10 Social Problems with the Agricultural Use of Urban Wastewater

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10.1 Introduction[1]

Social scientists have taken an interest in the distinct components of federal water management policies, often following what government officials were already focusing on. More attention has been paid to recording water rights, the modification of all usage rates, especially domestic use, and the formation of entities for shared responsibility with users within water management e.g. with the establishment of the *Consejos de Cuenca y Comités Técnicos de Aguas Subterráneas* (Watershed Councils and Technical Committees for Subterranean Water). Other issues, such as that of reusing water in safe conditions and assessing the progress of watershed treatment, have remained in the background. Often current or trustworthy general information about these issues is lacking. This chapter assesses the agricultural reuse of urban wastewater, focusing on the case of the Valle del Mezquital in Hidalgo, but also analysing findings about other examples in the country, which are limited. It is this simultaneous assessment of irrigation with wastewater and the research on this phenomenon that has been conducted in Mexico by social scientists.

The agricultural use of water discharged from cities has important environmental, economic and social impacts; this has been the basis of conflicts that have arisen in Mexico during the past two decades. Organized communities have vigorously protested in favor of the agricultural use of wastewater (which in some cases has been used for more than a century, as in the case of Mezquital or San Luis Potosí), and are against being the recipients of urban waste that contaminates their rivers and properties. This chapter discusses the different types of locally organized social resistance groups that clarify, halt or modify government actions, bringing into question the State's capacity to regulate the use of quality water for irrigation for overall health; the social argument is for the quantity and quality of water that is received. These issues are examined below:

1. The assessment of wastewater irrigation as a foundation of agricultural development, related to rural and urban development policies that seem to have collapsed.
2. The characterization of the parties in these conflicts, both those who support the cases of consolidated irrigation with wastewater and those who defend clean water for crops.
3. The assessment of public performance, marked by the sluggishness of water treatment processes which clearly delay planned work, and demonstrate the impossibility of implementing the current legal framework.
4. A research agenda that links the regional water crises with the collapse of national agriculture.

10.2 Objective

This chapter offers an assessment of the agricultural reuse of urban wastewater and of the reasons why this topic must be systematically addressed by social scientists researching water use in Mexico. Social scientists must be able to respond to these frequently asked questions: Why have the proposed treatment techniques not been carried out? Why are their results so scarce? This chapter also shows that the social argument focuses both on the quantity and quality of the water received; it does not discuss the proposed treatment techniques, but rather the reasons why these proposed techniques are not put into operation by government agencies and/or are rejected or seen as untrustworthy by different local farmer groups, and why they fail.

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1 Keywords: irrigation and conflicts, watershed treatment, wastewater.

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10.3 Urbanization and Irrigation with Urban Wastewater

While agricultural irrigation with wastewater from domestic origins and the use of excrement and other organic waste as fertilizers are very old, this chapter only discusses irrigation based on vast increases in land treated with concentrated urban wastewater. This method is more recent and its importance and dissemination began during the second half of the 19th century.

The method of irrigating crops with wastewater began in Paris in 1868 as a means of decreasing the contamination of the River Seine downstream, which was also seen as a way of treating wastewater. By 1872, close to 900 hectares of land surrounding the French capital were being irrigated with this technique. In 1904 some 5,300 hectares benefited, a third of which were city properties that were rented to settlers 6reusing countries:

- In Great Britain in 1875 about 50 places used wastewater for irrigation, including Edinburgh.
- In Mexico wastewater from Mexico City has been used for irrigation since 1886 in the Valle del Rio Tula.
- In Australia in 1892 the first agricultural area was irrigated with wastewater from Melbourne.
- In France in 1904 about 5,300 hectares surrounding Paris were irrigated with wastewater from the city.
- In the United States in 1904 urban wastewater was used for agricultural irrigation in 40 sites, although the earliest example dates back to 1871 in Lenox, Massachusetts.
- After the construction of a sewerage system in Santiago in Chile in 1908, wastewater was pumped into the Zanjón de la Aguada and the Rio Mapocho, that flow into the Rio Maipo. This water was immediately used for agriculture.
- In Germany in 1910 some 17,200 hectares were irrigated with wastewater from Berlin.
- In India agricultural wastewater irrigation began in Delhi in 1913 under the supervision of British engineers who introduced this method to Asia. But in Bombay it had begun as early as 1877.
- In Cairo (Egypt) in 1915 urban wastewater was used for agricultural irrigation.[2]

Between the last quarter of the 19th century and the first two decades of the 20th century agricultural irrigation with urban wastewater became a generic method in several countries, both in the centre and also peripherally. Thus, cities became regular water suppliers for irrigation as well as consumers of clean water from other agricultural zones.

10.4 A New Interest in Wastewater Irrigation

In the 1920s and 1930s, agricultural production with wastewater was abandoned by the majority of industrialized countries.

> At the same time, the profiting and recovery were discredited and few engineers or scientists demonstrated any interest in the systematic study of the engineering, agronomical, microbiological and public health aspects by reusing wastewater in agriculture. All of this changed after the Second World War, when a new push towards scientific and engineering interests developed in industrialized countries as well as developing countries (Shuval, 1986: 4).

Three new considerations contributed to this new stage of the developing interest in urban wastewater irrigation.

1. The use of wastewater for irrigation is a good strategy for barren and semi-barren areas, where water resources are scarce and where human and industrial water consumption competes with that of agriculture.
2. Reusing water can be attractive for developing countries, since it economically represents valuable organic supplies that can maintain and improve soil fertility. Theoretically, this situation can decrease the dependency that those countries have on industrialized fertilizers, besides improving their income while cutting production costs.[3]
3. The use of wastewater in agriculture must be carried out with special care in order to limit health risks. It is necessary to establish very strict rules for treating the water being used, as well as for reg-

2 Sources: Shuval (1986); National Academy of Sciences USA (1974); Ríos Brehm (1995).

3 For example, according to a study by Jewell and Seabrook (1979), if all human waste was used from the 638 million inhabitants (population in 1978) in India, their 0.9 million tons of phosphorus and 0.8 million tons of potassium would be enough to cover the demand for chemical fertilizers for its national agriculture. In India irrigation with wastewater is common and an important sanitary risk, as a recent study by Hofstedt (2005) has shown.

ulating harvestable crops (Blumenthal et al., 2003; Hofstedt, 2005).

For an analysis of the comparative effects of these three points the cases of Israel and Chile will be reviewed. Israel presents the condition of an environment that lacks water, in an area where the competition for this liquid acquires a dramatic political dimension, making water availability a national security issue (Shuval/Dweik, 2007). To reduce the pressure on this resource for human consumption, in Israel treated wastewater is used for industrial and agricultural uses, and this requires high quality.

In Israel the state controls the wastewater[4] and its Global Plan for Hydraulic Systems shows an increasing interest in taking advantage of wastewater. In 1982, Israel used 50 million m^3 of wastewater directly for agricultural purposes, 24 per cent of the total 211 million m^3 produced. Of this, 41 per cent is treated rural sewage water and 42 per cent is urban sewage water. In total, around 10,000 hectares of land mainly dedicated to cotton farming (87 per cent), citrus trees (7 per cent), fodder (3 per cent) and crops (1.8 per cent) were irrigated. In 1985, from the total amount of water used for agricultural irrigation, 85 per cent was drinkable and 15 per cent was marginal.[5] The government projection for the year 2000 was that these proportions would be 63 per cent and 37 per cent respectively (Banin, 1993: 173).

Israel's sanitation regulations, which are based on California's, prohibit crop farming with raw wastewater, unless a special permit is granted by the government, certifying that the quality of the water used complies with the legal treatment requirements. While in California and Israel rigorous sanitation controls exist, in the case of using wastewater from the city of Santiago de Chile for agricultural purposes, a severe sanitation problem arose that was resolved in 2007 with the construction of a treatment system.

4 Article 1 of the Israeli Water Laws from 1959 states: "The water resources of the State are public property. The water resources are subject to the control of the State and are intended for the ure of its inhabitants and for the development of the country".

5 They include all sources of water from surface, rain and sewage such as treated wastewater, agricultural sewer water, urban sewers, water originating from floods and salt water.

10.5 The Case of Chile

Israel and the United States, particularly California, are clear examples of new policies for the agricultural use of wastewater, and particularly its treatment before using it in the fields. Both countries have been mindful of the sanitary and safe reuse of water, treating the contaminants before applying them to agriculture. On the contrary, in Latin America, authorities have continued and still continue to propose plans for reusing water that omit the treatment processes prior to using it in the fields, and this agricultural use is considered as a valid way of treating urban wastewater. This is the case in Lima, Peru; in the Valle del Mezquital that is fed by wastewater from Mexico City and used in agriculture; and for many years the wastewater from the city of Santiago de Chile, to name just some of the most representative cases. Considering all of these circumstances, we face a severe sanitation problem, with examples of relatively high mortality rates due to a lack of water quality control and the types of crops that are irrigated.

In the case of Santiago de Chile, the liquid in the water pipes in times of drought consisted of water almost 100 per cent from the current of the Rio Mapocho – the Rio Maipo's tributary is found in Chile's central region. The community of this town generates 850,000 m^3 of wastewater daily; 90 per cent has domestic origins and 10 per cent industrial. At the end of the 1990s, only 4.7 per cent of this waste received treatment of any kind. Water that had not been treated was permitted to flow down the Zanjón de la Aguada, the Rio Mapocho and the Rio Maipo, dispersing 15 m^3 per second.

Roughly 16,000 hectares adjacent to the city were irrigated with this water to produce close to 20,000 tons of crops a year, including lettuce, cabbage, and cauliflower, their main market being in Chile's capital. "This irrigation method of reusing water has caused an important problem with public health, where the region presents increased rates of typhoid fever incidents, which are higher than in the rest of the country" (Ríos Brehm, 1995: 184). According to a United Nations study, the worst problem in the Maipo basin was "irrigating one of the city's most important horticultural producing areas with contaminated wastewater from Gran Santiago, and this is one of the main causes of diseases that affect the community" (NU-CEPAL-PNUMA, 1980: 353, cfr Court Moock et al. 1979).

In a study prepared for the Empresa Metropolitana de Obras Sanitarias (Metropolitan Company for Sanitation Work), results came back stating that the totality of the irrigation canals that were analyzed contained levels of fecal coliforms that were higher than the Irrigation Water Norm. The canals that were most contaminated were those fed by the Zanjón de la Aguada, which, together with the Rio Mapocho, are the main exit route for city drains (CADE-IDEPE, 1990). According to Ríos Brehm, the poor water quality for irrigation in Chile "is fundamentally due to the use of untreated water that comes from rivers and canals that in many cases are the recipients of domestic and industrial contaminants" (Ríos Brehm, 1995: 174). According to this author, all irrigation canals in the Rio Maipo basin rise to above 5,000 to 7,000 times the established norm for fecal coliforms.

A medical investigation in 1974 revealed that 57 per cent of the surveyed population had at one point been infected with salmonella and 30 per cent had developed antibodies against typhoid (Prado, 1974, cited in NU-CEPAL-PNUMA, 1980: 362). In the mid 1970s, between 150 and 200 cases of typhoid appeared every year in the Chilean capital for every 100 inhabitants, and in 1992, rates were recorded between 58.3 and 69.5 cases for every 100,000 inhabitants; this was above the 2.3 registered in Argentina and the 0.2 in the United States, and even above the 20.5 average for South America. The epidemiological studies carried out by the Comité Chileno para la Tifoidea (Chilean Typhoid Committee), from the Chilean Ministerio de Salud (Ministry of Health), concluded that crops irrigated with wastewater from the city were the main vector for the disease (Shuval, 1986: 81–84).

Although the Chilean sanitation legislation contained sanctions for those who used contaminated water to irrigate crops and fruits that were consumed raw, these measures "were not applied until 1991, the year in which a cholera surge was produced in the city" (Ríos Brehm, 1995: 182). This is specifically a grave inconsistency in the state's provisions that according to what specialists say:

> is basically due to the lack of political intent regarding this matter, which is reflected in the lack of economic and human resources (to ensure the fulfilment of the law). A tragicomic example is the application of Resolution No. 350, which is for the irrigation of raw crops from the SSMA (*Servicio de Salud del Medio Ambiente* [Environmental Health Service]). This resolution dates back to 1983 and was not applied until the cholera surge of 1991. On that occasion, crops that had been irrigated with contaminated water in the Maipu zone were burned... Currently, though there may be a suspicion that contaminated water is still used for irrigation, there is no wider investigation (Ríos Brehm, 1995: 182).

This is exactly what happened in the Mexican case of 1991, where after the first few months of governmental alarm over cholera, vigilance disappeared and crops continued to be cultivated with wastewater. Note another similarity between Mexico and Chile: the dispersal of administrative competencies and the duplication of duties.

Currently, the Comisión Nacional de Riego de Chile (National Chilean Irrigation Committee) has started a programme to use treated wastewater in agriculture. For this, a system of treatment plants was constructed to clean wastewater from the capital; the results are yet to be evaluated, although it is known that the use of untreated water for agricultural irrigation has decreased.

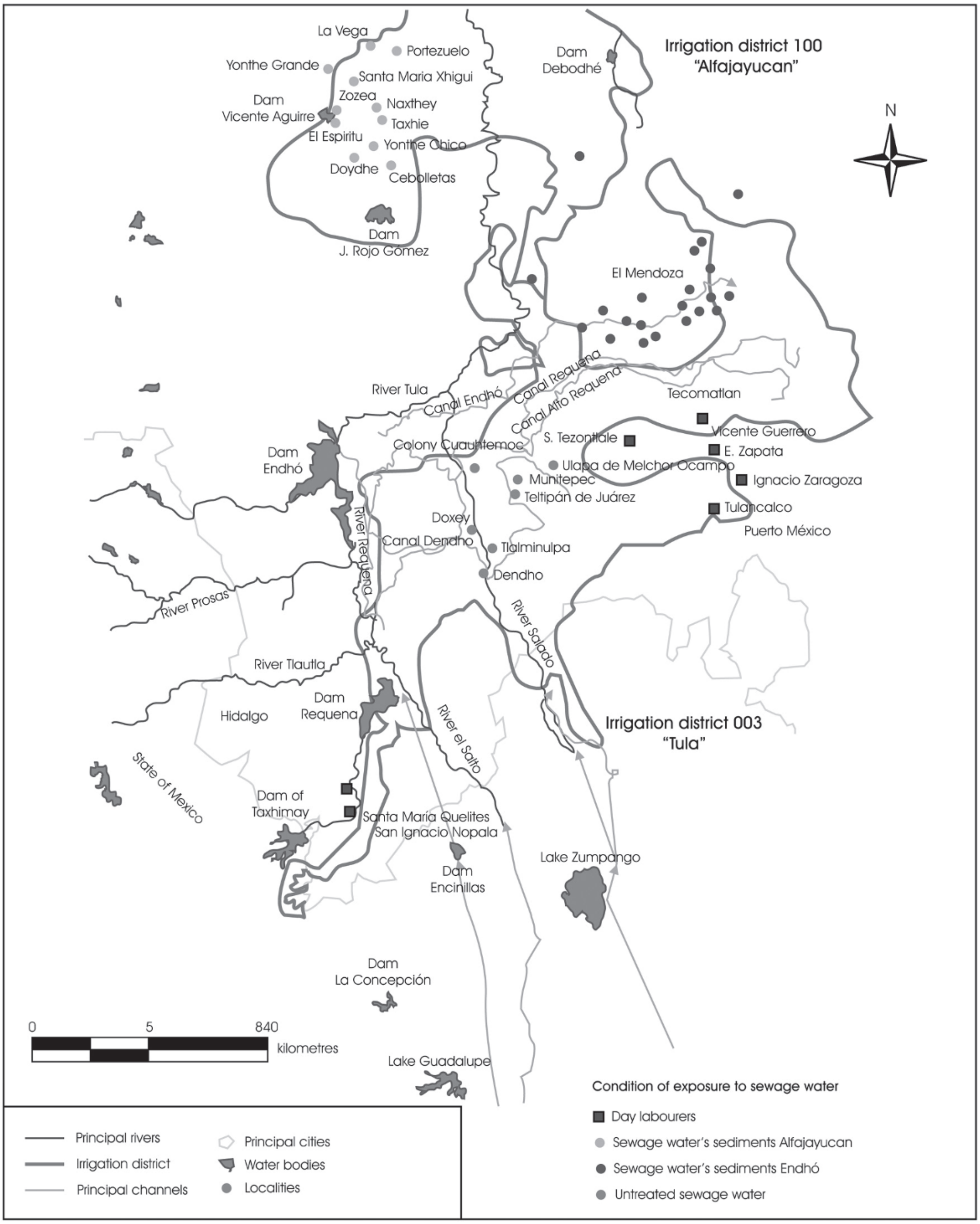
10.6 The Case of the Valle of Mezquital in Mexico

The Valle del Mezquital occupies the south-west and central part of the state of Hidalgo, north-east of Mexico City; it is the furthest south-east border of the vast barren territories that extend through the Mexican north and north-east. The irrigated section is organized into two irrigation districts: 03 and 100. These use a network of main canals and dams, mainly organized around the supply received from discarded water from the metropolitan area of the Federal District.

The last decade of the 19^{th} century is the moment when the relationship between Mexico City and Mezquital was set up as a way of linking wastewater supplies with agricultural use. In part, it is due to the completion of the first tunnel in Tequixquiac that would be more successful than the Tajo de Nochistongo tunnel in artificially opening the basin in the Valle de Mexico and connecting it to the Rio Tula basin. Also, it was the first time the system was designed not to release flooded water accumulated during rainy seasons, but to systematically separate wastewater that came from the city (Musset, 1992: 206). At that time, a regular, permanent and long-term relationship was created. With this, Mezquital became the destination for a permanent flow of wastewater: the liquid that Mexico City discards (figure 10.1).

After the armed movement of 1910, and burdened by the demands of local agricultural groups who were led by corporate leaders of the official party (who at the same time were looking to be accommodated at all levels of the new government), the federal executive branch looked for ways to increase the irrigated

Figure 10.1: Distribution of water for agricultural use in the Valle del Mezquital and types of population exposure. **Source:** CONAGUA (2001: 24).



area, beginning in the 1930s. That role was played out by an agreement signed by President Manuel Ávila Camacho in 1942, where Mezquital was recognized as

> one of the main sources of agricultural product supplies for the capital and republic and... any disposition that increases the production of that district will be reported as a sensitive benefit, as much for the users as for the overall economy of the country (Aboites, 1997).

For that reason, decisions were made to increase the volume of wastewater provided up to 130 m^3 in the low season and 154 m^3 during the rainy season. Due to the growth of the sewerage service in Mexico City, and the increase in water provision for the inhabitants of the capital, it was practically guaranteed that the district would always have available increasing volumes of water for agricultural irrigation. This is a truly privileged situation in relation to all other irrigation districts, since they are always aware of the possibility of losing their water resources, rather than the guarantee of increasing them.

After completing the Tequixquiac tunnel, the construction of the water links between Mexico City and Mezquital began, and with the agreement signed by Ávila Camacho these links were consolidated. The later increases in wastewater volumes received and in irrigated areas developed from a tendency clearly marked in this document. Table 10.1 refers to the documented changes in total irrigation in the Valle del Mezquital with the wastewater from Mexico City:

Table 10.1: Increase in the irrigated surface in the Valle del Mezquital (1931-1990). **Sources:** Bistráin (1961); Aboites (1997); Peña (1997); CEPAL (1991): statistical annex.

Year	Hectare surface	Volume of water in millions of m^3
1931	12,000	238 annual average
1962	25,000	463 annual average
1971	70,000	
1990	90,000	1391

With the construction and start-up of the deep drains, the city's drainage system capacity increased, and this allowed a larger quantity of available water resources to be maintained. The information in table 10.1 allows the increases in wastewater volume entering Mezquital to be compared.

10.7 The Ambiguity of Using Wastewater

Even though at the beginning of the relationship the initiative was taken by the federal government and Mexico City, local participants in Mezquital played a sufficiently active role. From the water concessionaries who constructed the essential parts of the irrigation system (and who continue to be central to the system today), to the farmers who in post-revolutionary times requested water, political alliances were organized and constructed with local leaders to ensure the benefits from a good relationship with the central government that would ensure increasing volumes of wastewater discarded by Mexico City.

Throughout the whole process the relationship appeared to be mutually beneficial. The quality of the water, as wastewater with dissolved organic materials, was also seen positively to increment the crop yield. If the city released the undrinkable water, no one seemed to suffer by it. The city benefited by diverting water that could generate disease amongst its inhabitants, and Mezquital benefited by obtaining a valuable agricultural resource (the large quantity and quality of the fertilizer). The environment also benefited because when passing through different parcels of land, the water would be cleaned, decreasing the contamination of the bodies of water that were the final recipients.

The metropolitan area of the Valle de Mexico operates 27 wastewater treatment plants: 13 in the Federal District and 14 in the State of Mexico. The plants in the Federal District work at 55 per cent of their capacity and half of those in the State of Mexico at 50 per cent of their capacity. Altogether, they only treat 9 per cent of the total wastewater; the remaining 91 per cent leaves the Valle de Mexico without any treatment. Out of all those plants, the one in the Cerro de la Estrella and two from the Lago de Texcoco supply irrigation water within the Valle de Mexico, both after secondary treatment (Academia de la Investigación Científica, 1995: 116–120).

Although there has often been conflict between the agriculturalists and the federal administration about the cost of water, sanitation problems were never the main factor as they were in 1991, when cases of cholera started to be registered in Mexico. During this time, federal authorities dictated strict norms in order to suspend irrigation to all parcels of land in the Mezquital where they thought crops had been growing. This situation threatened the political alliances between the agriculturalist networks, the state, and federal government.

Between July and December of 1991, local, state, and federal authorities had to simultaneously recognize various realities:

a.) In the Valle del Mezquital, crops were being grown with untreated wastewater, a method that was prohibited in almost all countries where wastewater was reused for agriculture.
b.) Although they insisted on pointing out that it was only a relatively small surface that was intended for growing crops that were consumed raw, the

problem increased because the farmers thought it essential for their production strategy.

c.) Broad and detailed judicial guidelines did not exist at that time that would regulate wastewater irrigation in Mexico. Crop farmers were using a risky method for overall health, but it was not illegal. Casting aside hesitation, sanitation authorities – particularly the state manager for the Comisión Nacional del Agua (National Commission of Water, CONAGUA) – began to seize crops that had been harvested illegally, directly at each parcel of land. Punishing behaviour that had been tolerated for a long time was a challenge.

Crop farmers in the Ixmiquilpan area reacted against the government's actions by uniting in different ways and expressing their disapproval of the local arms of the Secretarías de Agricultura y de Salud (Agriculture and Health Ministries). Instead of complying with the government's ban, they organized the Comité en Defensa de las Hortalizas (Crop Defence Committee) and they began resisting the destruction of their crops. The committee brought together all farmers whose crops had been blacklisted, but the leadership was in the hands of small landowners (of 10 hectares or more), who had a stronghold on the regional market and sold their products to neighbouring cities like Pachuca, Mexico, Puebla and Queretaro. After a public struggle, the authorities gave in, due to the fact that the use of wastewater was the cause and product of the political corporate alliances that different federal and state governments had established with the farmers of that region.

Under these conditions, what had once appeared as the best solution for all parties involved resulted in tensions that exploded into the fear that harvesting crops that were irrigated with wastewater would propagate a great cholera epidemic in the 1990s.

The technical advances made throughout the world regarding the relationship between contagious diseases and the use of wastewater in agriculture, the new ways of treating these waters, the importance of guaranteeing good quality for reused water in agriculture, and the role of appropriate judicial regulation over the use of these waters, were all simply ignored by the Mexican authorities as far as agricultural irrigation with urban wastewater in Mezquital was concerned. This is why the farmers in Mezquital reacted with violence to the government's actions in prohibiting the use of wastewater for crop irrigation.

A similar case, although in a smaller area, has been documented and analyzed by Cirelli (2004) on the periphery of San Luis Potosi. In this case, government entities proposed a plan to exchange treated wastewater for subterranean water for use in urban supplies. This deal was supposed to be made with the thermoelectric plant near the municipality of Villa de Reyes. The planners 'overlooked' the fact that the wastewater that was intended for this exchange had come from being used by agriculturalists in Soledad, crop farmers with various products, including some areas that had been banned due to the new sanitation norm. Cirelli demonstrates how the quality of the water in question generated a group of social roles that are generally ignored in other studies about water management.

Returning to the case of Mezquital, apart from the fact that the government of Mexico City had obtained international credit in order to build the treatment plants, the work did not start, even though the site for a large treatment plant had been chosen, in the Valle del Mezquital. One social challenge is that a protest was planned by the agriculturalists from the Valle del Mezquital, since clean wastewater would reduce the amounts they received as well as the amount of organic material that fertilized their parcels of land.

In the case of San Luis Potosi, the current results have been paradoxical: the treatment plant was constructed (Tenorio tank), the agriculturalists accepted an agreement to maintain a secure supply to their crops using part of this water, but the thermoelectric plant – destined for treated water – initially refused to take this water, arguing that their production process could be affected. Part of the treated contaminants continues to be released into crop fields, as was agreed by the company running the purification plant (Dégremont).

10.8 Resistance against Wastewater Treatment: Lessons from the Lerma-Chapala Basin

The slow rate of progress observed in the case of treating wastewater supplied from Mexico City to Mezquital is not atypical. On the contrary, with the exception of some urban areas on the Mexico-US border, a constant high risk can be found facing wastewater treatment in the rest of Mexico. When purification plants are finally constructed, they have already been overtaken by the growing volume of water to be purified, or even worse, they demonstrate severe operational deficiencies and they even stop functioning at an efficient speed. To illustrate this, it is worth reviewing the case of the Lerma-Chapala basin, perhaps the best provided, according to the government. It is not possible to discuss a situation that involves the purification of wastewater for the entire country, and so the case of the Lerma-Chapala basin was selected, given the significant amount of federal investment allotted to it.

Four years before the Consejo de la Cuenca Lerma-Chapala (Lerma-Chapala Basin Council) was formed, the governors of Guanajuato, Jalisco, Mexico, Michoacan and Queretaro signed an agreement with the federal executive branch to move ahead with a programme to treat the basin. The commitment was to build 48 treatment plants for municipal wastewater, with the objective of reducing the contamination of what were considered the 'critical sections': Toluca-Alzate Presa (dam), Salamanca-Rio Turbio and La Piedad-Rio Duero. It was calculated that an investment of 292 million pesos[6] was to benefit the basin and reduce 50 per cent of the Biochemical oxygen demand (BOD) that were circulating within the currents.

In March of 1994, the Basin Council[7] reviewed the results optimistically: 42 plants had been completed and 7 were still in the process of being constructed[8]. The Consultant Council[9] had agreed on a second phase where 52 new plants would be constructed, with a budget of 722 million pesos, more than double the investment of that of the first stage. They also disclosed that they had 38 executive projects that had been terminated within the programme.

In the first phase, the objective was to treat 3,700 litres per second (lps) and in the second phase, 10,950 lps were expected to be treated. Having concluded the programme, 80 per cent of the contaminants in the basin were supposed to have been treated. The expectation was that upon completion in 1994, 48 treatment plants would be operating: 3 in Guanajuato, 5 in Michoacan, 2 in Queretaro, 16 in Jalisco, 20 in the State of Mexico, plus two more plants constructed by the industrial sector, PEMEX and the Comision Federal de Electricidad (Federal Electricity Commission), both in Salamanca. The projected number for the year 2000 was at least 98 treatment plants for municipal wastewater, treating 13,528 lps.

A superficial inventory was taken of the results and it provoked scepticism, not only from what could be seen in the water currents, or from the testimony of agriculturalists, but also from official data.[10] Guanajuato, the state that has the largest part of its territory in the basin, should now have 15 plants in the Lerma basin and be treating 5,690 lps. The results indicate that without even counting the installed capacity of all its treatment plants, it reaches this amount. One of the plants that was finished in the first stage, the one in Abasolo with 70 lps of installed capacity, was still not functioning in 2002.

But, owing to financial reasons, the majority of the plants that were planned for the second stage were built with less capacity, which means that they will soon be saturated with urban waste. The Celaya plant, for example, is working at its maximum capacity, while the one in Salamanca operates at 245 lps, while its capacity is 255 lps. In the case of treatment plants for municipal water, there is a very big difference between the installed capacity and the costs of operation, which may mean that a gap exists while re-collecting and conducting the water of the plant; it is true to say that they are only half-built. On the contrary, when there is a small difference between the installed capacity and the costs of operation, it means that expansion projects must be carried out to provide for the growing demand.

The State of Mexico seems to have performed better in complying with what was promised. The small communities that release into the Lerma River have stabilization lagoons (Almoloya, Atizapán, Atlacomulco and Mexicaltzingo, among others), while Toluca's contaminants, in great amounts and generally more contaminated, pass through one of the two large plants that include sewage sludge. A section of industry has treatment plants exclusively for its own waste.

Jalisco constructed various plants to clean the water that is released directly into Chapala Lake, such as the water from El Chante, San Juan Cosala, Chapala, San Juan Tecomatlan, Poncitlan and Tizapan El Alto, but until now it has not fixed the capital's sanitation system, particularly after a failure with Japanese credit (Boehm/Durán, 1998).

However, the differences between one entity and another could be less if the effective operation of the infrastructure is taken into consideration. A paradigmatic case is that of Michoacan. In Michoacan, the

6 All amounts are given in new pesos.
7 Created on 28 January 1993.
8 One of them from the second stage.
9 Consejo Consultivo de Evaluación y Seguimiento del Programa de Ordenamiento y Saneamiento de la Cuenca (Consultive Council for Assessment & Follow-Up of the Sanitation Regulation Programme of the Basin).

10 See the Inventario nacional de plantas de tratamiento de aguas residuales municipales (Inventory of treatment plants from municipal sewage water).

treatment plant programme has provided limited results, although it is true that most of the plants are found in the Lerma-Chapala basin. In 2004, there were 11 out of 16 treatment plants in the Lerma basin: one in each of the following municipalities: Briseñas, Jiquilpan, Sixto-Verduzco, La Piedad, Quiroga, Sahuayo, Venustiano Carranza, Zacapu and Zamora, and two in Patzcuaro.

Of the five plants that were built in the first stage, three did not function: La Piedad, Sahuayo and Pastor Ortiz. La Piedad was the pride of Michoacan during the first stage. Its special focus was due to the physical and social visibility of the organic contaminants that came from the fishing industry of that area and that were released into the river. Its design consists of two modules with anaerobic and facultative lagoons, with an installed capacity of 200 lps. To perform the purification process, pumping equipment is needed which allows water to travel through the different levels of the system. The pumping equipment has frequently failed and the plant has been non-operational over long periods of time.

The plants in Sahuayo consist of a plant with stabilization lagoons designed to treat 180 lps, which was finished in 1994 and is currently not in use. The third closed plant is the one in Pastor Ortiz, in the municipality of Jose Sixto Verduzco. In the last two cases, the lack of functionality (in those places only), did not prevent 300 hectares of crops from being irrigated with untreated water.

But perhaps the clearest example of resistance found in the treatment of the basin is the delay in the construction of the treatment plant for Morelia, which also appeared in the second phase of the plan discussed above and that could only be completed in 2009; it faces many serious questions about its design and location.

10.9 Conclusions

What has been reviewed here reveals that in the conflict about using untreated wastewater there exists a juncture where politics, health, economy and culture are interrelated. Sufficient evidence is available on the sanitary risk of irrigation with wastewater; this includes direct consumption of these products as well as the danger of the filtration of these contaminants into aqueducts and drinkable water networks. This means that it is pertinent to take regulatory sanitation measures for the use of wastewater, although those dictated by the federal government are incomplete because they only include crop irrigation, brushing to one side the possible contamination of the drinking water consumed in Mezquital or in other areas submitted to the same type of irrigation. What is required is the serious treatment of wastewater from metropolitan sewage given the contamination by industrial waste. Why have the government entities on all levels faced particular difficulties in significantly advancing the sanitation of wastewater for safe use?

All indications show that the model of expansion for the agricultural frontier has collapsed, starting with irrigation with wastewater as the axis of some kind of agricultural growth associated with policies for rural and urban development. It is particularly difficult to modify this situation due to the complexity that surrounds the way in which these irrigation areas were constructed, where the irrigators share collective interests and commitments with those entities that promoted this form of using urban waste.

However, we must call attention to these other points: discarded wastewater has an owner. For this reason, any modification to its use must be made by concluding agreements with the agriculturalists involved to allow for changes that guarantee the new and safe use of this water. Wastewater treatment must be carried out by sharing the costs between all parties involved. It is neither realistic nor just to assume that these costs can be transferred to the agricultural sector, which has already suffered.

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