

Rural Water Supply in Mexico*

Jorge A. Silva Rodríguez de San Miguel**

doi:10.11144/Javeriana.cdr13-78.rwsm

Recibido: 2016-09-16 Aprobado: 2016-11-21 Disponible en línea: 2016-12-20

Cómo citar este artículo: Silva, J. A. (2016). Rural Water Supply in Mexico. *Cuadernos de Desarrollo Rural*, 13(78), 123-141. <https://doi.org/10.11144/Javeriana.cdr13-78.rwsm>

* Este documento se realizó en el marco del proyecto SIP 2017182: Evaluación de la gestión del agua potable en México: retos y oportunidades.

** Doctor en Ciencias Administrativas, funcionario en la Jefatura del Departamento de Territorio y Ambiente en el Centro Interdisciplinario de Investigaciones y Estudios sobre Medio Ambiente y Desarrollo (Ciiemad) del Instituto Politécnico Nacional (IPN) de México. Correo electrónico: j.a.silva@outlook.com. Orcid: <http://orcid.org/0000-0002-0961-4696>



Abstract

The supply of water to rural areas has historically provided the Mexican government with a significant challenge. Years of uncertainty in relation to responsibility for water supply, as well as geographical differences across the country and a division between rural and urban areas, explain this phenomenon. I have reviewed in this paper a substantial proportion of the literature on this topic, the reasons behind its nature, and the solutions to the problem in Mexico, as my main aim. The key conclusion is that while improvements in rural water supply in Mexico have been made, further work is required for equality in its supply.

Keywords:

Mexico; rural water; water supply

Suministro rural de agua en México

Resumen

Históricamente, el suministro de agua a las zonas rurales ha sido un desafío importante para el gobierno mexicano. Las razones que explican dicho fenómeno incluyen años de incertidumbre en relación con la responsabilidad por el abastecimiento de agua, así como las diferencias geográficas en todo el país y la división entre las zonas rurales y urbanas. En este documento se lleva a cabo la revisión de una parte sustancial de la literatura sobre este tema, las razones que subyacen a sus características y las soluciones para resolver dicho problema en México. La conclusión clave es que, si bien se han logrado mejoras en el suministro de agua en las zonas rurales de México, se requiere más trabajo para lograr la igualdad en su oferta.

Palabras clave:

México, agua rural; suministro de agua

Introduction

The management and provision of water supplies in rural Mexico, in addition to rural sanitation, has long provided the country's government with a substantial problem, and one which is proving to be difficult to surmount. Rural water supply in Mexico, which has been extensively covered in a public administration context in various official reports, journal articles, and textbooks, does not just represent a serious challenge, but also takes a heavy and burdensome financial toll on the country and its administration. For many countries, water is a source of significant revenue (Chaudhry & Barbier, 2013; National Water Commission of Mexico [Conagua], 2007b; Stockholm International Water Institute, 2005; World Water Assessment Programme, 2009), but the income that is gleaned from water in Mexico is nominal, and even drains the resources of the government who subsidise water providers in rural areas (Organisation for Economic Co-operation and Development [OECD], 2013a).

The government has previously been accused of ignoring the real complexities and intricacies of rural water management, in an operational context, and for that reason it appears that there is general consensus among commentators that there has never really existed an unambiguous, detailed, and wide-reaching roadmap for the provision of water services in rural areas (International Renewable Energy Agency [Irena], 2015; Hassing, Ipsen, Clausen, Larsen, & Lindgaard-Jorgensen, 2011; Scott, & Banister, 2013). However, serious changes have been made since the decentralization of water supply in Mexico and improvements are ongoing (Conagua, 2014; Secretaría de Medio Ambiente y Recursos Naturales, 2004).

This paper evaluates a substantial proportion of the broad body of research and writing in relation to rural water supply in Mexico. The key themes synthesised are: the historical evolution of water supply in Mexico; geographical differences in Mexico in relation to water resources; the rural-urban division in relation to water supply; the inherent problems with rural water supply; improvements made to rural water supply, and the successes and failures of the steps taken.

Historical timeline of water supply in Mexico

Several sources have traced the history of water supply in Mexico, the key details of which are discussed briefly.

Between 1948 and 1983, water supply in Mexico was centralized and the Ministry of Water Resources (SRH) was placed in charge of it. In rural areas some participation was permitted through the creation of federal water boards, but this

was wholly dependent on the SRH (Angelakis, Mays, & Koutsoyiannis, 2012; Bennett, 1995; Scott & Banister, 2008).

From 1971 onwards, more specialized bodies were created across the nation as the country's population expanded and the centralized water supply system was no longer able to cope, but the government eventually opted for decentralization; this can be seen in the Article 115 of the Constitution, which expanded the municipalities' authority. This led drinking water provision to be a primary responsibility of municipalities with the support of the State (Conagua, 2014; Diario Oficial de la Federación [DOF], 2016; Goetz & Berga, 2006; Molle & Wester, 2009; Pablos, 2002). In 1982, the economy of the country fell into turmoil, and between 1983 and 1989, decentralization of water supply began, with the responsibility for water services being taken over by municipalities and the responsibility for helping these municipalities with any technical or financial aspects of water supply being retained by the government (Bennett, 1995; Castro, 1995; Secretaría de Medio Ambiente y Recursos Naturales, 2004). However, the majority of municipalities in rural areas were never made the recipients of the financial resources or the technical help required for the management of their own water supply systems (Scott & Banister, 2008; Scott & Banister, 2013). This explains why, in 1988, a mere 30 % of Mexican states controlled their own water supply, and when this was the case, the quality of the supply and the water itself was not to the same standard as in urban centres (Pablos, 2002; The World Bank, 2005). Between 1989 and the end of the 1990s, water provision underwent dramatic reform with the creation of the Conagua, which is now one of the most important organizations related to water supply in the country to date. Conagua is an administrative, normative, technical, consultative, and decentralized agency of the Ministry of the Environment and Natural Resources. Its mission is to achieve sustainable use, while its vision is to ensure Mexico is a nation that has sufficient water in both quantity and quality (Conagua, 2016). One of the functions of Conagua is to resolve the issue of small municipalities not being able to effectively take responsibility for their own water supply due to a lack of financial and technical support, and soon after its creation, it quickly became apparent that the decentralization process, while a good idea in theory, had not been implemented correctly (Garrido & Ingram, 2011; Pablos, 2002; The World Bank, 2005; Verner, 2010). Consequently, the Commission made a number of changes required to improve the decentralization process, including better transparency of water tariffs and autonomous water tariffs –linked with the actual price of water supply and free of

government control— the result of which was a great deal of new legislation and the amendment of much of the existing one (Verner, 2010; The World Bank, 2005; Pablos, 2002). By 1995, around 60 % of the municipalities effectively controlled their own water supply, as opposed to the approximate 30 %, when decentralization was first attempted (Garrido & Ingram, 2011).

Since 2000, a number of further reforms have been made, including rural areas being given responsibility of more functions involving water supply, incorporating decisions related to funding (The World Bank, 2005). More importantly, since February of 2012, Mexico makes part of the countries which have included in its Constitution the human right to water (Constitución Política de los Estados Unidos Mexicanos, 2014), and the government is responsible for complying with this. Moreover, just in 2014 a new legislation was proposed, which states that it is essential the participation of private companies in the financing of water supply (Arana, 2016; El Sol de México, 2016; Gamboa, 2015; OECD, 2013b). However, many local interest groups, citizens' groups, and non-governmental organizations have heavily criticized the legislation, suggesting that it works at the detriment of both rural residents (Arana, 2016; El Sol de México, 2016; Gamboa, 2015; OECD, 2015) as well as urban residents in some cases (Arana, 2016). That is why it has not had success. For example, the Water Operators' Association (Aneas) notes that the legislation fails to address waste water treatment in any real way, and argues that it offers a disproportionate benefit to certain industries (El Sol de México, 2016; Gamboa, 2015; Guerra, 2016; International Trade Administration [ITA], 2016).

At the regional level, Conagua performs its functions of monitoring and conducting through 13 Basin Organizations, whose field of competence are 13 Hydrological-Administrative Regions, and in each one of them there may be one or several Basin Councils (Conagua, 2015a). These basin organizations were introduced into the national water law of 2004, together with the restructuring of river basin councils (DOF, 2004). Basin councils were defined as joint bodies of mixed integration, which are instances of coordination, consultation, support, and advice, between Conagua—including federal agencies and entities, State or municipal—and representatives of water users and society organizations (DOF, 2004). Normatively, in the Councils only the President, the Governmental Vocals, and Users have voice and vote. However, the options to vote are usually those that the representatives of Conagua delineate or mark, and there is no guarantee that decisions and agreements made will be followed (Hernández-Suárez, 2011; DOF, 2004).

Regional differences and urban versus rural

On one hand, the wealthier North, Northwest and Central regions of Mexico, which are dry year around and see little rain, are home to almost 80 % of the country's residents, and these regions are accountable for a little under 90 % of the country's Gross Domestic Product (GDP) (Shretha, Anal, Salam, & van der Valk, 2015). The Northern regions make up about 50 % of the country's landmass, and only receive around 25 % of the rainfall (Guigale, Lafourcade, & Nguyen, 2001).

On the other hand, the less affluent Southern parts of Mexico are characterised by plentiful water resources (Guigale et al., 2001). Although these regions have copious water resources, they cannot be considered as suitable as supplies of water for the country's rural population because of their levels of pollution (Shretha et al., 2015; Spring, 2011), and the availability of these tainted resources lead to a far less than bucolic rural idyll. Moreover, such resources are not up to the necessary standard to act as the foundation for strong economic progression and environmental sustainability (Guigale et al., 2001; Shretha et al., 2015; Spring, 2011).

The provision of water and other services to urban areas, which are home to around 80 % of the country's residents, has always taken precedence. These areas are where political power and revenue expenditure lay. To the contrary, rural areas are perceived as less important (Miller, 1980; Scott & Banister, 2013).

With a notable few exceptions, a growing GDP has led to more and more people formerly living in rural areas relocating to urban areas, which has led to a burgeoning gap between urban and rural demographics (Alfaro, 1982; The World Bank, 2008). For this reason, investment in water supplies to rural areas has traditionally suffered and calls have long been made by local interest groups, citizens' groups, and non-governmental organizations for greater equality in terms of the distribution of water (Alfaro, 1982; Scott & Banister, 2013).

In areas where food production levels are high, and that production relies upon irrigation systems, investment in water supply is generally high (Scott & Banister, 2013).

Yet, in other than such areas, rural water supply has historically been poor. Many people in rural parts of Mexico live without running water, the consequence of which is that the water they do acquire in other ways is more expensive (Spring, 2011; Deininger, Litethany, & Batram, 2000). The irony of this is that people in poorer parts of the country are forced to pay more for water than those linked with urban water provision systems, which is why the call for better rural programmes has always been so strong (Llamas, Cortina, & Mukhejri, 2009; Scott & Banister, 2013).

In some rural parts of the country, water is distributed through a pipe of some sort, but the water is not treated properly and is not entirely safe for people to drink; this forces people to solve their water issue in various ways, including bottled water and filters (Llamas et al., 2009; Spring, 2011). Many rural areas in Mexico do not have water treatment facilities, and if the water in these areas, normally stored in small reservoirs, is not fit for human consumption, people often ignore this fact and drink it anyway, the dangers of which are substantial (Deininger et al., 2000; Spring, 2011).

In very small rural areas, where water from nearby sources—such as springs and streams—is stored in hand-made reservoirs, someone is given the responsibility for the maintenance of water distribution systems, often with the help of other residents (Arreola, 2010; Johnston, 1987). Also, a group of people is dedicated to monitoring water sources and are responsible for different tasks related to public health and protection of the environment, waste treatment, environmental education, and health (Sandoval-Moreno & Günther, 2013).

The lack of financial resources and insufficient provision of quality and quantity in terms of drinking water services have been negative factors that affect health and quality of life, leading to diseases, unfavorable conditions for students and teachers in schools, excessive workload on women who are commonly responsible for supplying water used in homes, among others (Jiménez Sánchez, 2010; Gutiérrez-Villalpando, Nazar-Beutelspacher, Zapata-Martelo, Contreras-Utrera, & Salvatierra-Izaba, 2013; Secretaría de Educación y Cultura, 2015; *We Are Water*, 2012).

In some rural areas, where government initiatives have not been of particular utility, bottled water is the key solution. Many men and women have carved a living out of bottling and delivering water to people in the country, the cost of which varies from area to area depending on supply and demand in addition to the number of competitors (Echternacht, 2014; Hancock, 1948; Wilder & Lankao, 2006). However, in some extremely poor rural parts of the country, bottled water is not an option within the means of local residents (Echternacht, 2014; Hancock, 1948; Wilder & Lankao, 2006).

In rural areas private wells may be found, but they are few and located at a considerable distance. Mexico has far fewer private wells than there are in the United States because low income families cannot afford their installation (Reid, 2007; The United Nations, 2013), unless they combine their money with that of other people in their locality, but consensus in such an instance is difficult to obtain, as is government approval (The United Nations, 2013; Wilder & Lankao, 2006).

Improvements in rural water distribution

While rural water management is problematic for the Federal Government of Mexico, the country indeed has implemented a relatively strong system of water supply in general (Conagua, 2015a; Gobierno de la República, 2014; Gobierno de la República, 2013), and rural water supply more specifically (Arreola, 2010; Inter-American Development Bank [IDB], 2013; Spring, 2011). A part of this system consists of implementation of plans and programs. For example, new water treatment plants have been built and the water network has been expanded in many parts of Mexico. Likewise, the Programme for the Construction and Rehabilitation of Drinking Water and Sanitation Systems in Rural Areas (Prossapys), which targets communities below 2,500 inhabitants, has improved water coverage in several marginal rural areas of the country such as Veracruz, Chiapas, Guerrero, Oaxaca, and Puebla (Universidad Nacional Autónoma de México [UNAM], 2014; IDB, 2013).

Since its development, this system has led to notable improvements of the availability of piped water supply, primarily in urban areas, which have seen a huge increase of approximately 90 % in the past 25 years (Arreola, 2010; Conagua, 2010). Although improvements have been made to the availability of piped water supply in rural areas, these are inferior in comparison to those made in urban areas (Public-Private Infrastructure Advisory Board, 2003), with increases of approximately 60 % in the past 25 years (Conagua, 2010).

Nonetheless, according to the 2000 census, prior to these improvements less than 30 % of people in rural areas received water on a regular basis (Fewtrell & Batram, 2001; Scott & Banister, 2013). Hence, the improvements made, despite being lesser than in urban areas, are appreciable. Moreover, efforts to make access to water in rural areas more extensive are ongoing, as are investments in doing so (Scott & Banister, 2013). Also, in the past 25 years Mexico has achieved a comprehensive and robust improvement of sanitation in rural areas, with an increase of approximately 70 % (Conagua, 2010; Scott & Banister, 2013). Since the decentralization of water supply in Mexico, as previously discussed, both water supply and sanitation is tasked to each municipal area. Although, this responsibility is delegated by some areas to state water utilities, and, in rural areas, to water boards, known as Juntas, which look after water supply (Gortari & González, 1994; The World Bank, 2005). Water supply in rural areas is also controlled using a variety of mechanisms, facilitated by government legislation. For example, alongside water boards, the responsibility for water supply management is also given to water committees, management units tasked with managing sustainable development, and community organisation initiatives (Galindo-Escamilla, E., & Palerm-Viqueira, J., 2012; Gortari & González, 1994).

Such improvements have been made partially as the result of an innovative countrywide method of funding the country's rural water supply and sanitation infrastructure, which is undertaken by Conagua (Scott & Banister, 2013). This involves the fulfilment of the Prossapys program objectives focused on building infrastructure to increase drinking water supply, sewage systems, and sanitation. Government efforts indicate that in 2015 there was an increase in drinking water coverage in rural areas, and during the year 2014, 8.886.2 million pesos were invested in infrastructure, which was 18.5 % higher than the previous year (Conagua, 2015b).

Improvements in water management have also been made thanks to community water management, which aims to improve integrated water management in rural areas; this involves the whole process of management. However, this is a form of self-management without the full participation of the government. For example, there is the case of Hidalgo, Chiapas, Tabasco, Veracruz, and Oaxaca, where some groups of communities have established their own form of government to manage water, from collection to distribution (Aguilar Amilpa, 2011; Galindo-Escamilla & Palerm-Viqueira, 2007; Gasca Zamora, 2014; Gutiérrez-Villalpando et al., 2013; Pimentel-Equihua, Velázquez-Machuca, & Palerm-Viqueira, 2012; Sandoval-Moreno & Günther, 2013).

The success of government programs such as Prossapys and others is a relief in the wake of the majority of utilities in the country performing poorly in terms of both technical and commercial efficiency, with non-revenue water falling at a mere 50 % in 2003 (OECD, 2003; World Water Assessment Programme, 2009). However, such utilities should not be criticized without consideration of why their performance was lacking. Essentially, the key issue was that water infrastructure required greater investment but people were unwilling to spend money on water services when the quality of water was so low. Funding could be gleaned as the result of a combination of institutional measures, as well as increasing consumer's awareness of water as an economic good, including fostering their willingness to pay for water services (OECD, 2003; Perry, Rock & Seckler, 1997; Wilder, 2005). Doing so would put an end to the vicious cycle in which customers are unwilling to pay for poor quality service and utilities do not have the means to improve their service (OECD, 2003).

As a result of the work of Conagua and high-performing utilities, rural water supply has definitely improved. A few rural areas have managed to develop their water supply services with general success, running at optimum efficiency as the result of the implementation of models that have permitted them to broaden their services to cater to the needs of as many of the local residents as possible. For example, deep wells have been equipped, the drinking water network has been expanded, and the number

of water treatment plants and rainwater collection systems has increased (Aguilar Amilpa, 2011; Arana, 2016; OECD, 2015; Pearce-Oroz, 2011; Sandoval-Moreno & Günther, 2013; Subdirección General de Agua Potable, Drenaje y Saneamiento, 2016).

It is estimated that by the end of 2015 the coverage of drinking water was 92.4 %: 95.1 % in urban areas and 82.9 % in rural areas. As for sewage, it was 91 %: 96.3 % in urban areas and 72.8 % in rural areas. The greatest backlogs in drinking water are presented in Guerrero, Oaxaca, and Chiapas; while in terms of sewage, they are Oaxaca, Guerrero, and Yucatán (Conagua, 2015a).

Discussion

While improvements have been made, it is still ostensibly clear that not all rural water boards have the technical, financial, commercial, and technical resources (OECD, 2013a) necessary for the provision of excellent water and sanitation services in an efficient way (Pearce-Oroz, 2011; SADM, 2016). Moreover, decision-making power is still centralised within the hands of Conagua, despite the fact that the government opted for decentralization. As a result, river basin councils lack planning and financing power to carry out their functions (DOF, 2016; OECD, 2013a). While some rural utilities manage to operate with efficiency now, the overwhelming majority remain disarticulated (Deskota Study Team, 2008; OECD, 2013a), lacking independence with regards to their operation, facing real pressure from the residents—and groups serving the interests of those residents—of the areas they cover, and struggling to cover the costs of their services (Arana, 2016; Deskota Study Team, 2008; OECD, 2003). For example, Mexican states and municipalities have greater independence than before, and water users and individuals participate in water management, but they still need to be taken more into account by Conagua. This is the case of river basin councils, which have supported federal agencies and entities (DOF, 2004), although it is still necessary to position them in a good place to avoid centralized decision-making of Conagua (OECD, 2013a).

While the popularity of corporate involvement in the provision of water and sanitation services is observable (OECD, 2013a), potentially because of the new legislation, the proposed 2014 General Water Law (which was not approved but people are still waiting for a new law), encouraged corporate involvement (Arana, 2016), primarily in urban centres (OECD, 2013a). On the whole, the only occasions in which corporations wish to become financially involved with water supply and sanitation in rural areas is when they have interests in food production requiring irrigation (Scott & Banister, 2013).

The divide between urban areas and rural areas is still very noticeable, as is the divide between the North, Northwest, and Central regions and the Southern regions of the country (Scott & Banister, 2013). Only about 25 % of the water providers in Mexico can be found in cities with a population of over 20,000, while the remainder can be found in small, poor rural areas which simply do not have the resources and the capacity to manage water and sanitation services in an efficient way (Desakota Study Team, 2008; Scott & Banister, 2013; The United Nations, 2013). In 2010, over 20,000,000 Mexican citizens resided in areas with a population of less than 2,500 and 25 % of those people did not have access to drinking water safe for human consumption (Desakota Study Team, 2008; Miller, 2001; The United Nations, 2013). While the General Water Law was designed with the intention of surmounting the financial problems encountered by urban areas in this respect, it has been criticized as actually being detrimental to the provision of urban water supply (Arana, 2016; OECD, 2015). It is suggested that helping rural areas struggling in financial and capacity terms, the diversity of Mexican water utilities must be taken into consideration (OECD, 2013a). In reality, a significant number of rural areas have still been unable to implement water supply systems, which have the ability to provide good quality water in an efficient way to residents (Arana, 2016; Esparza, 2014; Fewtrell & Batram, 2001; Miller, 2001; OECD, 2013a; Scott & Banister, 2013). The desire to encourage citizens to view water as an economic good worth paying for (OECD, 2005; Scott & Banister, 2008) could be a viable longer-term solution to the ongoing issue of poor water provision in urban areas, but this will only work if they, as consumers, are offered a product of an adequate quality worth paying for. At present, people are still being asked to pay for water, which is substandard. Water provision is not a noteworthy source of revenue for Mexico because many water utilities break even or do not manage to cover their operating costs, requiring subsidies from the government, and on average only 75 % of water bills are paid by rural residents (Conagua, 2007a; The World Bank, 2005).

While the problem still persists, albeit on a smaller scale than before, there is definitely a light at the end of the tunnel. In what seems to be a slower process than may be expected, improvements in the quality and efficiency of water supply in rural areas are still being made, and as time passes, these improvements should lead to more robust financial autonomy and sustainability (Arana, 2016; Esparza, 2014).

Investment in rural areas is also ongoing, and while most corporate investments are made in urban water and sanitation services, more and more financial assistance is being provided by foreign organizations. On the whole, the majority of water and

sanitation services are funded by Mexican organizations, but The World Bank and the Inter-American Development Bank contribute substantial figures on a regular basis to the development of water and sanitation service providers. For example, between 2004 and 2009, The World Bank contributed over \$130 million USD, funded by credit, to Mexican water supply services (The World Bank, 2010), and over the past 20 years the Inter-American Development Bank has funded by credit a number of water supply initiatives in Mexico to the sum of almost \$1 billion USD.

More and more programmes can be seen across the country (OECD, 2013a) one of which Galindo-Escamilla, E., & Palerm-Viqueira, J. (2012) discuss in great detail. Other programme was implemented by Sagarpa [Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación] (2016) in the state of Oaxaca, where a good proportion of residents live in rural parts of the state. The government has rolled out a programme consisting of a State Committee for Rural Development which focuses on planning and implementing rural productivity programs in order to strengthen the capacities of water service providers and encourage sustainable use of water in rural areas, based on interaction with the communities and their residents. However, one of the most successful programs is Prossapys (UNAM, 2014; IDB, 2013), which should continue supporting marginalized rural communities in the next years, regardless of the political party that is in power to manage the resource. Also, clear rules should be established to avoid non-compliance with operating regulations for the investment of public resources because this is a latent problem (OECD, 2013a).

In the case of community water management, the government should help this management look for ways to benefit communities because some of them work better without being subject to the governmental regulatory framework to support them. The only limitation they usually have is the scarce financial resources needed to improve their infrastructure (Aguilar Amilpa, 2011; Galindo-Escamilla & Palerm-Viqueira, 2007; Gasca Zamora, 2014; Gutiérrez-Villalpando et al., 2013; Pimentel-Equihua, Velázquez-Machuca, & Palerm-Viqueira, 2012; Sandoval-Moreno & Günther, 2013).

Conclusions

Historically, it is unambiguous why water supply in Mexico in general, and particularly in rural areas, has been problematic; the first culprit is the geographical location of rural areas and the positioning of water resources. Urban areas have

always taken precedence due to their political and economic power, whereas rural areas have been perceived as less important; although some rural areas have sufficient water sources, they are not suitable for the country's rural population. The second was centralization, since the main resource management organizations in the country are in urban areas. The third was decentralization carried out in a hugely ineffective manner. The decentralization of water and sanitation services, in addition to tasking each municipality with the responsibility of their own water management, attained some degree of success. Nevertheless, in most rural areas, water supply does not cover their entire population and it is not of the same quality as in urban areas. Moreover, efforts made by Conagua and a number of high-performing water utilities have proved themselves to be inadequate in the poorest rural areas, where the financial framework and capabilities to manage their own water supply are seriously lacking.

Although the water law of 2004 involved a greater number of water users through river basin councils, they still have limited capacities and are subject to the central power of Conagua. New legislative reforms are waiting to resolve these issues, improving financial sustainability and building capacities, as ongoing efforts are made at state and local levels, as well as internationally. An attempt was made with the proposed national water law of 2014 that failed.

While there is still a long way to go before rural water management is on par with that of urban areas in Mexico, progress is being made slowly and evidence from across the nation proves that while Mexico's rural water problem has not yet been wholly fixed, it is well on the way to being so.

A substantial proportion of the literature on this topic has been reviewed, which helps to understand the main rural water supply problems in Mexico. However, further work in each Mexican state and municipality is required to understand the particularities of each entity.

References

Aguilar Amilpa, E. (2011). *Gestión comunitaria de los servicios de agua y saneamiento: su posible aplicación en México*. Retrieved from http://repositorio.cepal.org/bitstream/handle/11362/26079/S2011150_es.pdf;jsessionid=27F0FF2D88167B3B30C03DE79CE0AF44?sequence=1

- Alfaro, J. (1982). *The bank's participation in rural water supply programmes in Latin America*. Washington, DC: The Inter-American Development Bank.
- Angelakis, N., Mays, L. W., & Koutsoyiannis, D. (2012). *Evolution of water supply through the millennia*. New York, NY: IWA Publishing.
- Arana, V. (2016). *Water and territory in Latin America: trends, challenges, and opportunities*. New York, NY: Springer.
- Arreola, D. D. (2010). *Tejano South Texas: a Mexican American cultural province*. Austin, TX: University of Texas Press.
- Bennett, V. (1995). *The politics of water: urban protest, gender, and power in Monterrey, Mexico*. Pittsburgh, PA: University of Pennsylvania Press.
- Castro, J. E. (1995). Decentralization and modernization in Mexico: the management of water services. *Natural Resources Journal*, 35(3), 461-489.
- Chaudhry, A., & Barbier, E. (2013). Water and growth in an agricultural economy. *Agricultural Economics*, 44(2), 175-189. doi: 10.1111/agec.12002
- Conagua (2007a). *Estadísticas del agua en México*. Ciudad de México: Comisión Nacional del Agua.
- Conagua (2007b). *Programas, trámites y servicios de la Conagua*. Retrieved from <http://www.conagua.gob.mx/CONAGUA07/Noticias/ProgramasTramitesyServiciosdelaConagua.pdf>
- Conagua (2010). *Statistics on water in Mexico*. Ciudad de México: Comisión Nacional del Agua.
- Conagua (2014). *Ley de Aguas Nacionales y su Reglamento*. Ciudad de México: Comisión Nacional del Agua.
- Conagua (2015a). *Estadísticas del Agua en México*. Ciudad de México: Comisión Nacional del Agua.
- Conagua (2015b). *Situación del Subsector Agua Potable, Drenaje y Saneamiento: Edición 2015*. Ciudad de México: Comisión Nacional del Agua.
- Conagua (2016). *Objetivos y estrategias*. Retrieved from http://www.gob.mx/cms/uploads/attachment/file/109732/OBJETIVOS_Y ESTRAT_GIAS.pdf
- Deininger, R., Lienathy, M., & Bartam, J. (2000). *Security of public water supplies*. Tihany, Hungary: NATO Science Series.
- Deskota Study Team (2008). *Re-imagining the rural-urban continuum: understanding the role ecosystem services play in the livelihoods of the poor in regions undergoing rapid change*. Retrieved from http://www.espa.ac.uk/files/espa/Final%20Report%20Desakota%20Part%20I_o.pdf

- DOF (2016). *Constitución Política de los Estados Unidos Mexicanos*. Retrieved from http://www.diputados.gob.mx/LeyesBiblio/pdf/1_240217.pdf
- DOF (2004). *Ley de Aguas Nacionales*. Retrieved from http://www.diputados.gob.mx/LeyesBiblio/ref/lan/LAN_ref01_29abro04.pdf
- Echternacht, L. (2014). *Pricing urban water: evaluation of economics in the water sector*. New York, NY: Springer.
- El Sol de México (2016, October 24). Quedaría “Congelada” Ley de Aguas; controversias en el Legislativo. *El Sol de México*. Retrieved from <https://www.elsoldemexico.com.mx/mexico/506778-quedo-congelada-otra-vez-la-ley-de-aguas>
- Esparza, M. (2014). Drought and water shortages in Mexico: current status and future prospects. *Secuencia*, 89, 103-121.
- Fewtrell, L., & Bartam, J. (2001). *Water quality: guidelines, standards, and health: assessment of risk and risk management for water-related infectious disease*. Geneva, Switzerland: World Health organization.
- Galindo-Escamilla, E., & Palerm-Viqueira, J. (2007). Pequeños sistemas de agua potable: entre la autogestión y el manejo municipal en el estado de Hidalgo, México. *Agricultura, sociedad y desarrollo*, 4(2), 127-145.
- Galindo-Escamilla, E., & Palerm-Viqueira, J. (2012). Toma de decisiones y situación financiera en pequeños sistemas de agua potable: dos casos de estudio en El Cardonal, Hidalgo, México. *Región y Sociedad*, XXIV(54), 261-298. Retrieved from <http://www.redalyc.org/articulo.oa?id=10223134009>
- Gamboa, D. (2015). *Turbidez en la Nueva Ley General de Aguas*. Retrieved from <http://ecoosfera.com/2015/09/turbidez-en-la-nueva-ley-general-de-aguas/>
- Garrido, A., & Ingram, H. (2011). *Water for food in a changing world*. New York, NY: Routledge.
- Gasca Zamora, J. (2014). Gobernanza y gestión comunitaria de recursos naturales en la Sierra Norte de Oaxaca. *Región y sociedad*, 26(60), 89-120.
- Gobierno de la República (2013). *Plan Nacional de Desarrollo 2013-2018*. Retrieved from http://www.sev.gob.mx/educacion-tecnologica/files/2013/05/PND_2013_2018.pdf
- Gobierno de la República (2014). *Programa Nacional Hídrico*. Retrieved from <http://files.conagua.gob.mx/transparencia/PNH2014-2018.pdf>
- Goetz, R., & Berga, D. (2006). *Frontiers in water resource economics*. New York, NY: Springer.
- Gortari, R. S., & González, J. L. S. (1994). *Rural reform in Mexico: the view from the Comara Lagunera*. San Diego, CA: Center for US Mexican Studies.

- Guerra, G. (2016). *Legislation on Use of Water in Agriculture: Mexico*. Retrieved from <https://www.loc.gov/law/help/water-law/mexico.php>
- Guigale, M., Lafourcade, O., & Nguyen, V. H. (2001). *Mexico: a comprehensive development agenda for the new era*. Paris, France: The World Bank Publications.
- Gutiérrez-Villalpando, V., Nazar-Beutelspacher, D. A., Zapata-Martelo, E., Contreras-Utrera, J., & Salvatierra-Izaba, B. (2013). Mujeres y organización social en la gestión del agua para consumo humano y uso doméstico en Berriozábal, Chiapas. *LiminaR*, 11(2), 100-113.
- Hancock, R. (1948). *The magic land: Mexico*. New York, NY: Coward-McCann.
- Hassing, J., Ipsen, N., Clausen, T., Larsen, H., & Lindgaard-Jorgensen, P. (2011). *Integrated water resources management in action*. Paris, France: the United Nations Educational, Scientific, and Cultural Organization.
- Hernández-Suárez, C. (2011). Nueva política del agua y herencias centralizadoras: el consejo de cuenca del Valle de México. *Agricultura, sociedad y desarrollo*, 8(3), 303-327.
- IDB (2013). *Programa para la Sostenibilidad de los Servicios de Agua Potable y Saneamiento en Comunidades Rurales*. Retrieved from <http://idbdocs.iadb.org/wsdocs/getdocument.aspx?docnum=38174840>
- Irena (2015). *Renewable energy prospects: Mexico*. Retrieved from http://www.irena.org/DocumentDownloads/Publications/IRENA_REmap_Mexico_report_2015.pdf
- ITA (2016). *2016 top markets report: environmental technologies: country case study: Mexico*. Washington, DC: US Department of Commerce.
- Jiménez Sánchez, J. J. (2010). *Agua y zonas rurales, México: Prossapys, etapas I y II*. Retrieved from <http://services.iadb.org/wmsfiles/products/Publications/38640009.pdf>
- Johnston, B. F. (1987). *US-Mexico relations: agriculture and rural development*. Stanford, CA: Stanford University Press.
- Llamas, M. R., Cortina, M., & Mukhejri, A. (2009). *Water ethics: Marcelino Botin water forum*. New York, NY: CRC Press.
- Miller, D. R. (1980). *Studies on rural development: studies on rural water supply systems*. Paris, France: OECD and Development Centre.
- Miller, C. (2001). *Fluid arguments: five centuries of water conflict*. Tucson, AZ: University of Arizona Press.
- Molle, F., & Wester, P. (2009). *River basin trajectories: societies, environments, and development*. Cambridge, MA: CABI International.
- OECD (2003). *Environmental Performance Reviews: Mexico 2003*. Paris, France: OECD Publications.

- OECD (2013a). *OECD Studies on Water: Making Water Reform Happen in Mexico*. Paris, France: OECD Publications.
- OECD (2013b). *Getting It Right Strategic Agenda for Reforms in Mexico: Strategic Agenda for Reforms in Mexico*. Paris, France: OECD Publications.
- OECD (2015). *Water Resources Allocation: Sharing Risks and Opportunities*. Paris, France: OECD Publications.
- Pablos, N. P. (2002). La política urbana de agua potable en México: del centralismo y los subsidios a la municipalización, la autosuficiencia y la privatización. *Región y Sociedad*, 14(24), 41-73.
- Pearce-Oroz, G. (2011). *Rural Water Supply and Sanitation Challenges in Latin America for the Next Decade*. Washington, DC: The World Bank.
- Perry, C. J., Rock, M., & Seckler, J. (1997). *Water as an economic good: a solution, or a problem?* Colombo, Sri Lanka: International Irrigation Management Institute.
- Pimentel-Equihua, J. L., Velázquez-Machuca, M. A., & Palerm-Viqueira, J. (2012). Capacidades locales y de gestión social para el abasto de agua doméstica en comunidades rurales del Valle de Zamora, Michoacán, México. *Agricultura, sociedad y desarrollo*, 9(2), 107-121.
- Public-Private Infrastructure Advisory Board (2003). *Private solutions for infrastructure in Mexico: country framework report for private participation in infrastructure*. Washington, DC: The World Bank and PPIAF.
- Reid, C.B.H. (2007). *The Texas-Mexico Water Dispute and its Resolution? Agricultural Liquid & Land Practice and Discourse along the Rio Conchos, Chihuahua, 1990-2005*. Retrieved from <https://repositories.lib.utexas.edu/handle/2152/3278>
- SADM (2016). *Mission and vision*. Retrieved from <http://www.sadm.gob.mx/PortalSadm/jsp/seccion.jsp?id=268&sadm=28>
- Sagarpa (2016). Sagarpa reforzará y replicará experiencias exitosas de Oaxaca: Héctor Velasco Monroy. Retrieved from <http://www.sagarpa.gob.mx/Delegaciones/oaxaca/boletines/2016/febrero/Documents/2016B024.pdf>
- Sandoval-Moreno, A., & Günther, M. G. (2013). La gestión comunitaria del agua en México y Ecuador: otros acercamientos a la sustentabilidad. *Ra Ximhai*, 9(2), 165-179.
- Secretaría de Educación y Cultura (2015). *Programa Escuelas de Excelencia para abatir el Rezago Educativo*. Retrieved from <http://www.sec.gob.mx/portal/docs/supervisores/2/2/2.2.1%20DIAGNOSTICO.pdf>
- Secretaría de Medio Ambiente y Recursos Naturales (2004). *Decreto por el que se reforman, adicionan y derogan diversas disposiciones de la Ley de Aguas Nacionales*.

Retrieved from http://www.diputados.gob.mx/LeyesBiblio/ref/lan/LAN_ref01_29abr04.pdf

- Scott, C. A., & Banister, J. M. (2008). The dilemma of water management 'regionalization' in Mexico under centralized resource allocation. Water management centralization. *International Journal of Water Resources Development*, 24(1), 61-74. doi: 10.1080/07900620701723083
- Scott, C. A., & Banister, J. M. (2013). The Dilemma of Water Management 'Regionalization' in Mexico under Centralized Resource Allocation. In Biswas, A. K., Benedito, P. F., Tortajada, C., & Palermo, M. (eds.), *Integrated Water Resources: Management in Latin America* (61-88). New York, NY: Routledge.
- Shretha, S., Anal, K., Salam, A., & van der Valk, M. (2015). *Managing Water Resources under Climate Uncertainty: Examples from Asia, Europe, Latin America, and Australia*. New York, NY: Springer.
- Stockholm International Water Institute (2005). *Making Water a Part of Economic Development: The Economic Benefits of Improved Water Management and Services*. Retrieved from http://www.who.int/water_sanitation_health/waterandmacroecon.pdf
- Spring, U. O. (2011). *Water Resources in Mexico: Scarcity, Degradation, Stress, Conflicts, Management, and Policy*. New York, NY: Springer.
- Subdirección General de Agua Potable, Drenaje y Saneamiento (2016). *Proyectos exitosos en el ámbito rural recibidos en el 2016 y casos de éxito del Prossapys*. Retrieved from http://www.gob.mx/cms/uploads/attachment/file/147983/7_SETL_Casos_de__xito_en_Localidades_Rurales_en_M_xicoV.pdf
- The United Nations (2013). *Mexico: UN water country brief*. Retrieved from http://www.unwater.org/fileadmin/user_upload/unwater_new/docs/Publications/MEX_pagebypage.pdf
- The World Bank (2005). *Mexico: Infrastructure Public Expenditure Review (IPER)*. Washington, DC: The World Bank.
- The World Bank (2008). *World Development Report 2008: Agriculture for Development*. Washington, DC: The World Bank and The International Bank for Reconstruction and Development.
- The World Bank (2010). *Decentralized Infrastructure Reform and Development Loan*. Paris, France: The World Bank.
- UNAM (2014). *El Agua en el II Informe de Gobierno del Presidente Enrique Peña Nieto*. Retrieved from http://www.agua.unam.mx/boletines/pdfs/AGUA_II_INFORME.pdf

- Verner, D. (2010). *Reducing Poverty, Protecting Livelihoods, and Building Assets in a Changing Climate: Social Implications of Climate Change for Latin America and the Caribbean*. Washington, DC: The World Bank.
- We Are Water (2012). *Rural women, a fundamental pillar for water management*. Retrieved from http://www.wearewater.org/en/rural-women-a-fundamental-pillar-for-water-management_254161
- Wilder, M. (2005). *Water, Power, and Social Transformation: Neo-liberal Reforms in Mexico*. Retrieved from <http://vertigo.revues.org/1925?file=1>
- Wilder, M., & Lankao, P. R. (2006). Paradoxes of Decentralization: Water Reform and Social Implications in Mexico. *World Development*, 34(11), 1977-1995. doi: 10.1016/j.worlddev.2005.11.026
- World Water Assessment Programme (2009). *Water Development Report 3: Water in a Changing World*. London, UK: Unesco.