

Karen Perez  
Fayetteville High School  
Fayetteville, Arkansas  
Mexico, Infrastructure

When many think of Mexico they think of blue water and beaches in the summer sun, along with parties and fun. Tourism is a huge piece of what most people see, it accounts for the majority of the 63% of income from the service industry. ([Investopedia](#), 2019). Although Mexico is a beautiful place with a booming tourist economy, few see the reality behind the coastal resorts and palm trees. A country corrupted and dragged down by cartels who have infiltrated the government for decades. Mexico is weighed down by poverty, as well as economically and politically unstable. It is also known for its people being driven away by the lack of basic necessities.

The issues began with its colonization by Spain and the lack of time and money to form a complete government, as it only became a true democracy in 2000. Many issues contribute to Mexico's low standing of 33 overall in the world ([U.S. News](#), 2019). Mexico has the fifteenth largest economy ([Investopedia](#), 2019), with a GDP of \$2.1 trillion ([U.S. News](#), 2019). But it is still wriggled with income inequality and violent crime, because of the cartels ability to grow rapidly and satisfy the drug demand of countries to the north, and having one of the world's highest kidnapping rates ([U.S. News](#), 2019). All of which is fed by the waves of migrants making their way to the U.S. to escape violence and poverty.

Although it is the second largest economy in Latin America ([Investopedia](#), 2019), it is still home to extremes of wealth and poverty. As a result, violence encompasses the lives of many families who struggle with basic needs. Typical families live very close, due to family being the center of social structure since the pre-Colombian era ([Love to Know](#), 2006). But because of a growing population and little infrastructure investment, most cities begin to grow at the edges through makeshift houses and with little necessities. These groupings of houses are called *Colonias*, or colonies, and the families sometimes lack water, electricity, and/or sewerage ([Britannica](#)). Colonies eventually form into modest livable communities, but the lack of governmental funding leads to these same families installing basic necessities themselves. Causing the use of low grade materials that don't hold up over time and lead to other health issues.

Mexico has been struggling to improve their water systems and its availability for decades. The government itself has had corruption in just about every level for just as long. This has caused the government to be more persistent with attempting to get rid of their responsibility for water sanitation and the infrastructure involved in such responsibilities. They have done so by labeling highly polluted water sources, such as rivers and streams as sewers ([FP Insider Access](#), 2015). Due to such actions, the private sector has picked up that responsibility and now deliver water to houses in jugs that they reuse once the household has finished the water ([FP Insider Access](#), 2015).

The issue with the private sector taking hold of the situation is that in 2015 the government of Mexico attempted to pass the General Water Act, an act that would allow for the full privatization of water. This would make water a business instead of a right for the people of Mexico. This act was halted and never followed through with because of protests held by the people of Mexico City. Although right wing politicians in Mexico are all for the privatization of water, the left wing is strongly against it, claiming most of the water will be industry based. Similar to the economic boom in Mexico from 1940's

to the 1970's. During this time, industries overused aquifer reserves and politicians promoted such uses because they promoted the economic growth of their country. At the same time, the population more than doubled in size, with many moving to northern Mexico. This made the majority of the population subject to the limited water resources of the most arid and semi-arid regions ([FP Insider Access](#), 2015).

It benefited Mexico not to privatize water because there was already evidence of it reducing infrastructure investment, raising prices, and increasing pollution. All of which were experienced by South Africa, Argentina, and Bolivia, who had privatized their water but then later municipalized it. Along with over one hundred other countries ([FP Insider Access](#), 2015).

In Mexico, the infrastructure has been poorly budgeted, leaving it to have very little growth. Due to a corrupted government, investment into infrastructure had dropped by 34% in 2017 from the previous year. The previous legislature was able to complete 80 roads and 50 highways but the country is still lacking in roads, ports, railroads, airports, and electricity supply ([We Build Value](#), 2018). One of the major projects begun by the new legislature is Tren Maya, a railroad that will traverse the Yucatan Peninsula and increase transportation. Many new ideas have been thought of in the past for specific issues like transportation, but overall infrastructure is struggling to grow, and the sector most affected is water treatment of potable water and sewage ([We Build Value](#), 2018).

A significant reason Mexico has not been able to fund infrastructure is due the billions of dollars spent on fighting the various cartels in the north. A [Forbes](#) article written by Dolia Estevez reported that in 2013 it cost Mexico \$172.7 billion USD on fighting the cartels. Estevez also wrote that due to the inefficiency and high corruption in the police force the military play a heavy role in fighting the cartels. An article from the [World Economic Forum](#) reports that in 2015 the impact of violence on the economy in Mexico was \$134 billion USD. This shows that the cost of fighting the cartels has been lowering, with the article showing the cost peaked in 2011.

The main focus is Matehuala, San Luis Potosi, the largest city in the northern region of San Luis Potosi. Matehuala sits on the interior plateau region of the Sierra Madre Oriental at 1,815 meters above sea level. Specifically in the Salado valley of the Catorce Mountains. Some corn is cultivated, but given its mostly arid climate, Matehuala is best known for mining and tanneries ([Britannica](#)). The local population has a diet of local foods, such as cactus fruit, palm tree flowers, beans, corn, and meat. As with most places in Mexico, Matehuala also has its fair share of local businesses. Many of which are tortilla shops, general stores, restaurants, and ice cream and Popsicle stands.

The challenges those in Matehuala face with water come in various forms, sanitation, flooding, pollution, and potable water. Matehuala has already seen immense flooding in May of 2019, with a total of 160 millimeters of rain falling in 3 hours. Although there were no fatalities and minor injuries, there was much damage done to commercial premises as cars were swept away and piled high on the streets ([Floodlist](#), 2019). This can be blamed on the insufficient amount of storm drains in the city, especially on the outskirts in the colonies. Contamination of tap water can be blamed on cheap products and low governmental funding of infrastructure. Which has led to the delivering of water in jugs, a reality for just about all Mexican citizens in cities. Matehuala citizens don't drink the piped water, but its sanitation is still important given it's used to wash clothes, dishes, and themselves. Which can facilitate the spreading of disease.

Another issue in Matehuala has to do with their groundwater contamination. Matehuala has an old and recent history of mining for silver, gold, lead, copper, and zinc, with Northern Mexico containing some of

the richest silver mines, allowing Mexico to be the leading producer of silver in the world in the past ([Britannica](#)). This was severely exploited by the Spanish and has caused much contamination in the groundwater, surface water, and soil of the area. Research done by an institution showed max arsenic concentrations in pluvial water storage ponds near potential sources of pollution that ended up being five times the Mexican water quality guideline. Specifically in Cerrito Blanco, five kilometers east of Matehuala, had the highest concentration of arsenic in its water, exceeding one hundred times the quality guideline ([Springer Link](#), 2004).

Arsenic contamination, due to it being labeled as a carcinogen, can cause acute and chronic toxicity. Leading to liver and kidney damage, and a decreased blood hemoglobin. Copper can enter from mining as well, it's an essential trace element, but can cause issues when in high doses. Such as stomach and intestinal distress, and liver and kidney damage. Silver is one of the highest possible contaminants, and can become very toxic in the right quantities. Such as Argyria, a blue gray coloration of the skin, mucous membranes, eyes, and organs that results in death ([USGS](#)).

One of the possible solutions to lessen flooding, that is likely to increase due to changing climate, is as simple as installing a drainage system. The lack of a sewage and drainage system contributes to increased flooding and future damage to the infrastructure. Preferred types of drainage for the terrain in Matehuala are surface systems, such as ditches or trenches. Ditches ([Aqua-Bright](#), 2015) and other types of systems that are wide and take up space are better to be implemented on the outskirts of the city. Given the self-growth of most cities in Mexico, Matehuala was built without the need for a drainage system in mind. Leaving little room to install large changes in the infrastructure. While the trench drainage system would be best installed near industrial and commercial buildings and areas ([Slot Drain](#), 2020).

The main solution I'm proposing in order to combat the issues of flooding and groundwater contamination is overall green infrastructure. Changing the way urban infrastructure is approached can help improve the impact of water, the economy, and community health and safety. A distributed green infrastructure can be very effective at handling the first couple of inches of rainfall before it becomes difficult to manage ([CNT](#), 2017). The most effective green infrastructure would probably be that of green roofs, rain gardens, and trees. All of which help support and increase biodiversity, as well as reduce urban heat island effect and overall high temperatures. The prominent result these practices leave is that of cleaner groundwater and lessened chance of contamination.

Rain gardens allow the slow absorption of water into the ground, filtering the water of pollutants and other harmful materials ([Division of Agriculture](#)). These pollutants are left behind in the soil of the rain garden, which utilizes them in order to help grow and support itself. The simple structure and implementation of rain gardens will also allow a better use of the land in colonies for parks and community areas. Which would help encourage social gatherings and communal importance.

Green roofs are also effective at absorbing rainwater and reducing heat islands ([EPA](#), 2019). Green roofs are a vegetative covering, either partial or full, on the roof of a building. It can be very useful in an area where the extremes of temperatures are becoming more prevalent. These roofs can be applied to just about any building, from small garages to commercial and municipal buildings ([Rodriguez Droguett](#), 2011). There are many environmental benefits that have been recorded in association with green roofs, such as thermal reduction and energy conservation. As well as increasing biodiversity and carbon sequestration ([EPA](#), 2019). With the improvement of air quality being a necessity in a city where the main fuel for vehicles is diesel. But the main type of roofing that would be best applied to the infrastructure already present is extensive, a lighter and minimal maintenance green roof.

Another simple green infrastructure technique that could be easily applied to the urban environment in Matehuala is trees. There are already trees planted up and down the sidewalks in the colonies, and a plaza with trees that tower some of the infrastructure, but there is no concentration of trees exceeding that of 4 or 5. The addition of higher and more concentrations of trees can lead to a more diverse ecosystem and the minimization of risks related to water scarcity and floods ([Evans, 2012](#)). Trees could also solve the issue of erosion ([EPA, 2019](#)), a problem Matehuala is susceptible to due to its desert terrain. The community can be further encouraged and informed on how to help improve the infrastructure as well. Through gatherings on the fairground or in the plazas, the population that lives in the more clustered areas downtown can start implementing these green infrastructure ideas.

It is understandable that some may be wary of using green infrastructure, since it is a newer way of thinking about infrastructure. In Chicago however, they suffer from the urban heat island effect, and have planted many trees to combat this. They have also installed a green roof on City Hall, allowing them to collect data. Chicago reported that the green roof helped reduce storm water runoff by 50%, as well as reduce the energy used, saving the city \$5, 500 annually on heating and cooling ([U.S. Climate Resilience Toolkit, 2010](#)). In San Antonio, they have experienced what the loss of tree canopy, with the American Forest Organization reporting an immense tree loss had increased storm water flow by millions of cubic feet. Due to this, San Antonio recognizes the benefits of green infrastructure and aims to reinstall a tree canopy in the city in order to reduce the temperature, as well as reduce and filter the storm water flow ([Columbia University, 2014](#)). Both of these cities show the benefits of simple green infrastructure, with Chicago having taken data of the effects of a green roof, and San Antonio recognizing the negative effects of losing trees.

Although these three green infrastructure techniques help to clean water that ends up in the groundwater, a more direct solution is the use of Virtual Curtain. Virtual Curtain is a technology that uses hydrotalcites, minerals that are able to absorb various contaminants, one of which is arsenic. The technology is from Australia, where it has already demonstrated success when put in use at the Queensland mine, discharging the same as 20 Olympic swimming pools of rainwater-quality water. The same could be done in Matehuala, as well as other major mining areas in Mexico. ([CSIRO, 2020](#)).

The majority of funding possible for projects that would help implement these green infrastructure techniques come from grants. A great investment project set up by the Mexican Government is the CerPI, a certificate designed to finance new infrastructure projects ([Harris Gomez Group](#)). With the main focus being on greenfield projects, such as that of green infrastructure. A grant that is set in the U.S. and is funded by both United States and Mexican citizens is the Mexican Innovation Fund Grant. This grant was established through Harvard alumni and friends in Mexico, and is managed by the David Rockefeller Center for Latin American Studies. Its priorities include sustainable urban and regional development and will fund projects of up to \$100,000 ([Harvard University](#)). Local governments could attain additional funding from development banks, like Banco Nacional De Obras y Servicios Públicos, or BANOBRAS. A development bank that prioritizes infrastructure, and provides long term funding to both private developers and state and municipal governments. Its principal sectors that relate to green infrastructure are water and social and urban infrastructure. Another development bank that supports water development is FONADIN, or Fondo Nacional De Infraestructura. ([Mexico Projects Hub](#)).

Most solutions put in place to combat issues that range over such large communities are usually seen as complicated or costly. Especially when challenged with a problem that correlates water sanitation and infrastructure. But the application of green infrastructure can be done at such a simple and local level, and

still affect a large community. The implementation of green roofs, rain gardens, and a larger focus on trees will help with regulating precipitation, extreme temperatures, and cleaning up the groundwater. This is a step in the right direction, allowing for the water to eventually reach levels of human consumption. It is also more economically sustainable. Since the last election, the Mexican government has made an effort in growing the infrastructure budget. Obrador, the new president, wants to reform investment strategy by doubling the spending on large projects and increasing the construction budget. There is also a movement for energy sources, greener energy sources, with higher investment in solar and wind technology by foreign and private companies. It is even estimated Mexico will have 50% new energy by 2021 (Tetakawi, 2019). With the increased investment in infrastructure and the poorer areas of Mexico, the country is sure to improve economically, environmentally, and locally in its cities that have been lacking in basic necessities.

### Bibliography

Adler, David. "The War for Mexico's Water", FP Insider Access, The Slate Group, 31 May 2015, <http://www.foreignpolicy.com/2015/07/31/the-war-for-privatization-mexicos-water/#:~:text=The%20water%20that%20does%20make.gastrointestinal%20infections%20from%20water%20consumption> ., (accessed Aug. 5, 2020).

"Arkansas Rain Gardens", Division of Agriculture" *Research and Extension*, <https://www.uaex.edu/environment-nature/water/conservation/rain-gardens.aspx>, (accessed Jan. 25, 2020).

Brown, John. "Different Types of Drainage Systems", *Slot Drain*, 2020, <https://blog.slotdrainsystems.com/different-types-of-drainage-systems>, (accessed Feb. 4, 2020).

"Cleaning Up Contaminated Mining Wastewater", *CSIRO*, January 31, 2020, <https://www.csiro.au/en/Research/MRF/Areas/Community-and-environment/Minesite-environmental-management/Virtual-curtain>, (accessed Feb. 10, 2020).

“Contamination of Groundwater”, *USGS*,

[https://www.usgs.gov/special-topic/water-science-school/science/contamination-groundwater?qt-science\\_center\\_objects=0#qt-science\\_center\\_objects](https://www.usgs.gov/special-topic/water-science-school/science/contamination-groundwater?qt-science_center_objects=0#qt-science_center_objects), (accessed Jan. 18, 2020).

Economides, Christopher. “Green Infrastructure: Sustainable Solutions in 11 cities across the United States”, Columbia University Water Center, 2014,

[http://water.columbia.edu/files/2014/04/Green\\_Infrastructure\\_FINAL.pdf](http://water.columbia.edu/files/2014/04/Green_Infrastructure_FINAL.pdf) , (accessed Jul. 30, 2020).

Estevez, Dolia. “Mexico’s Astonishing Costs of Fighting Drug Cartels Have Not Reduced Violence”, *Forbes*, 19 July 2014,

<http://www.forbes.com/sites/doliaestevez/2014/06/19/mexicos-astonishing-spending-on-fighting-drug-cartels-has-not-reduced-violence/#3e5e6e0254ac> , (accessed Aug. 5, 2020).

Evans, Kate, “Make it Rain: Planting Forests Could Help Drought-Stricken Regions”, *CIFOR*, July 23, 2012,

<https://forestsnews.cifor.org/10316/make-it-rain-planting-forests-to-help-drought-stricken-regions?fnl=en>, (accessed Feb. 9, 2020).

“Financing”, How to Invest?, *Mexico Projects Hub: Investment and Infrastructure*,

<http://proyectosmexico.gob.mx/en/how-mexican-infrastructure/financing/> , (accessed Feb. 9, 2020).

Garcia, Judit Covarrubios. “Mexican Family Culture”, *Love to Know*, 2006,

<https://family.lovetoknow.com/family-values/mexican-family-culture>, (accessed Feb. 5, 2020).

“Green Infrastructure Case Studies: Municipal Policies for Managing Storm Water with Green Infrastructure”, *U.S. Climate Resilience Toolkit*, Oceans and Watersheds, August 2010, <http://toolkit.climate.gov/report/green-infrastructure-case-studies-municipal-policies-managing-stormwater-green> , (accessed Jul. 30, 2020).

“Lessons From Mexico-Funding Energy and Infrastructure Projects”, *Harris Gomez Group*, <https://www.hgomezgroup.com/2016/05/17/lessons-from-mexico-funding-energy-and-infrastructure-projects/#up>, (accessed Feb. 9, 2020).

“Matehuala”, *Encyclopedia Britannica*, <https://www.britannica.com/place/Matehuala>, (accessed Feb. 1, 2020).

“Mexico-Flash Flooding in San Luis Potosi After Torrential Rain”, *Floodlist*, 2 June 2019, <http://www.floodlist.com/america/mexico-flash-flooding-in-san-luis-potosi-after-torrential-rain> , (accessed Feb. 10, 2020).

“Mexico Innovation Fund Grants”, *David Rockefeller Center For Latin American Studies Harvard University*, <https://drclas.harvard.edu/mexico-innovation-fund-grants>, (accessed Feb. 9, 2020).

“Obrador: Infrastructure a Priority”, *We Build Value, We Build Value Digital Magazine*, 7 November 2018,

<http://www.webuildvalue.com/en/reportage/obrador-infrastructure-a-priority.html> , (accessed Feb. 5, 2020).

“Overview of Mexico”, *U.S. News*, 2019, <https://www.usnews.com/news/best-countries/mexico>, (accessed Feb. 5, 2020).

Razo, Israel, et al., “Arsenic and Heavy Metal Pollution of Soil, Water, and Sediments in a Semi-Arid Climate Mining Area in Mexico”, *Kluwer Academic Publishers*, February 2004, Springer Link, <https://link.springer.com/article/10.1023/B:WATE.0000015350.14520.c1> , (accessed Feb. 1, 2020).

Rodriguez Droguett, Barbara. “Sustainability Assessment of Green Infrastructure Practices for Storm Water Management: A Comparative Energy Analysis”, *ProQuest*, State University of New York, April 2011. <http://search.proquest.com/docview/900864997> , (accessed Feb. 7, 2020).

Schippa, Camila. “This is how much violence costs Mexico’s economy”, World Economic Forum, 2 May 2016, <http://www.weforum.org/agenda/2016/05/this-is-how-much-violence-costs-mexicos-economy/> , (accessed Aug. 10 2020).

Silver, Caleb. “The Top 20 EConoies in the World”, *Investopedia*, November 19, 2019, <https://www.investopedia.com/insights/worlds-top-economies/#15-mexico>, (accessed Feb. 5, 2020).



“Soak Up the Rain: Trees Help Reduce Runoff”, *EPA*, October 11, 2019,  
<https://www.epa.gov/soakuptherain/soak-rain-trees-help-reduce-runoff>, (accessed Feb. 9, 2020).

“The Advantages of Mexico’s Infrastructure Improvements”, *Tetakawi*, December 19, 2019,  
<http://insights.tetakawi.com/mexico-is-getting-serious-about-infrastructure> , (accessed Feb. 1,  
2020).

“Types of Drainage Systems”, *Aqua-Bright: Irrigation and Illumination*, November 25, 2015,  
<https://www.aquabrightllc.com/blog/types-of-residential-drainage-systems/>, (accessed Feb. 4,  
2020).

“Using Green Roofs to Reduce Heat Islands”, *EPA*, June 11, 2019,  
[http://www.epa.gov/heatislands/using-green-roofs-reduce-heat-islands#:~:text=Using%20roofs%  
20in%20cities,up%20to%20205F](http://www.epa.gov/heatislands/using-green-roofs-reduce-heat-islands#:~:text=Using%20roofs%20in%20cities,up%20to%20205F) , (accessed Feb. 7, 2020).

Wolf, Anna. “Increased Rainfall and Urban Flooding...and Solutions!”, *CNT*, August 15, 2017,  
<https://www.cnt.org/blog/increased-rainfall-and-urban-flooding-solutions>, (accessed Jan. 18,  
2020).