ISSN 0798 1015

Vol. 41 (Issue 17) Year 2020. Page 2

Mexico's efforts to improve its water management systems

Los esfuerzos de México para mejorar sus sistemas de gestión del agua

SILVA, Jorge A. 1

Received: 23/07/2019 • Approved: 05/05/2020 • Published 14/5/2020

Contents

ABSTRACT:
Mexico has put a great deal of time and effort to improve their water management systems, to little avail. The purpose of this paper is to focus on Mexico's efforts to improve its water systems, particularly in the rural areas, what the results are, and what can be improved. For literature review, the PRISMA method was followed. The results show that the government must be willing to work with local organizations and governments.
Keywords: Communities, rural areas, safe water, water management

RESUMEN:
México ha dedicado mucho tiempo y esfuerzo para mejorar sus sistemas de gestión de agua, con poco éxito. El propósito de este artículo es centrarse en los esfuerzos de México para mejorar sus sistemas de agua, particularmente en las áreas rurales, cuáles son los resultados y qué se puede mejorar. Para la revisión de la literatura, se siguió el método PRISMA. Los resultados muestran que el gobierno debe estar dispuesto a trabajar con organizaciones y gobiernos locales.
Palabras clave: Comunidades, zonas rurales, agua potable, gestión del agua

1. Introduction

In the past, Mexico's water control was centralized. The process of decentralization began in 1992 (Hidalgo-Toledo et al., 2019) following the passage of the National Water Law. The nation had already begun experimenting with innovative water management, but change was to continue; in 2004, the government passed the 2004 Constitution, which had significant changes in the way that water was to be handled. With the passage of the Constitution, executive basin organizations were developed with the idea that different views towards water and water access throughout the country could be considered. However, there was an unanticipated result: Instead of leading to the development of social and community involvement, the private-sector involvement increased dramatically, and citizen participation was stymied.

The government may have intended to transition to a culture of water, but it has failed to enact the laws that would make it possible (Wilder, 2010). The results have been mixed at best. In Guadalupe, for example, private water purveyors sold low-income people what seemed like a good deal but turned out to be contaminated water (Ríos & de Santiago, 2014). Clearly Hidalgo-Toledo et al. (2019, p. 153) were correct when they related, "In spite of the importance of those changes, there are still serious problems surrounding water and there is no simple way to reorganize the role of the federal government as the leading entity in water management". The problem is severe; nearly 15 percent of Mexico's aquifers are overstressed (Silva, 2018).

Many of the municipal areas in Mexico now provide water and sanitation. However, in doing so, they disallow citizen participation and any discretionary funds end up as a benefit to either private interests or the political parties (Alatorre, 2018a). Instead of providing local control, the current application of the Constitution is leading to corruption. Alatorre (2018a) argues that the nation as a whole does not consider the systemic nature of water and the water cycle. Instead, he suggests, water management in most of Mexico is considered a linear undertaking. Because the goal is to provide income for private concerns, the emphasis remains on being pipe heavy. Relying on piping of water, transporting water, pumping water, draining water, rebuilding infrastructure, and moving water in pipes over long distances seems to be the preferred method of operation (Alatorre, 2018a). By treating water in this manner, private organizations are virtually assured of constant contract work. As McCulligh and Tetreault (2017) pointed out, the government is still stuck in the years when huge dams equated to water management. This attitude must change. Water problems are essentially governance problems (Casiano et al., 2017).

While the various regions of the world have suffered from either too much, or too little, water, even for generations, the nature of the suffering due to water issues has not changed. Today, approximately 10% of the population still lacks even basic sanitation (Kochhar et al., 2015). This figure is consistent with the situation in Mexico, where the lack of water is not necessarily a problem, but how water is diverted for use in various industries, particularly mining and energy. According to Alatorre (2018), the problem is made worse by climate extremes in various parts of the country, and which may or may not be related to global climate change. Groundwater tends to recharge when the ground is cooler (Taylor et al., 2013). As forest areas are harvested and their water service systems are degraded, runoff increases, soil erodes and compacts, and water quality is reduced (Bai et al., 2013). High levels of Escherichia coli (E. coli.) in the water lead to concerns about the infamous 'Montezuma's Revenge'. High E. coli. concentrations in Mexico are the norm in Mexico (Luby et al., 2015). Along with E. coli., harmful microbes can be distributed through groundwater (Schmoll et al., 2006).

Throughout the course of the years since the ratification of the constitutional changes, the government and various citizens' groups have sought to ratify the General Water Law, or "Ley General de Aguas" (LGA). In 2012, the first National Congress endeavoured to draft that bill, but it was not accomplished until 2015. The reasons relate strongly to the private sector participation discussed earlier. However, once the bill was established and submitted to the Mexican congress, it still was not approved. Alatorre (2018a) argues that in the government's effort to get the bill fast tracked, other laws throughout the nation were infringed. The other issue was that several governmental offices opposed ratification, as well as some citizens. There was a great deal at stake financially for groups that can profit from centralization and government control of water issues.

During the period 2013-2014, citizens groups met to propose an alternative to the LGA. The Citizens' Initiatives for General Water Law (IC-LGA) worked with various professionals and academics to consider how to proceed. The work was given to various commissions for their input into policy, including sanitation, how to manage watersheds, how to protect the aquifers, how to handle urban water issues, preventing further pollution, administering water justice, and how to ensure that the water could be used to develop food sovereignty (Alatorre, 2018a). Once the commissions established their recommendations, attorneys established legal phraseology, and the group agreed on a final draft of the language. During this time, the organization had established nearly 100 working groups, representing different interest groups, in different regions of the country. These working groups reviewed the proposed language and law, suggested changes, and finalized the recommendations.

In 2015, the IC-LGA was presented to a number of representatives; when it was published in the Senate, 22 senators had endorsed it and represented four pollical parties in doing so. Alatorre (2018a) asserts that one of the chief benefits of this legislation is that it encompasses views from a wide variety of points of view and does not stem from one perception. The result, he suggested, was a 'cross-pollination' between scientific knowledge and the deeply rooted practical knowledge of people working in the territories" (Alatorre, 2018a). The mutual feedback also helps negate the abilities of transnational organizations who may seek entry for fiscal reasons, as well as smaller private organizations who may be seeking to gain a larger power base and thus a strangle-hold on benefits and contracts. It may also help recognize concerns of citizens who regard water pollution and the need to remedy river degradation as being part of the local culture (Perló & Zamora, 2017).

The purpose of this paper is to focus on Mexico's efforts to improve its water management systems, particularly in the rural areas, what the results are, and what can be improved. The methodology of the literature review is reviewed, using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses [PRISMA] (2015, 2018) methodology, as well as the results of the review, a discussion of the results, and the most relevant conclusions.

2. Methodology

The methodology for this study follows the PRISMA process for developing systematic literature reviews or meta-analyses of literature. PRISMA (Moher et al., 2015) is the overall process that consists of a checklist and a flow diagram (PRISMA, 2015); it establishes a process that ensures all documents considered in the analysis or review are evaluated within the same set of parameters.

The PRISMA methodology is the method used by the Cochrane Systematic Reviews (PRISMA, 2015, 2018). By utilizing an established and organized methodology, each piece of literature can be analysed using the same criteria, giving a more objective method of comparison of the information. As a result, the overall way that meta-analysis is conducted and reported is improved (Shamseer et al., 2015). Adding an element of reflexivity can help readers understand the intent of the data (Cook, 2016).

The PRISMA checklist has a total of 27 items that should be evaluated; however, not all the items will be relevant to each type of subject or subject evaluation. The checklist also has an associated flow diagram; the diagram represents a simplified overall version of the process that the checklist details (Moher et al., 2009). Essentially the process has four main processes. The first consists of identifying the documents that may be adequate for inclusion. The second process is the screening, in which documents are examined to determine if any are duplicates; the documents are counted. In the third step, the documents are examined to determine their eligibility for the study. In the final step, the documents that are to be included in the analysis are identified, counted, and organized (Moher et al., 2009). In the research being produced for this article, the documents identified in the fourth step will be entered in a table, and the major points of the document will be described.

A more detailed view of this process suggests that in the very first step of the process, identification, abstracts of the materials to be screened are collected. They can be identified through database searches, including Google Scholar, but can also be identified through other means as well, including recommendations by scholars, researchers or study participants. In the screening step, records are screened in a cursory manner, and records that do not appear to meet the criteria that were established for the study are excluded. In the third phase, the full-length articles are pulled and evaluated to determine whether they meet the requirements of the study. Finally, the selections are made as to which documents will be utilized in the study. The number of documents accepted for the analyses is counted, and the documents are summarized. Both qualitative and quantitative documents can be considered for the analysis (Moher et al., 2009); although the PRISMA was originally utilized for quantitative studies, it has recently gained favour for qualitative study analysis. For the purposes of this current study, each of the documents finalized for inclusion in the study is summarized in a table for the reader's ease.

As part of the organization of the documents in this final step before the discussion and report, a number of basic themes are identified. Each of these basic themes is part of an organizing theme and a global theme. The initial organizing themes included 'hydrosocial territories' and 'rural communities in Mexico'. Each of these organizing themes supports a few basic themes, which will be identified in the discussion and results. In addition, any number of basic themes may be identified during the process; the researchers are not limited to two organizing themes or a particular number of basic themes.

2.1. Inclusion and exclusions

An effort was made to utilize recent literature in this research. An outer limit of fifteen years was established for inclusion, but few older documents were included. Except for one document from 2006, all the included documents were far more recent. The included documents were comprised of government reports, academic journals, and information from water interest groups. A total of 15 documents were included.

Documents that referred to any of the search terms but did not include information about Mexico were excluded, except for Foster and Loucks (2006). The Foster and Loucks document was so informative on the general topic of non-renewable groundwater that it was considered seminal to the research. This was also the oldest document included in the literature.

2.2. Search

Hydrosocial territories, public administration, migration, drought, public policy, disease vectors, sick, health, and rainwater, environment and agriculture were terms that were used in searching, either alone or in conjunction with each other. Not all of the documents meeting these terms were used in the review.

3. Results

The search terms 'Mexico sick water' netted over 17,400 results. Searching on the terms 'Mexico public administration environment water' yielded 22,400 results. All of these results were within the

last five years. The decision was made to limit the number of documents analysed to 15, they were selected based on a variety of views related to problems and solutions of water issues in Mexico's rural regions. Every effort was made to consider a wide variety of situations in the selections for study.

The general process that took place during organization of the data began reading the selected documents and extracting the themes reported by the original researchers. The information was placed in a spreadsheet. The findings of each of the studies or literatures were recorded. It was noted when themes seemed to be interrelated. The information from the documents in table 1 was then analysed and additional literature was used to support or refute the conclusions.

Table 1
Characteristics of included documents

Author and Date	**Type of document**	**Title**	**Comments**
Alatorre (2018b)	Report	'Flowing movement': Building alternative water governance in Mexico	He discusses the impact of water not only from the life-giving aspect, but from the social, political, and environmental perspectives
Calvert (2018)	Website document	Making a difference in Mexico	Excellent basic statement regarding the status of various water projects currently underway in Mexico
Casiano et al. (2016)	Journal	Water governance decentralisation and river basin management reforms in hierarchical systems: do they work for water treatment policy in Mexico's Tlaxcala Atoyac sub-basin?	The research uses the Governance Assessment Tool to help understand governance and its impact so that more effective programs can be developed and utilized
Rojas et al. (2015)	Journal	Spatial distribution of nitrate health risk associated with groundwater use as drinking water in Merida, Mexico	Investigate the health risks in the Merida area associated with using groundwater as drinking water
Foster and Loucks (2006)	Governmental Report	Non-renewable groundwater resources: A guidebook on socially-sustainable management for water-policy makers	This report addresses a very wide variety of water concerns, ranging from the concern of water as a non-renewable resource through legal considerations of dealing with water when its distribution has significant social and economic dimensions
Fuentes-Galván et al. (2018)	Journal	Roof rainwater harvesting in central Mexico: Uses, benefits, and factors of adoption	In the state of Guanajuato the researchers concluded that social interactions could make the use of rainwater more efficient and lead to its expansion as a solution for water shortage
García-García et al. (2016)	Journal	Constructed wetlands: A solution to water quality issues in Mexico?	One possibility for fighting water pollution in Mexico is to construct wetlands
Grafton et al. (2019)	Journal	The water governance reform framework: Overview and applications to Australia, Mexico, Tanzania, USA and Vietnam	The researchers propose a Water Governance Reform Framework (WGRF) and then evaluate its potential efficacy
Hidalgo-Toledo et al. (2019)	Journal	River Basin Organization,	This journal article discusses the role of the

		the best path towards integrated water resources management?	Mexican government in water control and distribution and concludes that the policy approach established in 1992, Integrated Water Resources Management (IWRM), is still in transition
Mokondoko et al. (2016)	Journal	Assessing the service of water quality regulation by quantifying the effects of land use on water quality and public health in central Veracruz, Mexico	Mokondoko et al. assert that a number of the eco-system problems in Mexico are related to an overall lack of policy guidance rather than on a lack of money or technology
Ramírez-Hernández et al. (2018)	Journal	Environmental risks and children's health in a Mayan community from Southeast of Mexico	The researchers conducted analysis of environmental risks and how they contribute to children's health conditions in Southeast Mexico, in a Mayan community
Sámano-Romero et al. (2016)	Journal	Assessing marginalized communities in Mexico for implementation of rainwater catchment systems	The researchers concluded that the Domestic Rainwater Harvesting Systems (DRWHS) represents a viable way to provide drinking water, assuming the projects are under local control
Scott (2013)	Journal	Electricity for groundwater use: constraints and opportunities for adaptive response to climate change	This journal article discusses the use of groundwater in electrical pumping and the impact of night-time power supply using subsidized rates for pumping
Turrén-Cruz et al. (2019)	Journal	Evaluation of sanitation strategies and initiatives implemented in Mexico from community capitals point of view	This journal article discusses human development and well-being in terms of sanitation challenges and investigates initiatives that are in place in Mexico
World Health Organization [WHO] (2018)	Governmental report	Mexico: Highlights based on country report UN Water Global Analysis and Assessment of Sanitation and Drinking Water (GLAAS)	Basic facts, provided by the WHO, relating to Mexico. Demographics, health, sanitation and drinking water, financial basics, governance, monitoring, human resources, financing, and human equity are all discussed so that their application to rural water actions can be determined

Source: authors cited in the table.

3.1. Political context

How has Mexico fallen into the water desert, when Peña, the President, vowed to move Mexico into the future? Dresser (2017) has pointed out that Peña's approval ratings are the lowest ratings of any president in more than 20 years. She suggests that he promised to "Move Mexico," but he has single-handedly moved Mexico in the wrong direction. The problem seems to be that Peña decided to decentralize power, but no one remembered that if power was decentralized, a new power model would need to be developed. It was a matter, she believes, of realizing that the 'pie' would not be made bigger, but the slices of the pie would be divided up significantly different. In essence, a governmental model that barely worked was being reworked, and the new 'pieces' were being given to corrupt contractors and to political cronies. This perception is in agreement with Alatorre (2018a) as well as with Husted's (2002) observation that until the early 2000s, Mexico had low corruption scores.

Peña originally trumpeted that there would be 11 structural reforms to the government that would make a huge difference in how the nation would be able to operate. While the political parties in the government approved the reforms, they have somehow been lost in the day to day mess of doing business. Dresser (2017) argues that part of the problem was that Peña would make top down

pronouncement, without ever considering the wants or needs of the bottom echelons of both the government and the populace. The regulatory reforms promised in the energy sector were too weak to actually materialize. While Peña rolled out an educational reform, his government did not consider the possibility that the educational staff in the nation would not be able to understand what it was that they were supposed to be changing (Dresser, 2017). All of these concerns are reasonable; the Defense Intelligence Agency (2012) pointed out, if groundwater depletes and it is more difficult to grow food, governments begin to destabilize. A recent example of this occurred in Syria (Kelley et al., 2015). Syria's case is especially relevant to Mexico because it was poor management that led to part of the depletion process.

Sixteen multimillionaires in Mexico now own 9 percent of Mexico's gross domestic product (GDP). The peso is being devalued, 43 students who tangled with the city, state and federal police simply disappeared. In Tanhuato, a number of civilians were killed by the federal police (Correa et al., 2018; Ochoa & Torres, 2017; Speck, 2019). In 2018, Peña was replaced with Andrés Manuel López Obrador, but the metaphor of "el lodo", or mud, a mixture of water and dirt which make it impossible to tell which is which, is still in use. It is particularly ironic that this descriptor has been used to describe the Mexican government when one of their critical issues is that of water availability. Non-state actors have such power in Mexico that it can be very difficult to determine who really holds power and what type of power they hold (Estevez, 2018; Gallagher, 2018; Gzesh, 2018; Hincapie, 2018; Trevino-Rangel, 2018; Waddell, 2018). This is particularly true in a decentralized water system, which was intended to put the power of water in the hands of the people, but which really placed the power in the hands of civilian contractors who never consult with the people Alatorre (2018b).

With a strong political background of corruption, it is not a surprise that the government of Mexico is rooted in individual gain (Tetreault & McCulligh, 2018). The water supply industry in Mexico is particularly corrupted. At the present time, the water in many urban and rural areas does not meet safety requirements for chemical concentrations. Tetreault and McCulligh (2018) argue that as water policy was enacted throughout history, the policies made the problems worse. While it is true that making a policy does not guarantee the results (Meier & McFarlane, 1995), there is no guarantee that the results will be better; they may become worse.

The more water that is consumed, the more concentrated minerals and chemicals in the remaining water supply become (as the water lessens). At the same time, Mexico has extremely high limits on contaminants in water compared to most nations. Water is also given as a priority to businesses, like Anheuser-Busch, who are willing to divert it for their commercial operations (Tetreault & McCulligh, 2018). The net result is that residents of Mexico can go thirsty or may consume contaminated water because Nestles or Anheuser-Busch have bought the area's drinking water. Furthering the concerns not only of how the water is handled but of how corruption contributes to the water system in Mexico, the government of Mexico has classified the information relating to how much it charges for the water it provides to companies. As an example, Tetreault and McCulligh (2018) were able to file an information request for the government and elicit the information that Anheuser-Busch is allowed to take 1.5 times the amount of water from aquifers than the equivalent of local drinking water, but the amount the government charges is strictly classified and cannot be released to the public.

3.2. General facts

Basic facts provide a great deal of information about Mexico and allow the reader to determine how the empirical facts interrelate with the research. In 2017, Mexico had a population of 129 million. Twenty-one percent of Mexico's population is rural. The population growth rate is approximately 1.32%. Roughly 416 children under age 5 die each year in Mexico from diarrhoea; this represents a figure of approximately 4 per 100,000 (WHO, 2018). Diarrhoea results from poor water, poor sanitation, and/or poor hygiene, all related to water quality.

In Mexico, 81% of the rural population has basic sanitation services, while 94% of the rural population has basic drinking water sources. Of the urban population, 91% have basic sanitation, and WHO reports that 100% of the urban population has basic drinking water sources. It should be noted, however, that other resources disagree that 100% of the urban population has basic drinking water sources in Mexico; there is significant evidence that some areas must import drinking water. WHO (2018) also reports that national water policies not only exist but have implemented in the following areas: urban and rural sanitation, urban and rural drinking water, hygiene promotion, water and sanitation in schools and health care facilities, infection prevention and control.

Urban area sanitation services are defined in the policies as well. Access to basic sanitation, municipal wastewater services, safe uses of wastewater, and policies relating to faecal sludge collection are all defined in order to prevent illness in urban areas. Rural areas, however, have a different level of concentration. According to WHO (2018), rural areas concentrate on sustainability. The measures, and who the responsibility is assigned to, are defined as follows: keep rural water supply over the long term – cities, local water boards, and local committees; improve the water supplies - cities, local water

boards, and local committees; repair damaged water pumps - cities, local water boards, and local committees; repair damaged latrines in schools - cities, local water boards, and local committees; empty or replace full latrines - cities, local water boards, and local committees; maintain sewers and water treatment facilities - cities, local water boards, and local committees; ensure environmental sustainability of water - cities, local water boards, and local committees; ensure drinking water meets standards – federal, state and city governments.

WHO (2018) reported that in Mexico, the plan includes non-governmental stakeholders, is based on evidence-based decision-making, is based on a national plan, and has poof of the coordination process that is utilised. No budget has been established, government agency participation is not reported, and mutual review is not part of the plan (WHO, 2018). Kochhar et al. (2015) pointed out that even if operational funds are budgeted, there must be funds for maintenance. This is one of the big failures in nations that decide to bring their water standards up.

The picture of community and user participation is dismal. While the law and/or policy define procedures for user participation, (and sometimes defines the participation of women), WHO (2018) reflects that community participation is noticeably light. Urban sanitation, urban drinking water, water pollution control, water quality monitoring, allocation of water rights, water resources management, and environmental protections related to water all have user participation procedures defined by law but had little to no community participation. Community participation is moderate in dealing with rural sanitation, rural drinking water, and hygiene promotion. The only activity with high participation is sanitation in healthcare facilities. Law or policy in Mexico specifically defines female participation in water resource management, sanitation, drinking water issues, and hygiene protection. There is no record if women as a group are participating in these areas, but with general participation of the community population moderate to very low, it seems unlikely that this participation is by women (WHO, 2018).

Joint reviews from various sectors are provided by law, related to sanitation, drinking water and hygiene. There is no record as to the last time these reviews (if any) took place. WHO (2018) does report that there is adequate data for decision making in these sectors to make policy and strategy decisions, allocate resources, ensure quality of service delivery and be able to determine the water quality status, the ability to make decisions relating to notational standards, to respond to disease outbreaks related to sanitation and water issues, to identify public health priorities in disease reduction, and to be able to identify health care facilities that need improvements.

In the case of regulations relating to sanitation and drinking water, the achievements are nearly evenly split, with urban areas being able to achieve a far higher level of achievement than rural areas. In the regulatory areas, there are binding national standards, data is collected on coverage, service quality, and overall quality, and again compliance is split between the rural and urban areas. There is no effort or information being made on having the regulatory separate from the operational service providers or achieving independent funding. Importantly, there is no information as to whether the regulatory authority could give findings without government clearance or dismiss employees without the government's permission and there is only limited ability to take action against non-performers (WHO, 2018). This finding by WHO supports the contentions by Alatorre (2018b) and Tetreault and McCulligh (2018) relating to corruption and to power distribution in Mexico. Scott (2013) hints at a lack of regulatory supervision or of purchased favours when he reported that when organizations give. This journal article discusses the use of groundwater in electrical pumping and the impact of night-time power supply using subsidized rates for pumping. The net effect is that increasing rates of night-time groundwater pumping is now threatening the rural water supplies.

Internally displaced persons, refugees, and people with disabilities are not covered under plans for vulnerable population groups. Further, there are no financial measures available that will help increase access for poor populations, the displaced, or people living with disabilities (WHO, 2018).

While human resources areas (policy, planning, construction, operations, maintenance and so on) are given a high report and the existence and implementation of a financing plan is given a high rating, financial issues receive significantly lower ratings, with reporting not even available from the water service agencies. Financial reporting is not available for sanitation or drinking water, and the proof of utilization of available funding occurs less than 50% of the time. Rural sanitation and drinking water units are able to recover their costs between 50 and 80% of the time, while urban sanitation and drinking water units are able to recover costs less than 50% of the time. Neither urban or rural sanitation, drinking water supply or drinking water quality have enough finance to meet the national targets (WHO, 2018).

3.3. Analysis

Casiano et al. (2016) report that regardless of increased policy reforms, there is a difference between saying the policy is now a decentralized approach, and there actually being a decentralized approach. Despite change requirements, the change has not occurred. Hidalgo-Toledo et al. (2019) pointed out

that there are serious water issues in Mexico and at this point, they believe that "there is no simple way to reorganize the role of the federal government as the leading entity in water management," (Hidalgo-Toledo et al., 2019, p. 153). This would suggest that the role of power needs to be taken completely out of the hands of the government and put into the hands of local organizations or municipal or regional governments. Yet, as García-García et al. (2016) pointed out, the only way that most of the water projects, especially constructed wetlands, can be a success is if the government partners with private organizations and local governments. Carvalho et al. (2017) editorial reviewed a number of constructed wetland projects and concluded that the concept of the constructed, i.e. wetlands offers great hope to areas that lack water if only the projects can be coordinated. The importance of constructed wetlands takes on new meaning when one considers that they can be used to filter out pharmaceuticals or street chemicals (Storrs, 2015). Low cost (Belmont et al., 2004), and easily maintained, (Kurzbaum et al., 2012) constructed wetlands offer hope to smaller rural communities.

Even something as simple as changing the crop mix in an area can increase groundwater (Bierkens et al., 2017) but even that must be coordinated with local governments. The groundwater system is critically important; it affects the amount and quality of the water that is available to sustain human life, as well as animal and plant lives, through the ecosystem (Gleeson et al., 2016).

Aside from the high numbers of residents who do not have access to clean water, Ramírez-Hernández et al. (2018) found that lack of clean water is one of the highest contributors to parasites in children, as well as to vector-borne diseases such as mosquitos and the diseases they spread. Further, Ramirez-Hernandez et al. found that agrochemicals represent a high risk in the water supply. The conclusion that agrochemicals in water are not safe is in direct conflict with conclusions by Rojas et al. (2015) that rainwater dilutes the chemicals enough that they are not dangerous. Both studies took place in the same area; the only difference was that Rojas et al. (2015)'s study was sponsored by the local government. The results are even more suspicious based on the study by Cabañas et al. (2010) which shows that Merida, the site of the Rojas et al. (2015) study, has one of the highest levels of hazardous waste contamination in the country. Whether the problem comes from a liquid chemical runoff or from runoff resulting from disposal of physical items (Nnorom et al., 2011) is irrelevant to the results.

Grafton et al. (2019) reviewed the water governance reform framework in relation to several projects, including one in the Colorado River basin in Mexico and the United States. They concluded that transparency is increasing, but marginalized groups are still being excluded from capacity building. The WHO report contained the same conclusion. Mokondoko et al. (2016) found that the problems related to the eco-system were linked to a lack of policy guidance, more so than to a lack of money or technology. This essentially mirrors Alatorre's (2018b) opinion, which considers water to be at the epicentre of a battle between money and humans. In Alatorre's (2018a, 2018b) perception of the ecosystem, money is at one end of the spectrum and people are at the other. People want money, but they also need a healthy ecosystem. The desire for the money frequently wins.

Sámano-Romero et al. (2016) conducted research on marginalized communities and discovered that the members of these communities are far more aware of environmental conditions and situations than the government may have believed. They determined that a locally led water catchment system would be easily managed by these communities. Fuentes-Galván et al. (2018) also found that members of rural and marginalized communities were actually very knowledgeable about the environment and the state of the water ecosystem. They found that rainwater users understood a great deal about the use of rainwater. They surveyed five rural areas. In these areas, the surveyed residents were able to provide a great deal of information to the researchers. In turn, Fuentes-Galván et al. (2018) were able to develop additional water-use plans for these areas. Residents were knowledgeable enough about local environmental cycles that they were able to identify times when particular rain events happened, and how they should respond to these environmental cues. The researchers concluded that social interactions could actually make the use of rainwater more efficient and lead to its expansion as a solution for water shortage.

Rojas et al. (2015) reached the conclusion that high levels of nitrates from agricultural runoff, measured at levels that would indicate danger to humans, are not actually dangerous. Instead, Rojas et al. argued, their research showed that enough rainfall would hit the aquifer to dilute the nitrate levels. Although Rojas et al. (2015)'s work was an empirical work, it was highly funded; the National Science and Technology Council of the United States provided funding, as did the government of the Yucatan. This suggests that the results might not be unbiased or impartial.

At the time this article was being written, Turrén-Cruz et al. (2019) had finished conducting a study which concludes that despite sanitation being fundamental to human development in developing countries, it is not a priority. Instead, finances, politics and infrastructure are prioritized. Without changing priorities, the situation will not change.

4. Conclusions

Foster and Loucks (2006) introduced a number of ways that nations are dealing with water issues in their nations, including in the developing nations like Mexico. However, the suggestions made by Foster and Loucks (2006) will only be effective if the government becomes more transparent and less corrupt. Until this first step is resolved, there will be no point in continuing.

Calvert (2018) reported on a number of projects that were undertaken by Rotary International and the Water and Sanitation Rotarian Action Group (WASRAG), Rotarians were able to conduct these projects by getting the permission of the federal government and the district government. The organization signed a five-year agreement to develop pilot projects that would begin with needs assessments and proceed through development and implementation of pilot projects. The group was unable to "get established" but after finding grant money the process proceeded. The implication is that the government was not willing to actually provide funding for these projects.

In order for Mexico to make progress, the government must be willing to work with local organizations and local governments. It must be willing to make the people of Mexico a priority. Finally, it must be willing to develop controls that will prevent corruption at all levels. Anything less will result in the status quo.

Bibliographic references

Alatorre, G. (2018b) *'Flowing movement': Building alternative water governance in Mexico*. Transnational Institute. http://longreads.tni.org/state-of-power-2018/flowing-movement-building-alternative-water-governance-in-mexico/

Alatorre, G. (2018a). *People's control over water in Mexico. State of Power 2018*. http://aguaparatodos.org.mx/peoples-control-over-water-in-mexico/

Bai, Y., Zheng, H., Ouyang, Z., Zhuang, C., & Jiang, B. (2013). Modeling hydrological ecosystem services and tradeoffs: a case study in Baiyangdian watershed, China. *Environmental Earth Sciences*, *70*(2), 709-718. https://doi.org/10.1007/s12665-012-2154-5

Belmont, M. A., Cantellano, E., Thompson, S., Williamson, M., Sánchez, A., & Metcalfe, C. D. (2004). Treatment of domestic wastewater in a pilot-scale natural treatment system in central Mexico. *Ecological Engineering, 23*(4-5), 299-311.

Bierkens, M. F., Reinhard, S., de Bruijn, J., & Wada, Y. (2017, April). *The shadow price of non-renewable groundwater*. Paper presented at EGU General Assembly Conference Abstracts, Vienna, Austria. http://adsabs.harvard.edu/abs/2017EGUGA..19.9714B

Cabañas, D., Reza, G., Sauri, R., Méndez, R. I., Bautista, F., Manrique, W., Rodríguez, E., Balancán, A., & Medina, R. (2010). Inventario de fuentes potenciales de residuos peligrosos en el estado de Yucatán, México. *Revista Internacional de Contaminación Ambiental, 26*(4). http://www.scielo.org.mx/scielo.php?script=sci_arttext&pid=S0188-49992010000400002

Calvert, M. (2018). Making a difference in Mexico. *Rotary International and Water & Sanitation Rotarian Action Group (WASRAG)*. https://www.wasrag.org/stories/making-a-difference-in-mexico

Carvalho, P., Arias, C., & Brix, H. (2017). Constructed wetlands for water treatment: new developments. *Water, 9*(397). https://doi.org/10.3390/w9060397

Casiano, C., Vikolainen, V., & Bressers, H. (2016). Water Governance Decentralisation and River Basin Management Reforms in Hierarchical Systems: Do They Work for Water Treatment Policy in Mexico's Tlaxcala Atoyac Sub-Basin? *Water, 8*(5), 210. https://doi.org/10.3390/w8050210

Casiano, C. C., Özerol, G., & Bressers, H. (2017). "Governance restricts": A contextual assessment of the wastewater treatment policy in the Guadalupe River Basin, Mexico. *Utilities Policy, 47*, 29-40. https://doi.org/10.1016/j.jup.2017.06.006

Cook, D. A. (2016). Tips for a great review article: crossing methodological boundaries. *Medical Education, 50*(4), 384-397. https://doi.org/10.1111/medu.12983

Correa, C. P., Forné, C. S., & Rivas, R. G. (2018). Deadly Forces: Use of Lethal Force by Mexican Security Forces 2007–2015. In A. Anaya-Muñoz & B. Frey (Eds.), *Mexico's human rights crisis* (pp. 23-42). University Of Pennsylvania Press.

Defense Intelligence Agency (2012). *Global water security: Intelligence community assessment*. https://www.dni.gov/files/documents/Special%20Report_ICA%20Global

%20Water%20Security.pdf

Dresser, D. (2017). *Mexico: Why Mexico fell apart, and how to fix it. Berkeley Review of Latin American Studies, Spring 2017*. https://clas.berkeley.edu/research/mexico-why-mexico-fell-apart-and-how-fix-it

Estevez, A. (2018). Bridging legal geographies: Contextual adjudication in Mexican asylum claims. In A. Anaya-Muñoz & B. Frey (Eds.), *Mexico's Human Rights Crisis* (pp. 147-166). University of Pennsylvania Press.

Foster, S. & Loucks, D. (2006). *Non-renewable groundwater resources: A guidebook on socially-sustainable management for water-policy makers.* UNESCO and World Bank.

Fuentes-Galván, M., Ortiz, J., & Arias, L. (2018). Roof rainwater harvesting in central Mexico: Uses, benefits, and factors of adoption. *Water, 10*(2), 116. https://doi.org/10.3390/w10020116

Gallagher, J. (2018). The judicial breakthrough model: Transnational advocacy networks and lethal violence. In A. Anaya-Muñoz & B. Frey (Eds.), *Mexico's human rights crisis* (250-272). University of Pennsylvania Press.

García-García, P. L., Ruelas-Monjardín, L., & Marín-Muñíz, J. L. (2016). Constructed wetlands: a solution to water quality issues in Mexico? *Water Policy, 18*(3), 654-669. https://doi.org/10.2166/wp.2015.172

Gleeson, T., Befus, K. M., Jasechko, S., Luijendijk, E., & Cardenas, M. B. (2016). The global volume and distribution of modern groundwater. *Nature Geoscience, 9*(2), 161-167. https://doi.org/10.1038/ngeo2590

Grafton, R. Q., Garrick, D., Manero, A., & Do, T. N. (2019). The Water governance reform framework: Overview and applications to Australia, Mexico, Tanzania, USA and Vietnam. *Water, 11*(1), 137. https://doi.org/10.3390/w11010137

Gzesh, S. (2018). Mexican asylum seekers and the Convention Against Torture. In A. Anaya-Muñoz & B. Frey (Eds.), *Mexico's human rights crisis* (pp. 167-186). University of Pennsylvania Press.

Hidalgo-Toledo, J. A., Hernández-Arce, C., & Vargas-Velázquez, S. (2019). River basin organization, the best path towards integrated water resources management? In H. R. Guerrero García Rojas (Eds.), *Water policy in Mexico* (pp. 153-169). https://doi.org/10.1007/978-3-319-76115-2

Hincapie, S. (2018). Women's human rights in the armed conflict in Mexico: Organized crime, collective action, and state responses. In A. Anaya-Muñoz & B. Frey (Eds.), *Mexico's human rights crisis* (pp. 63-85). University of Pennsylvania Press

Husted, B.W. (2002). Culture and international anti-corruption agreements in Latin America. *Journal of Business Ethics, 37*(4), 413-422. https://doi.org/10.1023/A:1015248921716

Kelley, C. P., Mohtadi, S., Cane, M. A., Seager, R., & Kushnir, Y. (2015). Climate change in the Fertile Crescent and implications of the recent Syrian drought. *Proceedings of the National Academy of Sciences, 112*(11), 3241-3246. https://doi.org/10.1073/pnas.1421533112

Kochhar, K., Pattillo, C., Sun, Y., Suphaphiphat, N., Swiston, A., Tchaidze, R., ... & IMF Staff Team (2015). *Is the glass half empty or half full?: Issues in managing water challenges and policy instruments*. https://www.imf.org/external/pubs/ft/sdn/2015/sdn1511.pdf

Kurzbaum, E., Kirzhner, F., & Armon, R. (2012). Improvement of water quality using constructed wetland systems. *Reviews on Environmental Health, 27*(1), 59-64. https://doi.org/10.1515/reveh-2012-0005

Luby, S. P., Halder, A. K., Huda, T. M., Unicomb, L., Islam, M. S., Arnold, B. F., & Johnston, R. B. (2015). Microbiological contamination of drinking water associated with subsequent child diarrhea. *The American Journal of Tropical Medicine and Hygiene, 93*(5), 904-911. https://doi.org/10.4269/ajtmh.15-0274

McCulligh, C., & Tetreault, D. (2017). Water management in Mexico. From concrete-heavy persistence to community-based resistance. *Water Alternatives, 10*(2), 341-369. http://www.water-alternatives.org/index.php/alldoc/articles/vol10/v10issue2/359-a10-2-9/file

Meier, K. J., & McFarlane, D. R. (1995). Statutory coherence and policy implementation: The case of family planning. *Journal of Public Policy, 15*(3), 281-298. https://doi.org/10.1017/S0143814X00010059

Moher D., Liberati A., Tetzlaff J., Altman D., & The PRISMA Group (2009). Preferred reporting items for systematic reviews: The PRISMA Statement. *PLoS Med 6*(7), e1000097. https://doi.org/10.1371/journal.pmed.1000097

Moher, D., Shamseer, L., Clarke, M., Ghersi, D., Liberati, A., Petticrew, M., ... & Stewart, L. A. (2015). Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement. *Systematic reviews, 4*, 1. https://doi.org/10.1186/2046-4053-4-1

Mokondoko, P., Manson, R. H., & Pérez-Maqueo, O. (2016). Assessing the service of water quality regulation by quantifying the effects of land use on water quality and public health in central Veracruz, Mexico. *Ecosystem Services, 22*, 161-173. https://doi.org/10.1016/j.ecoser.2016.09.001

Nnorom, I. C., Osibanjo, O., & Ogwuegbu, M. O. C. (2011). Global disposal strategies for waste cathode ray tubes*. Resources, Conservation and Recycling, 55*(3), 275-290.

https://doi.org/10.1016/j.resconrec.2010.10.007

Ochoa, J. A., & Torres, H. A. H. (2017). Attacking illegality with more illegality. The case of federal presidential intervention in the state of Michoacán, Mexico. *Quaestio Iuris, 10*(3), 1760-1775. https://doi.org/10.12957/rqi.2017.28625

Perló, M., & Zamora, I. (2017). Perspectivas ambientales sobre la contaminación y la recuperación del Río Magdalena en la Ciudad de México. *Revista Internacional de Contaminación Ambiental, 33*(3), 377-391. https://doi.org/10.20937/RICA.2017.33.03.02

Preferred Reporting Items for Systematic Reviews and Meta-Analyses [PRISMA] (2015). *Welcome to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) website!* http://www.prisma-statement.org/

Preferred Reporting Items for Systematic Reviews and Meta-Analyses [PRISMA] (2018). *Standards for the reporting of new Cochrane Intervention Reviews*. http://www.prisma-statement.org/News.aspx

Ramírez-Hernández, H., Perera-Rios, J., May-Euán, F., Uicab-Pool, G., Peniche-Lara, G., & Pérez-Herrera, N. (2018). Environmental Risks and Children's Health in a Mayan Community from Southeast of Mexico. *Annals of Global Health, 84*(2), 292–299. http://doi.org/10.29024/aogh.917

Ríos, A. & de Santiago, R. (2014, July 28). Agua en Guadalupe, de derecho humano a jugoso negocio. *La Jornada Zacatecas*. http://ljz.mx/2014/07/28/agua-en-guadalupe-de-derecho-humano-jugoso-negocio/

Rojas, A. Y., Pacheco, J. G., Esteller, M. V., Cabrera, S. A., Camargo-Valero, M. A. (2015). Spatial distribution of nitrate health risk associated with groundwater use as drinking water in Merida, Mexico. *Applied Geography, 65*, 49-57. http://doi.org/10.1016/j.apgeog.2015.10.00414

Sámano-Romero, G., Mautner, M., Chávez-Mejía, A., & Jiménez-Cisneros, B. (2016). Assessing marginalized communities in Mexico for implementation of rainwater catchment systems. *Water, 8*(4), 140. https://doi.org/10.3390/w8040140

Schmoll, O., Howard, G., Chilton, J., & Chorus, I. (Eds.). (2006). *Protecting Groundwater for Health: Managing the Quality of Drinking-water Sources*. World Health Organization.

Scott, C. A. (2013). Electricity for groundwater use: constraints and opportunities for adaptive response to climate change. *Environmental Research Letters, 8*(3), 1-8. http://doi.org/10.1088/1748-9326/8/3/035005

Shamseer, L., Moher, D., Clarke, M., Ghersi, D., Liberati, A., Petticrew, M., Shekelle, P., & Stewart, L.A. (2015). Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015: elaboration and explanation. *BMJ, 349*, g7647. https://doi.org/10.1136/bmj.g7647

Silva, J. A. (2018). *Water management In Latin America and the* Caribbean. Alicante: 3Ciencias.

Speck, M. (2019). Great Expectations and Grim Realities in AMLO's Mexico. *PRISM, 8*(1), 68-81.

Storrs, C. (2015, March 16). Designing Wetlands to Remove Drugs and Chemical Pollutants. *YaleEnvironment360*. https://e360.yale.edu/features/designing_wetlands_to_remove_

drugs_and_chemical_pollutants

Taylor, R. G., Scanlon, B., Döll, P., Rodell, M., Van Beek, R., Wada, Y., ... & Konikow, L. (2013). Ground water and climate change. *Nature Climate Change, 3*(4), 322-329. https://doi.org/10.1038/nclimate1744

Tetreault, D., & McCulligh, C. (2018). Water Grabbing via Institutionalised Corruption in Zacatecas, Mexico. *Water Alternatives, 11*(3), 572-591. http://www.water-alternatives.org/index.php/alldoc/articles/vol11/v11issue3/454-a11-3-7/file

Trevino-Rangel, J. (2018). Superfluous lives: Undocumented migrants traveling in Mexico. In A. Anaya-Muñoz & B. Frey (Eds.), *Mexico's human rights crisis* (107-123). University of Pennsylvania Press.

Turrén-Cruz, T., García-Rodríguez, J. A., & López, M. Á. (2019). Evaluation of sanitation strategies and initiatives implemented in Mexico from Community Capitals point of view. *Water, 11*(2), 295. http://dx.doi.org/10.3390/w11020295

Waddell, B. (2018). Emigration, violence, and human rights violations in Central Mexico. In A. Anaya-Muñoz & B. Frey (Eds.), *Mexico's human rights crisis* (pp. 124-146). University of Pennsylvania Press.

Wilder, M. (2010). Water governance in Mexico: political and economic apertures and a shifting state-citizen relationship. *Ecology and Society, 15*(2). http://www.ecologyandsociety.org/vol15/iss2/art22/

World Health Organization [WHO] (2018). *Mexico: Highlights based on country reported GLAAS 2016/2017 data*. https://www.who.int/water_sanitation_health/monitoring/investments/country-highlights-2017/mexico-glaas2017-country-highlight-20181107.pdf?ua=1

---

1. Doctorate in Administrative Sciences. CIIEMAD, Instituto Politécnico Nacional. j.a.silva@outlook.com

Revista ESPACIOS. ISSN 0798 1015
Vol. 41 (Nº 17) Year 2020

[Index]