero aquifers. The perspectives that water scarcity is viewed through in Ensenada and its shift from mitigation to adaptation will also be analyzed through the lens of the farmers that I interviewed, who are my uncles in Maneadero, the legislators who I spoke to, and the academics who have done extensive research on water management and aquifer exploitation through levels of demand.
Perspectives and Experiences with Climate Change in Ensenada

The Maneadero Valley, part of the Municipality of Ensenada, has been significant for its agricultural production since the early 1900’s and its constant “Mediterranean” weather. Daesslé et al. (2005) mentions that Maneadero’s early farming years depended on the adoption of “monoculture system of chilli and alfalfa. Farming activities changed between the 1940s and 1970s mainly into tomato and olive trees; to later evolve into more diverse crops, such as horticulture, marrow, peas, potatoes, string bean, flowers, etc.” Ensenada’s constant weather consists of an average temperature of 26.8°C with an average minimum of 11.7°C, this information is obtained from data collection from 1980 to 2018 weather records (Cortés-Ruiz and Azuz-Adeath 2021). When I interviewed Maneadero’s Ejido President, he mentioned that the temperature in Ensenada was similar to that of the Mediterranean:

This ejido for years was number one in the country and continues to be one of the most important at the ejido level. That is why we must conserve the land as agriculture, producing [...] The climate we have is a Mediterranean-type climate. We are in the middle of the wine belt, which is called the Mediterranean Belt and we have a climate here averaging 25 degrees per year. As who says, we have natural air conditioning all year round [...] this climate allows us to practically have crops all year round.

Este ejido por años fue el número uno del país y sigue siendo uno de los más importantes a nivel de ejido. Por eso debemos de conservar la tierra como agricultura, produciendo [...] El clima que tenemos es un clima de tipo Mediterráneo. Estamos en medio de la franja del vino, que le nombran la Faja del Mediterráneo y nosotros tenemos un clima aquí de promedio 25 grados anuales. Como quién dice, tenemos aire acondicionado natural todo el año[...] este clima nos permite prácticamente tener siembra todo el año.
- Raymundo Carrillo

He claims that Maneadero was at one point the most important agricultural producer in Mexico, and is still one of the most significant producers of the country. Raymundo also
mentions that this “Mediterranean” climate allows for agriculture to be active year round. Recently, the possibility to farm the full potential year round is decreasing.

Ensenada has been struggling greatly due to increasing effects from climate change consisting of drought, temperature rises, and aquifer saltwater intrusions. These effects have been severely catalyzed by not measuring levels extracted from aquifer leading to the overexploitation of aquifers and causing salinity of instructions into the aquifers. Extracting water from aquifers should not be an issue since this has been practiced for years, the issue is that the aquifers are being recharged at the rate that water is being extracted. I spoke with Dr. Rodrigo Méndez Alonzo, an ecology and conservation researcher from CICESE in Ensenada, and explained the specific types of droughts that are possible to occur:

Drought is a very complex issue, we normally understand drought as the hydraulic deficit that does not allow you to meet the needs of any kind, human or ecosystem. Since it is a difficult decision to say when it is a drought, there are different types of drought. Normally four types of drought are considered: Meteorological drought is when there are levels of precipitation that are lower than expected on average in a given time. For example, when two consecutive years pass with precipitation averages lower than the historical one, you can already consider that it is a meteorological drought or at first it would not be meteorological. There are other types, hydrological drought is when the levels of reservoirs, lakes, rivers, aquifers, are lower than expected over time.

Then there is another drought, which is the agronomic drought or the drought of human impact, which is when the amounts of precipitation or the extraction of water, the use of water, is not enough to be able to maintain agricultural productivity. The type that I work with is plant scale drought. We understand plant-scale drought as the process where plants cannot extract water from the soil to maintain the absorption of carbon that, finally, by photosynthesis leads to the production of sugars, plant, tissue, fruits, etc.

La sequía es un tema muy complejo, la sequía normalmente la entendemos como el déficit hidráulico que no te permite satisfacer las necesidades de
cualquier tipo, humanas o ecosistémicas. Como es una decisión difícil decir cuándo es una sequía, hay diferentes tipos de sequía. Normalmente se consideran cuatro tipos de sequía. La *sequía meteorológica* es cuando hay niveles de precipitación que son menores a los esperados en promedio en un tiempo determinado. Por ejemplo, cuando pasan dos años consecutivos con promedios de precipitación menores al histórico, ya puedes considerar que es una sequía meteorológica o al principio no sería meteorológica. Hay otros tipos, la *sequía hidrológica* es cuando los niveles de los reservorios, lagos, ríos, acuíferos, son menores a los esperados a lo largo del tiempo.

Luego, hay otra sequía, que es la *sequía agronómica* o la sequía del impacto humano, que es cuando las cantidades de precipitación o la extracción de agua, el uso de agua, no es suficiente para poder mantener la productividad agrícola. El tipo que yo trabajo es la *sequía a escala planta*. La sequía a escala planta la entendemos como el proceso donde las plantas no pueden extraer agua del suelo para mantener la absorción de carbono que, finalmente, por fotosíntesis lleva la producción de azúcares, planta, tejido, frutas, etcétera.

-Rodrigo Méndez Alonso

After he clarified the types of drought that are present, looking at Maneadero’s case, I was able to make connections with agronomic drought, meteorological droughts and hydrologic drought. Ensenada is obviously going through meteorological drought because the temperatures are inevitably increasing globally due to elevated carbon dioxide emissions which is affecting the amount of precipitation occurring. Ensenada is also enduring a hydrological drought because of the overexploitation of the aquifers and the lack of or slow aquifer recharge (Daesslé et al. 2005). All of this combined will cause agronomic drought because there is not enough water in the aquifers for agricultural irrigation, and the aquifer is what all of Ensenada and Maneadero’s domestic, industrial, and agricultural demand relies on, which is increasing as well.

The water demand in Ensenada is increasing in all sectors of demand. The demand on water could possibly have been increased due to the ratification of the North American Free Trade Agreement. NAFTA was ratified in 1992 and put into effect in
1994. This meant that the tariffs on goods being exported through the Canada, US, and Mexico borders were removed to promote trading between these countries. This allowed for easier access to trade across borders. Meaning that for the United States, it would be the most beneficial if the maquilas were close to the border, which is why we see each border state in Mexico run big maquiladoras producing billions for Mexico and the US. The Counter Human Trafficking Compliance Solutions website provides a map (Figure 1) showing the locations of the biggest and most significant maquiladoras in Mexico, referring to their production in Mexican pesos:

![Map showing production of maquiladora plants in Mexico in 2003](image)

Figure 5. Map demonstrating the production of maquiladora plants in Mexico in the year 2003 from Counter Human Trafficking Compliance Solutions. The scale of production is calculated in billions of Mexican pesos. (“What Are Maquiladoras and Why Are They so Common along the US-Mexican Border? – CHTCS” 2017).

If we look at the positioning of these maquiladoras, they are strategically built next to the border to cross goods much more efficiently, having to invest less in exporting
transportations. We can also see that Ensenada is a marked location on the map in Figure 5, very close to Tijuana, Tecate and Mexicali which are also big producers. The county of Ensenada is made up of 51,952 km² (Daesslé et al. 2008), and of all that area, all maquiladoras are placed on the north part of Ensenada. The pressure on maquiladoras and their production grew which provided more work opportunities and promoted migration to Ensenada. Not to mention the agricultural industry and the availability of field working jobs which are also prominent.

Ensenada is a growing city that is requiring increasing amounts of water to sustain the population and the economy. When I spoke with Manedero’s Ejido President, Raymundo Carrillo, he touched on the origins and the founding of Manedero. He mentioned that the first people who founded Maneadero were composed of migrants from other parts of Mexico and the United States. And, that the current growing population is still consisting of migrants who are arriving from various parts of Mexico and some from southern California. Many who have access to cross the border find it extremely practical to settle in Ensenada and cross the border when needed.

This is much of what happens, migration, people seek to improve their lives. Right now we have had a lot of migration also due to crime in the center of the country. There are many people who have come from other states fleeing the violence. For example, right now there are so many people from Michoacán, who have come from the violent parts of Michoacán, they are coming here, from Sinaloa. Despite the fact that there is violence here too. There it is stronger and that migration does not stop. All these people demand housing, they demand property, water. They bring needs and here they have found that facility. The field is well paid here in this area. People manage to get a piece of land, because there are many facilities to buy land, they build their little house. What they cannot do there in a lifetime, they come and do it in three, four years. Apart from their cart, they move, there are more facilities because of the advantage that we are from California neighbors, practically.

Este es gran parte lo que pasa, la migración, la gente busca mejorar su vida. Ahorita hemos tenido mucha migración también por la delincuencia que hay
en el centro del país. Hay mucha gente que ha llegado de otros estados huyendo de la violencia. Por ejemplo, ahorita es tanta la gente de Michoacán, que ha llegado de las partes violentas de Michoacán se vienen para acá, de Sinaloa. A pesar de que aquí también hay violencia. Allá es más fuerte y esa migración no para. Toda esa gente demanda vivienda, demanda propiedad, agua. Traen necesidades y aquí han encontrado esa facilidad. El campo es bien pagado aquí en esta área. La gente logra hacerse de un terreno, porque hay muchas facilidades para comprar tierra, hacen su casita. Lo que no pueden hacer allá en toda una vida, vienen y lo hacen en tres, cuatro años. Aparte su carrito, se mueven, hay más facilidades por la ventaja que estamos de vecinos de California, prácticamente.

- Raymundo Carrillo

Not only have many people migrated to Maneadero for job opportunities at maquiladoras, they have also opted to work in the fields since agriculture is a leading producing economic industry in the area. Many people who decide to work in the agricultural industry have worked their way to own a piece of land, build their house on it, and also use it for agricultural purposes. This is exactly what my grandparents did. When people take these steps, the people who own that property have total access to the aquifer, through the drilling of the mantle and creating a water well that can pump as much water as needed. This is how Maneadero was founded, this is how Maneadero keeps functioning, so now we need to find methods to control and accurately measure the amount of water extracted by land owners.

Understanding water accessibility for farmers who own their land and have created water wells to extract is an extremely crucial aspect to grasp the severity of private aquifer exploitation. Interviewing Alejandro Guzman also allowed me to understand how water wells and perforations work in Maneadero. He mentions that there are hundreds of water wells all over the Maneadero Valley that are actively pumping all year round to provide for domestic and agricultural purposes:
There are wells throughout the basin. Imagine 500 wells, 400 wells, 300. Each farm if it has a concession has a well and each concessionaire has the water inside his farm like your uncle Héctor, I know that he has two or three wells on his farm. [...] The concession is practically a permit from the federal government so that they can extract water.

En toda la cuenca hay pozos. Imagínate 500 pozos, 400 pozos, 300. Cada rancho si tiene concesión tiene pozo y cada concesionario tiene el agua dentro de su rancho como tu tío Héctor, yo sé que tiene dos o tres pozos en su rancho. [...] La concesión es prácticamente un permiso de parte del gobierno federal para que puedan extraer agua.

- Alejandro Guzman

He also states that there is a governmental concession that allows well owners to actively extract water from the wells, but in limited amounts to prevent overexploitation of the aquifer. The concession allowed for measured water exploitation, but without a water gauge, there is no account for measuring the amount of water that is being pulled out.

The increasing demand for water in Ensenada is indeed a big conundrum for water sustainability. In the past years, many academics and farmers have realized that the aquifers have been overexploited due to low water pressure levels from the aquifers. Interviewing Alejandro Guzman, he mentioned that there is a document called “disponibilidad de agua subterránea,” or groundwater availability in English, stating that the designated extraction volume is 38 million m$^3$ and the recharge is of 20 million m$^3$, meaning that there is an 18 million m$^3$ deficit of water recharge in the aquifer of Ensenada. This is actually newly calculated since CONAGUA decided to administer the use of water gauges for those who exploit water privately. I asked my mother about my grandparents' use of wells, she mentioned that the water gauge was installed in the well 10 years after making the well. This means that the records for how much water was exploited from the aquifer can only be estimated and not accurately quantified. Alejandro
Guzman also made sure to mention that water gauges were actually implemented late into the process of extracting water from the aquifers. Like I mentioned earlier, my grandparents built their water well for their fields and home in 1985, but implemented the water gauge in 1995. The amount of water that has been extracted before the use of the water gauge in all of Ensenada is a complete mystery.

Not only is the amount of water extracted a mystery at some points, the conditions of the aquifer and water levels are also a complete mystery. There's not enough or any available significant studies that have been done on the aquifers of Ensenada or Baja California. The aquifers are inaccessible or very hard to get to in order to study. When I asked my uncle about his water well, he mentioned that the person who perforated on his land to create a well said that the aquifer and underground water sources are truly a mystery:

I imagine that there is, I believe, as the one who drilled for two, three years says that we have been drilling, that we draw water. The driller says, "It's that down is a mystery. You don't know how the roll is down." Here it is said that this whole area, which is the social room, all this, about 1 kilometer more up it is believed that, it is not known if there is a type of lagoon below.

Eso me imagino que hay, creo yo, como dice el que perforó desde hace dos, tres años que perforamos, que nos sacamos agua. El perforador dice, "Es que abajo es un misterio. No lo sabes cómo está el rollo abajo". Aquí se dice que toda esta zona, lo que es el salón social, todo esto, como 1 kilómetro más para arriba se cree que, no se sabe si hay un tipo de laguna abajo.

- Tío Adrian

The fact that the same company and head of the perforating company do not have any information on the aquifers and the underground water sources is an issue. Perforations are regular practice in areas that rely on underground water sources. The fact that many wells are still being drilled and the conditions of the underground aquifer is a mystery
becomes a concern. If the same people who are perforating for well creations are not aware of the underground conditions, further harm will be caused to the aquifer. The extraction of water through wells does not seem to stop or lessen, therefore the reasoning behind the possibilities to mitigate the effects of overexploitation in the water is crucial.

Many have thought of methods and ways to mitigate the effects of climate change but we are too far into contaminating the world to try and reverse the effects. Raymundo Carrillo mentioned that due to the lack of water and inaccessibility to continue practicing agriculture, many of the land owning farmers decided to sell their property to lotify into housing projects. As Mr. Carrillo mentioned before, the Maneadero Valley is perfect to keep agricultural production the main industry of the area, and to keep helping the farming families and farmworkers keep their profession is crucial. After studying many of the effects from climate change impacting Ensenada and the agricultural system, many academics and scholars have realized that the main issues are now underground, and the underground climate needs to be attended to in order for the community and industries to stay afloat. The most significant method to help aid the aquifer and farmers at these levels are to find methods to recharge the aquifers and find other sources of water.

Many studies have been conducted by academics such as Mariana Villada-Canella, Leopoldo Mendez-Espinosa and Luis Walter Daesslé stating that treated residual wastewater could be the future for Ensenada's water source. Not only for agricultural purposes but also to help recharge the aquifers indirectly. When I asked Maneadero's COTAS Engineer about the use of treated water for Maneadero, he mentioned that:

**Practically the treated wastewater can be called another source. The two sources of Maneadero are groundwater and water from the El Naranjo**
treatment plant, which is water that was already used there in the city, it was treated by the operating body, which is in this case CESPE. It is practically sent to Maneadero for agricultural use, that use is not allowed today for the irrigation of vegetables, practically it is for fodder, flowers.

Prácticamente el agua residual tratada la podemos llamar como otra fuente. Las dos fuentes de Maneadero son el agua subterránea y el agua de la planta de tratamiento El Naranjo, que es un agua que ya se utilizó allá en la ciudad, se trató por el organismo operador que es en este caso la CESPE. Es prácticamente enviada a Maneadero para uso agrícola, ese uso no es permitido hoy en día para el riego de hortalizas, prácticamente es para forrajes, flores.

- Alejandro Guzman

Treated waters would become a new source of water for the people of Ensenada.

Maneadero’s Ejido president mentioned that the use of treated waters would allow the support for the agricultural production in therms of water availability. He also mentioned that this would also prevent more farmers to sell their land and lotify these fertile and blessed lands in Maneadero.

All this to say that there needs to be more consciousness from the community in accepting that all actions need to be taken in order to help the people of Ensenada and the agricultural production of Maneadero. After seeing the effects of climate change in Ensenada, and how they are affecting farmworkers and ultimately the community, this allows us to think of the next steps to take. Many solutions have been thought of and planned, but will mainly be discussing the use of treated waters for Ensenada.

Necessary Shift from Mitigation to Adaptation: Adoption of Treated Waters

From the impacts of climate change, the community of Ensenada has decided to push through and keep extracting water from low-level aquifers, causing the intrusion of sea water into the aquifer and contaminating not only the wells of many users, but also
contaminating the land they irrigated using this water. Many people don't really see the harm in over exploiting the aquifers for domestic and agricultural purposes. The first step to help aid the harm that has been done to Ensenada and Maneadero's aquifers is to actively make sure that the community is conscientiously using water, and that they are aware of the current aquifer state and its negatively evolving climate. This section will analyze how treated waters can be used, and are currently being used, to mitigate the damage that has been done in the past decades. There is no longer the possibility to mitigate climate change in a meteorological manner, but there are methods to help aid the climate change that is happening underground.

When I was conducting my interviews, one of my questions was “How can we mitigate the effects of climate change,” to which I received various answers to, but all referred to the aquifers and its recharge. Most of the effects of climate change are affecting the underground climate which is also affecting the aquifer, and due to the inaccessibility to the underground mantle, very little data has been able to be gathered and studied (Winkler 2013). This is an extremely crucial concerning the agricultural industry since it uses approximately 80 percent of the water extracted from aquifers as stated by Dr. Rodrigo Mendez:

Yes we can mitigate it. Let's remember what drought means. We have to think about what definition of drought are you going to think about here. We cannot mitigate the meteorological drought, because due to climate change the droughts are going to be increasingly extreme, of greater intensity, and of longer duration, but the agronomic drought we still have methods to avoid the escape of that. Remember that the volume of fresh water used, the largest user of the volume of fresh water used, is always agriculture. Agriculture consumes between 70% and 80% of fresh water consumption in this State, which greatly reduces the water available for industry or for human, domestic use. We still have room to play there, we have the possibility of using alternative sources of water. There is still plenty of room to avoid
falling into a day zero. We do have options. We cannot mitigate the weather due to climate change, but it must also be very clear that CO2 emissions have to be radically reduced so as not to continue intensifying these drought cycles, but even so we have options as citizens to be able to press, to continue investing in what we are doing, and being able to develop these mitigation technologies.

Sí lo podemos mitigar. Recordemos qué significa sequía. Tenemos que pensar qué definición de sequía vas a pensar acá. La sequía meteorológica no la podemos mitigar, porque por culpa del cambio climático las sequías van a ser cada vez más extremas, de mayor intensidad, y de mayor duración, pero la sequía agronómica todavía tenemos métodos para poder evitar la fuga de eso. Recuerda que el volumen de agua dulce utilizado, el mayor usuario del volumen de agua dulce utilizado, siempre es la agricultura. La agricultura consume entre 70%, 80% del consumo de agua dulce en este Estado, lo cual reduce mucho el agua disponible para industria o para uso humano, doméstico. Tenemos todavía margen para jugar ahí, tenemos posibilidad de usar fuentes alternativas de agua. Todavía hay mucho espacio para poder evitar caer en un day zero. Si tenemos opciones. No podemos mitigar la meteorológica por culpa del cambio climático, pero también tiene que quedar muy claro que se tienen que reducir radicalmente las emisiones de CO2 para no seguir intensificando estos ciclos de sequías, pero aun así tenemos opciones como ciudadanos para poder presionar, para seguir invirtiendo en lo que estamos haciendo, y poder desarrollar estas tecnologías de mitigación.

-Dr. Rodrigo Mendez

Not only does he mention that the agricultural industry consumes more than 75% of the water, but also claims that the drought can be mitigated in regards to finding alternative water sources. He also mentioned the case scenario of a “day zero” which refers to the drought in Cape Town causing people to ration 50 Liters of extraction per day per resident (Sousa et al. 2018). We hope Ensenada never gets to this level which is why we need methods of mitigation. Distinctly, I receive the response from Dr. Mariana Villada-Canela, who mentioned that there is no longer room in the room to try and discuss methods to mitigate climate change. Rather, that the way to truly help aid the conditions in which Ensenada is at, needs to come from an “adaptation” perspective:

I believe that it is already very difficult to speak of the word mitigation at this stage of our existence. Much was said when climate change began, the
first IPCC reports on mitigation and adaptation measures. I think that for a few years we stopped talking about mitigation, we are already in the adaptation phase. That is why there is a lot of talk about other issues such as resilience, which is also a topic, one could say, fashionable and associated with sustainable development.

Yo creo que ya es muy difícil hablar de la palabra mitigación a estas alturas de nuestra existencia. Mucho se hablaba cuando empezaba el cambio climático, los primeros reportes del IPCC sobre las medidas de mitigación y adaptación. Creo que desde hace unos cuantos años dejamos de hablar de la mitigación, ya estamos en la fase de adaptación. Por eso se habla mucho de otros temas como la resiliencia, que también es un tema, podría decirse, de moda y asociado al desarrollo sostenible.

- Dra. Mariana Villada-Canela

Dr. Villada-Canela mentioned that there needs to be a shift into the perspective of adaptation, rather than mitigation. But they both agree that there needs to be ways to mitigate the drought in terms of the water in the aquifer and the amount of water that is being used in general.

When people refer to there being no water for use, it becomes ironic since Ensenada is positioned on the coast, we technically have the whole ocean if we were really talking about all the water we have access to. But, the water that is needed to sustain agriculture, industrial and domestic needs is dependent on freshwater from the aquifer that is found beneath Ensenada and Maneadero. If farmers used water from the ocean to irrigate their land, all plants wouldn't be able to grow and the soil would be contaminated with high levels of sodium. When I interviewed Dr. Leopoldo Espinoza-Mendoza, he was able to make sense of the introduced ideology:

What I tell the farmers in Maneadero is that you will never run out of water, I tell them, because as it is a coastal aquifer, what happens is that as there is less fresh water, more salt water enters. They are not going to run out of water, but the water is going to be salt water. It is what has been seen historically, that the salinity of the wells, especially those that are attached to
the sea, have gone up. They started with salinities of 3,000, 4,000 milligrams per liter, until now reaching 12, 16 milligrams per liter, which is basically half the salinity of seawater. Sea water has a salinity of 34,000, for example. If you are already having yourself in your well for 17,000, it means that half of that water is seawater. Obviously that water with that salinity is of no use to you. You cannot plant anything because nothing is going to grow you, unless it is, for example, salicornia or one of those plants that are tolerant to that salinity. I think the asparagus can still hold 4,000, for example 5,000, but with difficulty, in reality, it does not grow very happily like that either. The drought in Maneadero is not going to be reflected in a lack of water, but rather a salinization of the water.

Lo que yo les comento a los agricultores en Maneadero es que ustedes nunca se van a quedar sin agua, les digo, porque como es un acuífero costero simplemente lo que pasa es que al haber menos agua dulce entra más agua salada. No se van a quedar sin agua, pero el agua va a ser agua salada. Es lo que se ha visto históricamente, que la salinidad de los pozos, sobre todo los que están pegados al mar, se han ido para arriba. Comenzaron con salinidades de 3.000, 4.000 miligramos por litro, hasta llegar ahorita a 12, 16 miligramos por litro, que básicamente es la mitad de la salinidad del agua del mar. El agua del mar tiene una salinidad de 34.000, por ejemplo. Si ya estás teniendo tú en tu pozo por 17.000, quiere decir que la mitad de esa agua es agua de mar. Obviamente esa agua con esa salinidad no te sirve de nada. No puedes sembrar nada porque nada te va a crecer, a menos que sea, por ejemplo, salicornia o alguna de esas plantas tolerantes a esa salinidad. El espárrago creo que todavía puede aguantar 4.000, por ejemplo, 5.000, pero ya con dificultad, en realidad, tampoco crece así muy alegremente. La sequía en Maneadero no se va a ver reflejada en una falta de agua, sino una salinización del agua.

- Leopoldo Espinoza-Mendoza

Dr. Espinoza-Mendoza explains how the water in the aquifers will also never finish, rather the water that is recollected naturally in the aquifer becomes increasingly salty due to over-exploitation. The water will never end, rather the water will merely become inaccessible to use for agricultural, industrial and domestic uses. He even mentions that there are some crops that are prone to surviving high levels of salinity in water that some farmers have decided and adopt to keep farming, due to only having access to their salt contaminated water. This perspective can only take us so far to change the plant that is being farmed, but some aquifers are too contaminated to the point where they can no
longer be used to irrigate their crops. People who are found in this situation are looking for alternatives for them to dilute the amount of salinity in the well and to ultimately use the water to irrigate the field. The use of treated waters would provide access not only to another source of water for the whole population of Ensenada, but it could also be used to recharge the aquifer. To have access to the treated waters being produced in Maneadero, farmers need to install a separate water treatment in order to use the water that comes from the wastewater treatment plant (WTP). The water that leaves the WTP is not fully purified and treated enough so that it can be used for irrigation purposes. Therefore, additional costs need to be spent by farmers in order to use this water source.

Figure 6. Map of Maneadero showing the areas where treated waters can be used for aquifer recharge. Image from Gilabert-Alarcón et al. 2018.
Governmental and Legislative Stakeholders on Adaptations

Water availability becomes a very delicate topic among a community that has suffered through water scarcity. Farmers have been the most affected since they require the most amount of water extraction to be able to continue their vocation in the field. The study by Gilaberto-Alarcon et al. (2018) stated that, “To reduce stress on water supplies and prevent seawater intrusion, [...] the Integrated Water Management Plan (Plan de Manejo Integrado: PMI) [...] suggested the use of RW from the wastewater treatment plant ‘El Naranjo’ (WWTPN) and recommended the construction of infrastructure for agricultural irrigation and artificial aquifer recharge” (Gilabert-Alarcón et al. 2018). Alternatives for water sources are present, but the actual execution of the alternative sources can only be executed through stakeholder approval. In order to have an understanding of the accessibility of water, actions for adaptation, and the implementation of alternative water sources, we need to inspect the administrative roles that hold control and power over water.

In theory, water doesn't have an owner or a price, yet water is claimed by people and priced at high prices that can become accessible for some people, absolutely making water inaccessible. In order to understand who claims water and who puts the price, we need to review the hierarchy of Mexican legal stakeholders who have power over the use of water and the implementation of treated wastewater. When interviewing the head of the SADER in Ensenada, when he referred to the cost of water to keep farming he said,

What we are going to have to look for are these alternatives and, above all, that people understand that there is no more expensive water than there is none. There we will have to look for those alternatives, both the Government, producers, organizations.
Lo que vamos a tener que buscar son esas alternativas y sobre todo que la gente entienda que no hay agua más cara que la que no hay. Ahí tendremos que buscar esas alternativas, tanto Gobierno, productores, organizaciones. - Ing. Fernando Sánchez

He definitely mentions that alternatives are crucial and need to be implemented in order for production to be maintained, but also implies that the economic factor will not seem to change. The table below created by Gilabert-Alarcón et al.,(2018), Figure 7, depicts the hierarchy of legal Mexican organizations and their powers in regards to many articles in the Mexican constitution and their association with water management: “wastewater, RW, groundwater and seawater, as well as on water usage for domestic purposes, agricultural irrigation, artificial recharge, and discharge into receiving (natural) bodies of land and
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Unpublished documents by the Federation

- Integral Water Program of the Municipality of Ensenada (PIAME, 2010)
- Integral Water Program in Ensenada (PIAE, 2008)
- Integrated Management Plan (PMI, 2003) for the Maneadero Aquifer, Baja California

Figure 7. Image demonstrating the Mexican legal hierarchy that is connected to water management in Mexico. Image from Gilabert-Alarcón et al., 2018

water*” (Gilabert-Alarcón et al., 2018). This information provided by Gilabert-Alarcón et al.(2018) allows the community and academics to analyze and further understand the
levels and steps that need to be overlooked and taken in order to make water sustainability a conversation topic in legislative settings.

When thinking of a smaller scale control of the water for the Ensenada region, the MENA report (2014) states that the Ensenada State Public Services Commission (CESPE) is in charge of collecting water from four aquifers to distribute needed water in the community. The Metropolitan Institute for Research and Planning (IMIP), provides public participation spaces for technical information to be provided by different types of actors (Villada-Canela et al. 2021). Guiding CESPE at a municipal level is the water management program called Integral water program of the Municipality of Ensenada, or PIAME. And also guiding CESPE at a state level is the Integral Water Program in Ensenada, or PIAE. Both the PIAE and the PIAME was created by IMIP (Villada-Canela et al. 2021) to help guide CESPE for more information on how to administer water. Lastly, the State Water Commission, Ministry for Water Management, Sanitation and Protection, or CEA-SEPROA, is responsible for water management infrastructure at a state level (Villada-Canela et al. 2021).

Since the initiation of drastic changes in agricultural production due to water conditions, many organizations and committees came together to try and figure out, what is happening? And, how can we address these issues? Alejandro Guzmán mentioned that Technical Groundwater Committee (COTAS spanish acronym) in Maneadero, which is the committee he is chief of, was created with the objective to assist and support farmers in Maneadero by realizing piezometric studies. This has allowed many people in the community to be informed and create some consciousness regarding the water wells and
the conditions they are inclined to reach. Mr. Guzman also makes note of the different
levels of water administrations that are present in water management in Maneadero:

Yes, finally the CONAGUA, as I was saying, is the highest level regulatory agency, first there is SEMARNAT and then CONAGUA. CONAGUA is the one that assigns or grants water for different needs. The utilities are ultimately also a user, who have to comply in the same way as any other, with the National Water Commission. They have to make their payments, they have to tell you how much water they are extracting, they have to tell you every time a meter breaks down, tell CONAGUA that it has broken down, that they have already replaced it with another meter, all those details. They are finally one more contributor to them.

Sí, finalmente la CONAGUA, como te decía, es la dependencia normativa de mayor nivel, antes está la SEMARNAT y después la CONAGUA. La CONAGUA es la que asigna o concesiona el agua para diferentes necesidades. Los organismos operadores finalmente son un usuario también, que tienen que cumplir de igual manera como cualquier otro, con la Comisión Nacional del Agua. Tienen que hacer sus pagos, tienen que declararle cuánta agua están extrayendo, tienen que indicarle cada vez que se le descompone un medidor, indicarle a la CONAGUA que se le descompuso, que ya lo sustituyeron por otro medidor, todos esos detalles. Finalmente son un contribuyente más para ellos.

- Alejandro Guzman

The CONAGUA is the principal record keeper of water extraction and is also the one
who provides water concessions to land owners who have private wells, by also requiring
people to purchase water gauges to measure the amount of water extracted from the
wells. People who use their wells also have to immediately report if the gauge is broken
or needs to be replaced by CONAGUA. Villada-Canela et al.(2021) mentions that the
various sectors believe that they are the ones who play a big part in informing the
stakeholders of the situations that are occurring in the community, which influence the
decisions on water management.
As mentioned at the beginning of the section, the Integrated Management Plan (PMI) suggested the possibility of using residual water to avoid sea water intrusion into the aquifers. But, in order for these tasks to be completed, Gilabert-Alarcón et al. (2018) mentioned that CESPE has to work in par with academic institutions in order to address the dire steps that need to be taken, by understanding what needs to be payed attention to first and so forth. They also mention that UABC and CICESE would need to conduct the following tasks: “(1) hydrogeological and water balance studies; (2) the legal framework analysis regarding the treatment, disposal and reuse of wastewater; (3) pilot projects for the aquifer recharge with RW; (4) regulations for the efficient use of RW; and (5) developing scenarios to address the adverse effects of climate change and population on water demands” (Gilabert-Alarcón et al. 2018). Villada-Canela et al. (2021) also mentions that the “scientific sector comprises academic, research, and technical institutions that address biophysics, engineering, and social aspects” (Villada-Canela et al. 2021). Having scientific departments conduct this research is a crucial factor, not only for decision making to ensure that the path taken does not keep furthering the harm that has already been made to the coastal aquifers of Maneadero, but also to educate and inform farmers and the community about water scarcity and aquifer conditions.

The higher education sector comprises part of the influence on decision making in legislative settings for better management to be implemented, but also to be able to provide accurate information to educate the community as a whole. Educate the community about the current conditions of the aquifers, the damage they’ve endured, and the possible solutions or methods to mitigate sea water intrusions into the aquifers. Legislative and stakeholding authorities do indeed have the last say on decisions made on
water management, but no decisions would be able to be made if there was no research
carried out on the conditions of the aquifer, or any information on the possibilities of
mitigating the drought. When interviewed, Dr. Villada-Canela mentioned that she needed
to have conferences and meetings with members of the Maneadero Ejido, farmers,
companies, company owners, and CESPE about water scarcity in Ensenada and how it is
ultimately affecting the community and future agricultural production. Similarly, Dr.
Espinoza-Mendoza mentioned that he and his research team work hard not only trying to
research and gather more information for the use of treated waters, they also go through
extensive efforts to educate and convince the farming community of the safety and utility
of the water, and in regards to the use of treated wastewater he mentioned:

It is what we would like or dream of one day being able to achieve in
Maneadero. We know that it is almost impossible because nobody wants to
pay for these types of facilities. You do need the money to do it.

Es lo que nosotros quisieramos o soñamos algún día poder lograr en
Maneadero. Sabemos que es casi imposible porque nadie quiere pagar por
eso tipo de instalaciones. Sí se necesita el dinero para hacerlo.

- Dr. Leopoldo

The academic sector that I interviewed are convinced that the implementation of treated
wastewater is the trajectory in which aquifers can be recharged and water can become a
more accessible resource for farmers, but the limitations consist of additional costs that
need to be paid by farmers and legislation articles needing to be approved.
CHAPTER 2:

Farmers and Community Affected by Water Scarcity and Poor Water Management

After conceptualizing the different factors that are involved in the exacerbation of water scarcity, the next step is to see specifically how farmers are managing polluted waters and evolving climate change for their production. My uncles, who I interviewed for this project, shared many experiences and struggles that they have to bear with every day in regards to inaccessibility towards advanced technology and expensive materials they need in order to maintain their production sustainable. In this chapter I will argue that land is fundamental for farming, yet not sufficient for success. Furthermore, I will also speculate water beyond the agricultural farming industry and think of the ways that these issues also relate to the community and society of Ensenada as a whole.

Land is Fundamental but not Sufficient for Success

For many people, the land they own is their only source of capital and income. In the case of my uncles, they inherited the land they have from their father who also farmed for his entire career. But back when my uncle's father was farming, the situation regarding water scarcity was very distinct. There were definitely seasons where the levels of precipitation were much lower than normal, which wouldn't really be realized through water scarcity and low water levels in the aquifer, farmers in Maneadero used to have streams of water that would reach all farms, but it has been decades since that method has been abandoned. Now, we are looking at this phenomenon where a group of farmers have acres of land but have no resources to keep farming in an effective manner. This section
will argue that although land ownership does indeed represent wealth, due to the lack of resources for farmers in Maneadero, land ownership for agricultural purposes no longer becomes a sign of prosperous wealth.

Although land is fundamental for all living species, through waves of anthropogenic pollution and harmful monoculturalism, only those who have the economic means can keep using these lands to produce income. When I spoke with the head director of the agricultural sector of SAGARPA, he mentioned clearly that the only way for the agricultural industry to become sustained is to adapt all the new and advanced technologies in order to keep producing sustainably, but also mentioned that there needs to be investments for water sources and water treatment installations:

**The value of production allows them to make investments. They are very large investments, in the millions of dollars.**

**El valor de la producción les da para hacer inversiones. Son inversiones muy grandes, de millones de dólares.**

-Ing. Fernando Sanchez

The director explicitly states that the investments are extremely high, in the millions to be exact. When I put this into perspective with my family, my uncles do not have the means to be investing millions into new technology. Ing. Fernando Sanchez also mentioned that the companies who can typically afford these investments to put water desalinator infrastructures are farming barries, due to their delicate nature and requirement of specific resources and materials. This causes the prices of berries to be higher and creates a much higher income for those who are farming berries in semi-arid locations. My uncle’s farm vegetables, a combination of corn, various peppers, peas, cucumbers, green beans, tomatoes, and herbs. In order for them to change their farming practices from
vegetables to berries, would additionally create an even bigger expense. This would be a completely inaccessible option for my uncles since they can barely afford to keep producing vegetables on their farm.

The inaccessibility to resources and material due to high prices is increasingly affecting my family. I finalized both of my uncles interviews by asking them; what would be your next steps if there no longer was enough water for Maneadero’s agricultural industry? I could tell they have thought of this question before because they answered immediately, my uncle Hector answered:

Right now here in Maneadero there is the option of taking treated water for flower. That would be for pasture. You would stop agriculture, vegetables, but you would go to flower, pasture for livestock.

Ahorita aquí en Maneadero está la opción de agarrar aguas tratadas para flor. Sería eso para pastura. Te dejarías de la agricultura, las hortalizas, pero te meterías a flor, a pastura para el ganado.
- Tío Hector

Hector mentions that there is the option of obtaining treated residual water as a solution to keep farming in Maneadero. He also mentions a very critical point when thinking of using treated waters in Maneadero. In order to use treated waters for irrigation purposes, if it is vegetables that are being cultivated on the land, the crops would have to change to pasture and flower production, no longer being able to farm vegetables, due to the need of certifying the water quality to farm vegetables and herbs that are for human consumption. Yet again, we see the issue of needing to invest to use the only other source of available water for Maneadero.
Although my other uncle also mentioned the use of treated waters throughout the interview, he had a different perspective to the question on the collapse of the aquifer water source. When I asked my uncle Adrian, he immediately answered:

**Find to see where, would have to rent or something. Go renting elsewhere, in other areas.**

**Buscarle a ver por dónde, habría que rentar o algo. Ir a rentar en otra parte, en otras zonas.**

- Tio Adrian

What he means by this is finding a space of land that has access to water, good water. This can mean a few kilometers south to San Quintin where there is abundant water, but could also mean crossing state borders in search for land and water availability. His response demonstrates how farmers, specifically farmers who come from family generations of farming, are displaced out of Maneadero looking for other areas with water abundance to keep providing for their families and themselves with the only knowledge of practice they hold.

Primary activities like farming, usually hold the background of family generations passing knowledge and inheritance of property and land to the future ones. When I spoke with Dr. Villada-Canela, she mentioned that the generational pattern is completely being obliterated due to the issues of water scarcity. When I interviewed the head chief of COTAS in Maneadero, he mentioned that, like my uncle Adrian, many people will not have the option to stay in Maneadero to practice agricultural production:

I believe that conditions, as we well know, are changing. The trend is that the cultivated area is gradually reducing, where only those who really have the economic resource will continue in the activity, the others will have to look for another option. We are already seeing it right now. He who does not have a greenhouse, who does not have an osmosis, who does not have a well-defined market, is risking the few pesos that he may have in the stock market. Some of
those same are going to thunder due to financial mismanagement, but those that do adhere to or are up to the needs or demands made by clients, are going to stay despite the circumstances, they are going to find solutions. Right now the water is treated, maybe right now it is an expensive solution, but in 20 years if there is no [aquifer water], believe me they will drink it.

Yo creo que las condiciones como bien sabemos van cambiando. La tendencia es que la superficie de cultivo se vaya reduciendo, donde solamente los que realmente tienen el recurso económico van a seguir en la actividad, los demás van a tener que buscar otra opción. Ya lo estamos viendo ahorita. Aquel que no tiene un invernadero, que no tiene una ósmosis, que no tiene un mercado bien definido, está arriesgando los pocos pesos que pueda tener en la bolsa. De esos mismos algunos van a tronar por malos manejo financieros, pero los que sí se apeguen o estén a la altura de las necesidades o de las demandas que les hacen los clientes, se van a mantener pese a las circunstancias, van a encontrar soluciones. Ahorita ya está el agua tratada, a lo mejor ahorita es una solución costosa, pero en 20 años si no hay [agua de acuífero], créeme que la van a tomar.

- Alejandro Guzman

Specifically related to Maneadero, Mr. Guzman states that farmers who don't have greenhouses, desalination plants, or a contracted client demanding production are risking whatever income they have to invest in necessary advanced technologies. He also states that farmers with “poor financial management” will collapse if they don't get updated with the advanced technologies needed to produce efficient vegetation in that area. We increasingly notice that farmers who are managing to produce abundantly have invested greatly in their materials and water purifiers.

Not having the economic needs to invest in a water treatment plant or greenhouses for farms can lead to farmers constantly struggling to produce efficiently or could end up with the collapse of the farmers business. The trauma of not having enough resources, money, support, technology, and ultimately being displaced is what drives many people to fear the agricultural industry in Maneadero. Dr. Villada-Canela mentions the phenomenon she encountered in 2014 and 2017 when conducting research with
farmers of Maneadero. She mentioned that the farm owners would speak about the future of their business in the area:

They told us, "My son no longer wants to dedicate himself to this," was a constant of all. "No, it's that my son no longer wants to do this", "My daughter no longer wants this, she wants to go do something else, she wants to study something else that has nothing to do with agriculture." They are no longer going to inherit those lands, who is going to work them?

Nos decían, "Es que mi hijo ya no se quiere dedicar a esto", era una constante de todos. "No, es que mi hijo ya no se quiere dedicar a esto", "Mi hija ya no quiere esto, ella se quiere ir a hacer otra cosa, quiere estudiar otra cosa que no tiene nada que ver con lo agrícola". Ya no van a heredar esas tierras, ¿quién las va a trabajar?

-Dr. Villada-Canela

Dr. Villada-Canela speaks on the effects of water scarcity in regards to the future of Maneadero’s agricultural industry by mentioning this phenomenon. The children of farmers in Maneadero are no longer interested in suffering the same hardships that their parents have been bearing. Because they probably have more resources and more options for their future compared to their parents, they choose to go in directions that are very distant from agriculture.

Nevertheless, I come to the conclusion that land is fundamental, yet not sufficient for success. We notice that various people have various takes on the ways in which water scarcity is affecting the community and the agricultural industry of Maneadero. We can see the water managers of the agricultural sector refer to the farmers’ poor financial management as the reason for the collapse of Maneadero’s industry. And I noticed that my family members who are constantly struggling to keep their production high are always blaming themselves, their poverty, and their methods in which they projected
their farming plan to be. New ways of approaching this issue is indeed needed for there to be more resources available for farmers in the area of Maneadero.

The Perspectives on Water Scarcity from Farmers, Academics and Water Managers

The view points in which we understand water scarcity and how it affects the community is significant in order to undertake strategies and methodologies to provide water equitably for the whole community. Depending on our realities in relation with water will determine how we see the conundrum of water scarcity. Equity is fundamental for the distribution of water. Water availability is very different to water accessibility, both of these concepts will be connected to the viewpoints of people mentioned in this section and how they affect groups of people distinctly.

Droughts are perceived in various ways depending on the location of the land, water accessibility and the quality of the water we have access to. When I interviewed the engineers from the water management organizations SAGARPA and COTAS, they mentioned shared ideas towards the drought that is currently happening in Ensenada. I first interviewed the head chief of COTAS Maneadero and his response was:

In reality, Baja California is an arid zone, we have always had drought, we have suffered from droughts. Maybe we had not visualized it as serious because the population was smaller 50 years ago, there is a lot of floating population. [...] Now, trying to understand the concept of drought, it has always existed here in Baja California and it has always been faced, it has never been so complicated.

En realidad, Baja California es una zona árida, siempre hemos tenido sequía, hemos padecido de sequías. A lo mejor no lo habíamos visualizado tan grave porque la población era menor hace 50 años, hay mucha población flotante. [...] Ahora sí, tratando de entender el concepto de sequía, siempre ha existido
Mr. Guzman mentioned that the climate pattern that is being noticed in Ensenada by him and the community classifies the drought as recurring and a phenomenon that has “always existed.” The mentioning of the floating population of Ensenada reminded me of the statement that the Maneadero Ejido President, Raymundo Carrillo mentioned. The community of Ensenada does indeed consist mostly of migrating families and population. The families and individuals who live in Ensenada have the ability to travel throughout the country, and due to Ensenada’s proximity to the border, many people also find it accessible to live a transborder life, shifting back and forth from Ensenada MX to Southern California USA. When I spoke with the head of the agricultural sector in SAGARPA, he mentioned that:

The precipitation here is normal, let’s not say it is a typical drought. What producers and everyone will have to do is know how to live with this drought. Not drought, but with this low rainfall.

La precipitación aquí es normal, no digamos que es una sequía típica. Lo que vamos a tener que hacer los productores y todo el mundo es saber convivir con esta sequía. No sequía, sino con esta baja precipitación.

- Ing. Francisco Sánchez

Mr. Sanchez mentioned that the drought is not a drought, rather just low levels of precipitation. Although we never spoke on what specific type of drought that was being discussed, he described the situation as mere lack of precipitation. I believe that speaking on the drought that is affecting Ensenada and the farmers of Maneadero should not be spoken about as just “low levels of precipitation.” The meteorological climate that is affecting the aquifers is putting farmers in Maneadero in an extremely vulnerable position (Villada-Canela et al. 2021).
When thinking of both perspectives of the current drought, the way they spoke of it made it seem as if climate change was not a pressing subject. Rather, made climate change seem like it's a recurring pattern that is normal, requiring merely finding ways to keep producing, methods to maintain the agricultural industry afloat. This language further makes the topic of drought and the effects towards the community and farmers become normalized.

**Approaches to Mitigate Anthropogenic Pollution and Aquifer Exploitation**

When looking at the effects of water scarcity towards the community, it is crucial for us to look at different narratives and paradigmatic perspectives towards water accessibility. This will allow for researchers and legislators to enact the necessary steps and movements to provide a reliable water source for the future generations of agricultural producers. When I spoke with Dr. Villada-Canela, she mentioned that I was looking at the situation of the drought through a lens that was necessary to understand. I was not only looking at the challenges of water accessibility for the benefit of farmers and the agricultural industry, I was looking at water accessibility through a lens that encapsulated domestic, touristic, industrial and agricultural demand. This would help me understand that the problematics with water management and water access not only affects farmers, but also affects every demander of water in Ensenada, although inevitably more so than others. Understanding everyone's struggle and experience with water is pivotal to provide a solution.

The most common methods that are talked about for an additional water source is mainly consisting of the adaptation of various expensive technologies to purify,
specifically desalinate the individual water from each well. When speaking with the
President of the Maneadero Ejido, he indicated that:

The way we see right now with the technology that is already in the world. The
treated water can be left drinkable even to drink, there is a technology to do it, it is a question of mentality more than anything. In other countries they do it.

La manera que nosotros vemos ahorita con la tecnología que hay ya en el
mundo. El agua tratada la puedes dejar potable hasta para tomar, hay una
tecnología para hacerlo, es una cuestión de mentalidad más que todo. En otros
países lo hacen.

- Raymundo Carrillo

The methods that are being thought of at a local legislative level are centered to keep
agricultural production successful. This mainly consists of treating the water that is
already available to farmers. And not necessarily to provide and create more water
sources for the community. This means that the view in which they think of creating
water accessibility should expand to encompass the community.

It is important to understand that different methods will help support certain groups of
people. Conversing with Dr. Villada-Canela allowed me to truly understand and
transform my view towards water accessibility and making sure that the view towards
providing water as communal:

You will find these different conceptions of drought. Obviously—Apart from
the social sciences, it studies, for example, this constructivist paradigm that
suggests that reality is built by us, how we perceive it, that is, it can be a
reality that exists independently of our perceptions, the real one of how much
water does There is, how much is not, measure it, we have equations, we can
make estimates, how much water is there and how much is not.

Vas a encontrar estas diferentes concepciones de la sequía. Obviamente—
Aparte de las ciencias sociales, estudio, por ejemplo, este paradigma
constructivista que sugiere que la realidad la construimos nosotros, cómo la
percibimos, es decir, puede ser una realidad que existe independientemente de nuestras percepciones, la real de cuánta agua si existe, cuánta no, medirla, tenemos ecuaciones, podemos hacer estimaciones, cuánta agua hay y cuánta no.

-Dra. Villada-Canela

We spoke about the construction of paradigms and the ways in which having a clear image of the communities constructed reality with water should be taken into account for the methods in which we see water becoming more accessible in the future. At the end of the day, it is not only the manufacturing and agricultural industry who require water accessibility in the area, the community as a whole is in desperate need for proper water management plans to be conducted to provide equitable water accessibility.

This being said, there is a completely different perspective in which I was able to see active methods to mitigate the effects of climate change on water accessibility. When I asked Dr. Rodrigo Mendez “What is the next step to fixing the water management system?,” he stated:

The next step is not a single step of a person, it is a step at a macro level, but there must be communication, there must be understanding that this problem is a compound problem, which not only depends on scientists, government or society, there must be a conjunction of all the factors to be able, first, to be aware that we are in a new world scenario, because we are talking about climate change, and second, that mitigation and adaptation to this new scenario of global climate change is necessary. The next step is, if you want to solve this, it must start because society must be informed, it must accept the reality of climate change, it must accept that emissions have to be radically restricted, it must accept that there must be changes in habit, which is very difficult, but they have to accept the habit changes first.

El siguiente paso no es un paso único de una persona, es un paso a nivel macro, pero tiene que haber comunicación, tiene que haber entendimiento de que este problema es un problema compuesto, que no solamente depende de científicos, Gobierno o sociedad, tiene que haber una conjunción de todos los factores para poder, primero, estar conscientes que estamos en un nuevo escenario mundial, porque hablamos del cambio climático, y segundo, que es necesaria la mitigación y adaptación a este nuevo escenario del cambio climático global. El siguiente paso es, si se quiere resolver esto, debe empezar porque la sociedad
debe estar informada, debe aceptar la realidad del cambio climático, debe aceptar que se tienen que restringir radicalmente las emisiones, se debe aceptar que hay que haber cambios de hábito, lo cual es muy difícil, pero tienen que aceptar primero los cambios de hábito.

- Dr. Rodrigo Mendez

This reflection on the steps to take from here on out are similar to the responses that I received from the other two academics I interviewed. There is a communal understanding that it is necessary for the community, government officials and academics to sit down and have conversations about the current state in which water management is being addressed. When there is any conundrum, the instinct is usually to point a finger at whoever's fault it was. But in case of water management and climate adaptation, like Dr. Mendez mentioned, the situation becomes a topic that needs to be addressed at a macro level. Meaning that we can no longer accuse a single person or organization for the poor water management. The system in which water is looked at and managed needs to be re-evaluated in order to adapt properly to evolving change in climate. Without the perspectives and help from every sector involved in water management, moving forward can become inefficient.

The community as a whole is aware that it is required to adapt to low precipitation, but don't have the understanding of the importance of coming together as a community and communicating needs and demands. This could be caused by data democratization of the conditions in which the aquifers are found and the steps that individuals need to take to help keep preventing continuous harm on the aquifers. Dr. Rodrigo Mendez also mentioned that:

These changes have to be made at the societal level, and if society doesn't accept them, the collapse has to be accepted. There are going to be breakdowns
in different ways. We are in a balance. Saying what the next step is very difficult, but you do have to be aware of the possible scenarios. At what level will we give these--? For example, on our part we are going to continue researching these technologies, but from there to whether they are applied in the field, it depends on society.

Se tienen que hacer estos cambios a nivel sociedad, y si la sociedad no los acepta, tiene que aceptarse el colapso. Va a haber colapsos de diferentes maneras. Estamos en una balanza. Decir cuál es el siguiente paso es muy difícil, pero sí se tiene que estar consciente de los posibles escenarios. ¿A qué nivel daremos estos--? Por ejemplo, de nuestra parte vamos a seguir investigando de estas tecnologías, pero de ahí a que se apliquen en el campo, depende de la sociedad.

- Dr. Rodrigo Mendez

Dr. Mendez mentioned that there is an abundant amount of information regarding the exact issue that Ensenada and farmers in Maneadero are going through, which is not new and has been happening in many places around the world. We just need to make sure to provide access to this information as well. This would allow for the community to fully understand and grasp their role as a community member in society. He also mentioned that skipping the step of making the community conscious of the issues could end in a collapse in society due to zero water availability. And if they don't want to accept the conditions in which we are found now, they will have to accept the collapse that will happen tomorrow.

Collectively, all the people who I interviewed manage to highlight keypoint issues in water management in Ensenada, with slightly different perspectives. I was able to take away that the most pivotal aspect in finding a solution to the problems regarding water accessibility in Ensenada, is to understand the realities that are constructed by every community in Ensenada. From the people who live in the center of the city who rarely have water issues, to the people who live on the side of the hill in Maneadero with no access to water pipes or water pressure.
Conclusion

Further research needs to be done on how we can mitigate the harm done to the aquifers. The exploitation of the aquifers of Ensenada and Maneadero is the prime reason the agricultural industry is struggling with production levels. Halfway into the project, I realized that the problems expanded and related to various people with power. The experiences of farmers do not seem to be enough for legislators and government officials to act upon water inaccessibility that is present in Ensenada. The system is now making individual farmers responsible for the lack of water for agricultural use.

There are many limitations to my research experiment. I would have appreciated the perspectives of local activists who have fought for water rights in the past. I unfortunately was not able to get in contact with any of them but will hopefully expand my research to include as many viewpoints as possible. Also, the legislative, federal and governmental systems holding power over water management and water ownership go beyond my ability to research and include in this project. The fact that I was able to find a figure explaining the hierarchy of Mexican legislation and stakeholders with power over water is only the start to my research on the systems that hold control over water. The costs of water, water management, water treatments and water transportation were also not found or used in this project. Having economic calculations would further help us understand the inaccessibility of water consumption for some groups of people.
Although I specifically highlighted Maneadero’s struggles in this project, it is important that I mention; water inaccessibility is not only affecting farmers, it is affecting every human and non-human trying to survive in Ensenada. Listening to everyone's construction of their reality with water is necessary for everyone in society to fully understand the severity and implications of water scarcity. Movements need to become more verbal when informing the community about the aquifers being exploited as we speak and it is up to us, the community, to fight for methods of aquifer recharge to be implemented. If the community does not become conscious of the current situation and their unsustainable habits, they will be forced to accept the collapse of water availability.


