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Articles

Hydropolitical processes in the conformation of the metropolitan municipal water system in Oaxaca de Juarez, Oaxaca, Mexico

Procesos hidropolíticos en la conformación del sistema metropolitano de agua municipal en Oaxaca de Juárez, Oaxaca, México

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Abstract

The objective of this research was to analyze the political framework of the domestic water supply system of the municipality of Oaxaca de Juárez, from its foundation in 1523 to its current metropolitan conformation. The study is based on hydropolitics, with a focus on collection, supply and control. The qualitative methodology was based on an explanatory analysis of municipal water management, supported by primary sources such as historical archives, official and statistical documents, as well as articles and academic research that allude to the historiographic process of water supply. Five key hydropolitical processes were identified: 1) The monarchic model of supply *versus* the Mesoamerican perspective of use (1523-1821); 2) municipal hydraulic construction (1755-1912); 3) intermunicipal legislation, agreements and conflicts (1821-1930); 4) interurban conformation of the municipal water system (1858-present), and 5) metropolization of the water service (1983-present). It's concluded that the water system of Oaxaca and its hydraulic construction have developed from incidental processes of control in the sub-basin of the Atoyac-Oaxaca River, generating conflicts, tensions and arrangements that transgressed the municipal sphere to form a metropolitan water entity.

Keywords: Hydropolitics, sub-basin, metropolization, catchment, supply, control.

Resumen

El objetivo de esta investigación fue analizar el entramado político del sistema de abasto de agua de uso doméstico del municipio de Oaxaca de Juárez desde su fundación en 1523 hasta su conformación metropolitana actual. El estudio tiene por base la hidropolítica, bajo un enfoque en la captación, abastecimiento y control. La metodología cualitativa se apoyó en un análisis explicativo del manejo del agua municipal, sustentado en fuentes primarias, como archivos históricos, documentos oficiales y estadísticos, así como artículos e investigaciones académicas que aluden al proceso historiográfico del abastecimiento de agua. Se identificaron cinco procesos hidropolíticos clave: 1) el modelo monárquico de abasto frente a la perspectiva mesoamericana de uso (1523-1821); 2) la edificación hidráulica municipal (1755-1912); 3) legislaciones, acuerdos y conflictos intermunicipales (1821-1930); 4) conformación interurbana del sistema de agua municipal (1858-actualidad), y 5) metropolización del servicio de agua (1983-actualidad). Se concluye que el sistema de agua de Oaxaca y su edificación hidráulica se han desarrollado a partir de procesos incidentales de control en la subcuenca del río Atoyac-Oaxaca, generando conflictos, tensiones y arreglos que transgredieron la esfera municipal hasta conformar una entidad metropolitana del agua.

Palabras clave: hidropolítica, subcuenca, metropolización, captación, abastecimiento, control.

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Introduction

At present, in order to understand the dynamics of supply and operation of the water system in the municipality of Oaxaca de Juárez, it is not only necessary to examine its current administrative configuration, but also to analyze its progressive metropolitan conformation. The latter evidences the political, legal and social process that has developed in the construction of the hydraulic infrastructure, as well as in the sources of supply, many of which come from places outside the delimited territorial circumscription.

The development of water supply in the city, together with its current problems and intermunicipal agreements, can be examined through the concept of hydropolitics, which is a useful tool of analysis that allows to evidence diverse geohydric processes (water spaces with differentiated political demarcations), which have developed within the territories that share water in terms of its collection, supply and control. Therefore, the objective of this research is to analyze the historical framework of water supply, with respect to the socio-political, legal and geographical dimensions that have developed between the city of Oaxaca and the surrounding municipalities. Thus, the research question is the following: Which hydropolitical processes have structured the metropolization of the water system of the municipality of Oaxaca de Juárez?

This study is organized into four sections. In the first, the concepts of metropolization and hydropolitics are presented with the variables of catchment, supply and control to study the conflicts and arrangements of the water history of the municipality of Oaxaca. The second section shows the structured methodological design, detailing the process of obtaining bibliographic, institutional and historical information. The third section presents the results and discussions based on the identification of five key hydropolitical processes. Finally, the fourth section presents the conclusions regarding the findings based on the research question posed.

Background

This paper bases its analysis on the historical process of the organization of the domestic water supply system in the municipality of Oaxaca de Juárez, a subject that has been studied by various authors at certain moments during the development of the city. At first, Gay-Castañeda (1881) mentions the first rivers from which the municipality was supplied. Iturribarria (1943) describes the hydraulic development of the city from its foundation, then known as the city of Antequera, until the beginning of the 20th century. In turn, Taylor (1973) specifies the uses of water from the political conformation by means of haciendas and exposes the first conflicts that developed over the use of river water. From this perspective, Topete (Topete-Pozas, 2017; Topete-Pozas, 2021) alludes to the various conflicts that were generated in the nineteenth and twentieth centuries between the Oaxacan Capital with the surrounding municipalities regarding the development of water supply from shared rivers. Likewise, Mendoza (2016) describes the process of public

construction of the hydraulic infrastructure built from the mid-19th century to the beginning of the 20th century. While, Riley (1996) addresses the inequities in the distribution of water in this capital city.

In this way, the main arguments that have been sustained within the historical analysis of water have been: **(a) descriptive**, due to the interest in characterizing the water management that has been developed in Oaxaca City during different periods of time (Gay-Castañeda, 1881; Iturribarria, 1943; Mendoza, 2016); **(b) explanatory**, regarding the political and social conditions that have been derived by the use and distribution of water through different populations established in the periphery of the capital city (Taylor, 1973; Riley, 1996; Topete-Pozas, 2017; Topete-Pozas, 2021). Under this distinction, this research delves into the increase in coverage and tensions as study criteria to advance ***the explanatory argumentation***, by examining the conformation of the metropolitan system through an analysis focused on the political-historical process of water use between the city of Oaxaca and the municipalities with which it shares the rivers in the area.

The concept of the metropolitan and its relationship with water

The term metropolitan refers, in essence, to a geographic-analytical concept that envisions a territorial, population and spatial growth of an urban center towards its periphery (Cook & Lara, 2013). In this way, metropolization is characterized by urban expansion that transcends its political-administrative boundaries; in this case, a central city

incorporates conurban communities and municipalities (Flores & Iracheta, 2015). Metropolization begins when a certain urban area exceeds its political-administrative boundaries. As it grows, this area annexes conurban communities to its extension, invading different municipal jurisdictions (Iracheta-Cenecorta, 1988). From this perspective, metropolization is understood on the basis of the interrelations between the central urban area and the conurban areas.

Water metropolization results from the merging of the demand and catchment process of two urbanizations into a larger conglomerate. The hydropolitical homogenizes and relates social life and urban water access as if it were a single city. In such a way that water is interrelated from different flows that supply and demand it between the growing city and the receiving cities of this population increase. A commercial water exchange is created that covers, in a metropolitan network, the supply of all the inhabitants. These flows are interdependent, since the water service offered by one city is complemented by the water volume of the other. This allows for a continuous exchange of water. At the same time, the water infrastructure increases for the interurban population.

Water stresses in the metropolization of water in the study area

Currently, the area surrounding the municipality of Oaxaca de Juárez is experiencing a metropolization of the water system caused largely by the intermunicipal transformation it is undergoing with the 27 neighboring municipalities and forms the Oaxaca Metropolitan Zone (OMZ) (Figure 1).

This situation leads to an uncoupling where the demand for water exceeds the municipal supply capacity, which is why the water supply is obtained from other municipal sources.

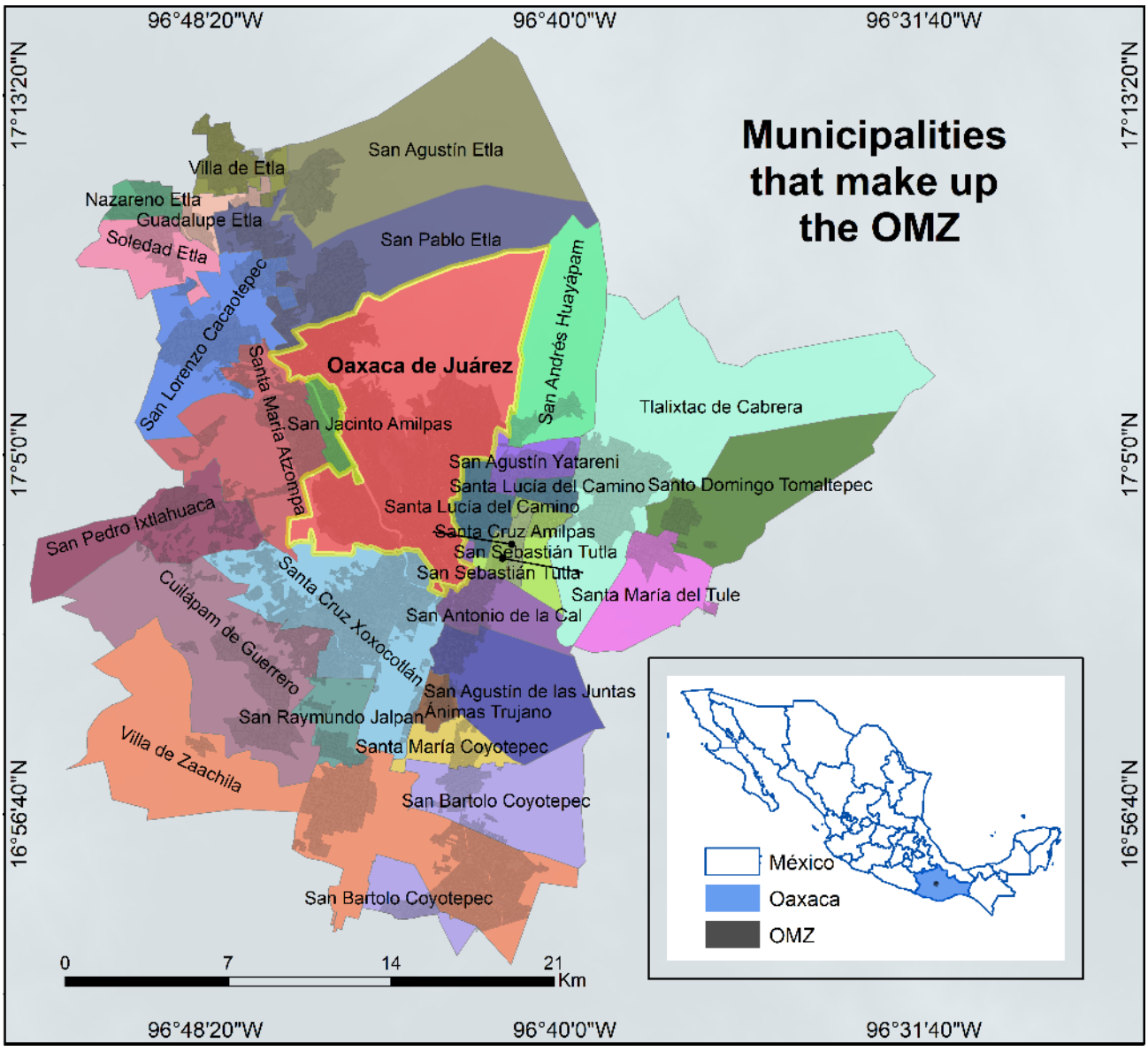

Figure 1. Location of the Municipality of Oaxaca and its metropolitan area. Source: Own elaboration based on INEGI (2020).

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Since 1990, the conurban areas of the municipalities adjacent to the city of Oaxaca have experienced a process of interurban growth, which triggered a progressive change in the use of agricultural land for housing (Table 1). Most of these settlements were located in areas far from municipal water networks. The water supply in these areas presented difficulties, since they were settled on unregulated land, which led to a greater demand for domestic water that the hydraulic infrastructure has been unable to provide adequately.

Table 1. Municipal percentage population growth of the OMZ.

Municipality	1990	2020	%
Santa María Atzompa	5 781	41 921	**625.2**
San Jacinto Amilpas	2 449	16 827	**587.1**
San Pedro Ixtlahuaca	2 674	14 552	**444.2**
San Agustín de las Juntas	2 646	11 391	**330.5**
Santa María Coyotepec	877	3 751	**327.7**
San Pablo Etla	4 228	17 116	**304.8**
San Sebastián Tutla	4 231	16 878	**298.9**
Villa de Zaachila	11 961	46 464	**288.5**
San Antonio de la Cal	7 941	26 282	**231**
Santa Cruz Xoxocotlán	30 762	100 402	**226.4**
Santa Cruz Amilpas	4 204	13 200	**214**
San Raymundo Jalpan	1 429	4 105	**187.3**

Municipality	1990	2020	%
Cuilápam de Guerrero	9 804	26 882	**174.2**
San Bartolo Coyotepec	3 825	10 391	**171.7**
San Andrés Huayápam	2355	6 279	**166.6**
San Lorenzo Cacaotepec	7061	18 339	**159.7**
Tlalixtac de Cabrera	5121	12 067	**135.6**
San Agustín Yatareni	2687	5 521	**105.5**
Ánimas Trujano	2282	4 564	**100**
Soledad Etla	3205	6 348	**98.1**
Sta. Lucía del Camino	29122	50 362	**72.9**
Villa de Etla	6 077	10 361	**70.5**
Guadalupe Etla	1 772	2 929	**65.3**
San Agustín Etla	2 819	4 168	**47.9**
Sto. D. Tomaltepec	2 353	3 386	**43.9**
Santa María del Tule	6 398	8 939	**39.7**
Nazareno Etla	3 207	4 293	**33.9**
Oaxaca de Juárez	213 985	270 955	**26.6**

Source: Own elaboration based on INEGI (INEGI, 1991; INEGI, 2020).

Hydropolitics as an explanatory concept of tensions

The OMZ has an area of 756.8 km^2. Its physiography is located in the Valles Centrales aquifer, within the Río Verde Atoyac Basin, sub-basin (RH20AC) of the Atoyac-Oaxaca River, made up of the Alto Atoyac, Río Salado and Bajo Atoyac micro-basins (INEGI, 2020). In turn, the

municipality of Oaxaca is the political nucleus of the OMZ. It is also the geographic center where the flows of the Atoyac, Jalatlaco and Salado rivers converge (Figure 2).

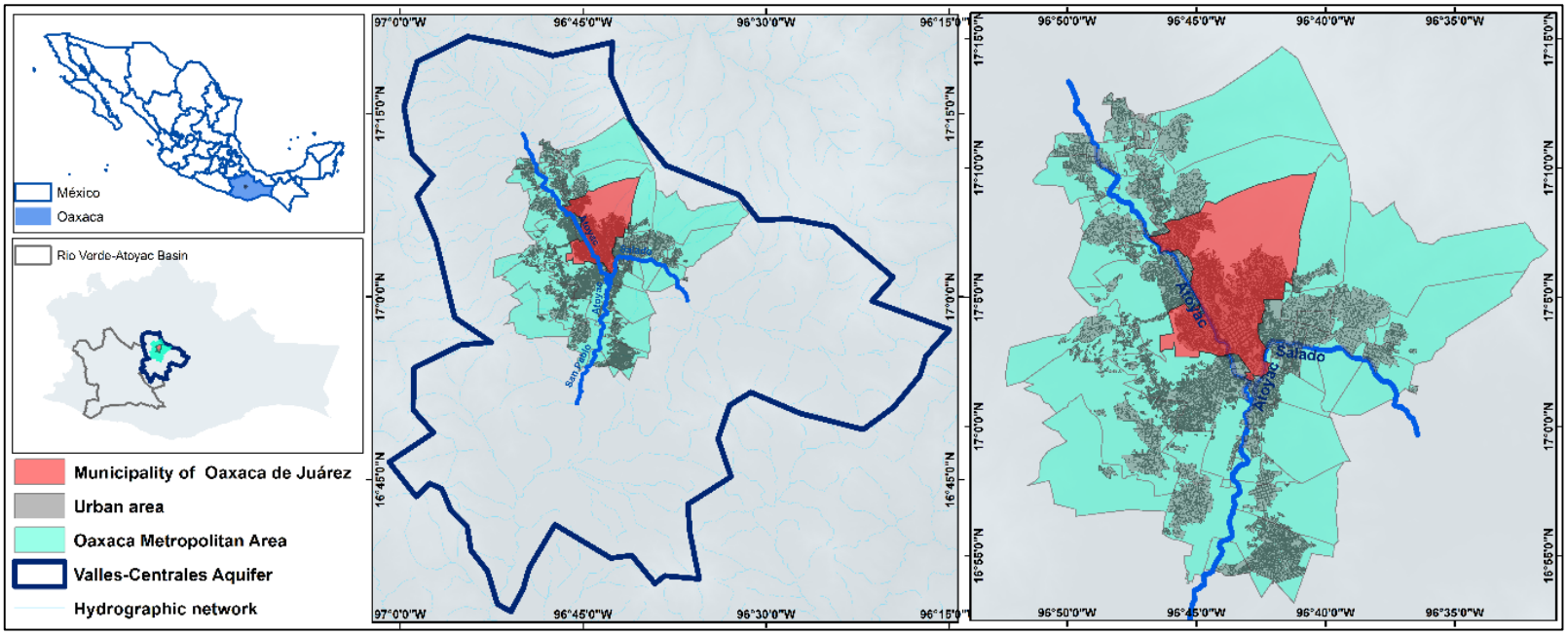

Figure 2. Atoyac-Salado tributary in the Municipality of Oaxaca. Source: Own elaboration based on INEGI (2020).

In water management, the municipality of Oaxaca de Juárez presents problems with respect to water collection, supply and control. The functioning of the water system is limited and ineffective in the face of the metropolitan growth experienced by the municipality (Semaedeso, 2022). Thus, there are conflicts that Political Ecology categorizes as ecological-distributive, derived from the different visions on the use of water, as well as environmental and political injustices, caused by the

inequitable demand, use and contamination of the actors or power groups present in the hydro-social cycle (Martínez-Alier, 2006).

As an explanatory concept, hydropolitics makes it possible to highlight and distinguish the various conflicts arising from the control of water, especially in areas with different municipal districts, such as the one in which the city of Oaxaca is located. It is an emerging study approach that analyzes: a) the problems derived from the common rights in its collection and supply, b) the legislations regarding its control, and c) the problems, conflicts and agreements originated by its use and coverage in different districts and political and social contexts.

Origins of the Hydropolitics concept

The concept of hydropolitics comes from the Middle East, where it was used to describe the political disputes of the nations of that region. These struggles are strongly related to the dynamics of access to and control of water. In 1979, John Waterbury was the first to transcribe the concept of hydropolitics, using it to refer to conflicts between countries adjacent to the Nile River basin (Waterbury, 1979). His definition referred exclusively to international political confrontations. In its beginnings, this author defined it as the capacity of States and geopolitical institutions to manage and manage shared water resources in such a way that the actors involved avoid disputes and conflicts over access (Waterbury, 1979).

Before the 2000s, the concept of hydropolitics was unknown in academic texts dealing with water conflicts in Mexico. In recent years, this concept has been translated as "hydropolitics" and began to be used in

academic texts in the country, reaching social and governmental instances (Kauffer, 2004). For its translation into Spanish, the word politics is used to refer to a sense of conflict or struggle for power. Thus, the Spanish interpretation of hydropolitics is related to conflictive aspects over water (Kauffer, 2004).

According to Kauffer (2010), there are two currents to conceptualize hydropolitics. The first is the geopolitical vision of the international school, which analyzes the dynamics of transboundary water conflicts based on the political systems that develop within the shared basin in each country. The second current is based on a redefinition provided by Turton (2002), which goes beyond the international sphere, introducing the concept of hydropolitics with respect to the analysis of the scales and diversity of events that occur within a political system.

The academy in Mexico adopted the approach of the international school based on a local sense (Avila, 2001; Kauffer, 2004), which has made it possible to analyze both the transboundary basins and the metropolitan areas of the country (De Alba-Murrieta, 2005). From this perspective, this research examines shared water at the intermunicipal level. Its importance lies in being able to focus the analysis according to a specific axis, which exerts constant pressure on the demand for water with the contiguous municipal scales in which it is located. In this case, the municipality of Oaxaca acts as the central junction point within the OMZ. The analysis focused on the identification of the socio-political actions of capture, supply and control that have been developed by the various actors identified, the historical context in which they were carried

out, as well as the impact they have generated to create the current metropolitan water system in the municipality of Oaxaca.

Materials and methods

The research applies a qualitative, analytical and explanatory methodology that discusses the logical understanding of the conformation of the municipal water supply system. The historical background was investigated through three primary sources: 1) the Municipal Archive of the City of Oaxaca (AMCO), the General Archive of the State of Oaxaca (AGEO), the General Archive of the Executive Power of the State of Oaxaca (AGEPEO) and the Historical Archive of Water (AHA); 2) official and statistical documents issued by the municipal, state and federal governments; 3) articles and academic research that describe in historical form, the progressive process of water supply that the city of Oaxaca has experienced over the years, from its foundation to the beginning of its metropolitan conformation.

The information obtained was examined based on two hydropolitical analysis criteria: **Coverage and tensions** (Figure 3). In the first, three variables were considered to understand the progressive increase in water management in Oaxaca de Juárez: *1) water catchment, 2) water supply and 3) water control.* However, this growth caused tensions with the adjacent communities, therefore, the search for information focused on the following aspects: *a) the problems* caused by the collection of the water sources from which the municipality of Oaxaca de Juárez has been supplied; *b) the conflicts* that have arisen over access to these bodies of

water and finally; *c) the arrangements* that have been generated for the contiguous supply between the city and the surrounding municipalities.

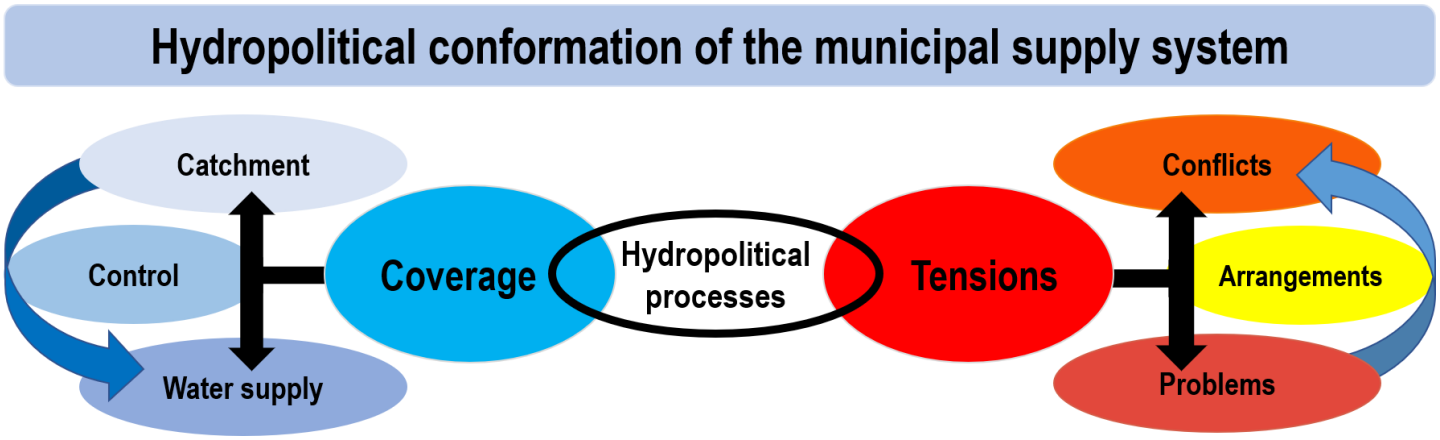

Figure 3. Research model.

The systematization of the information was .structured in the following phases. In the first phase, the different forms of water supply developed by municipal management through territorial negotiations and political agreements with neighboring municipalities were examined. In order to establish the hydropolitical area in each process, the increase in municipal coverage was analyzed and the tensions that have coexisted between the capital city and its areas of influence were refined, so that each dispute or problem was characterized in a political way. In the second phase, based on the Atlas TI 8 program, the historical information of the municipality's water management was organized and configured according to an analysis of the existing population and the hydraulic construction processes, in order to understand the demands, problems, disputes and arrangements that have configured the current water supply

system of the municipality of Oaxaca de Juárez, Mexico. Finally, in the third phase, with the support of the ArcGIS Geographic Information System, a cartographic representation of each process analyzed was made, showing the evolution of the municipal supply system.

Results and discussion

The results were structured on the basis of a processual treatment of the socio-political and legal moments of municipal water management that show the current causes of water problems. Figure 4 shows the historical development of each hydropolitical process analyzed on the conformation of the domestic water supply system.

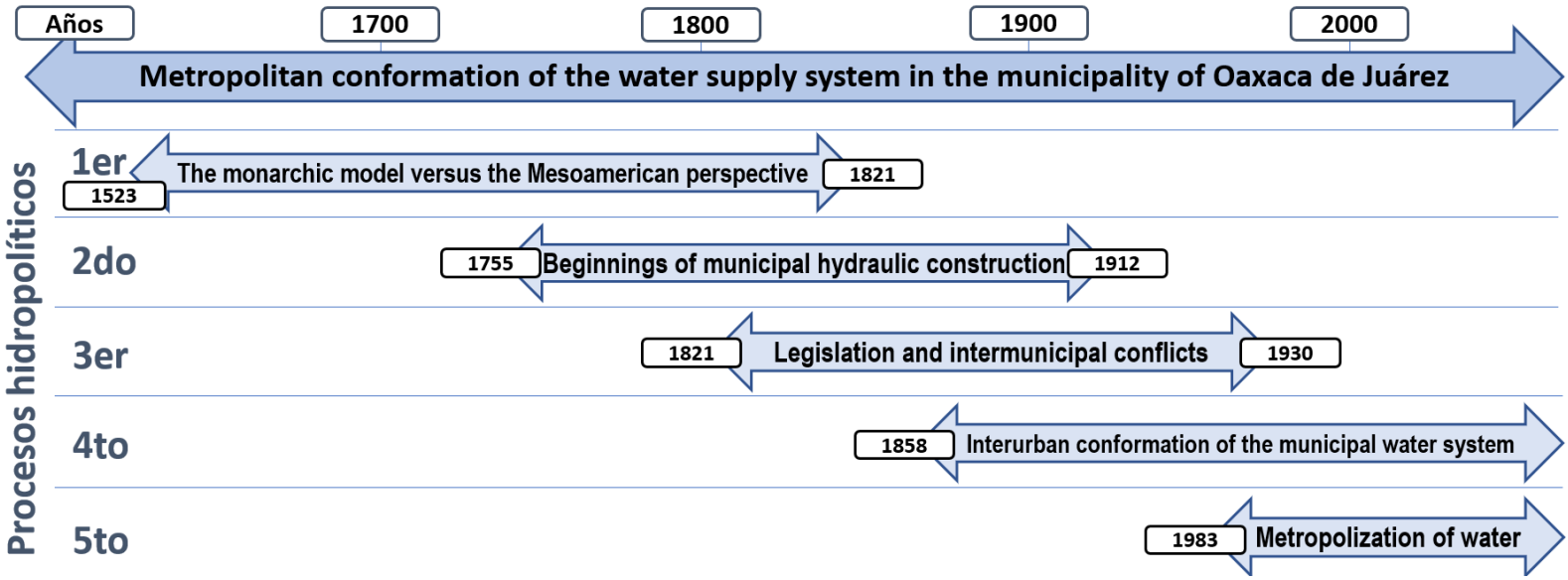

Figure 4. Hydropolitical processes.

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First process. The monarchic model versus the Mesoamerican perspective

The city of Antequera (today Oaxaca de Juárez) was founded in the interior of a great Central Valley, in a strategic space due to the presence of perennial rivers and large extensions of fertile land. Its establishment led to a systematic redistribution of the territory and its population. Initially, the residents of this small city were Spaniards and Creoles, leaving the Zapotec peoples already established in the surrounding areas. Thus, a first hydropolitical tension arose, motivated by two different logics of conceiving and valuing water.

a) Colonial catchment and supply

The city of Antequera was founded by the Spanish conquistadors in 1523. From its beginnings, this colonial town was supplied with water from several sources. In the northern part, water came from a spring located in the town of San Felipe del Agua. In the southern and eastern areas, the population used the flow of the Atoyac and Jalatlaco rivers. Meanwhile, in the more remote areas, there were few sources available to draw from; therefore, the inhabitants collected water from a nearby stream or an existing public fountain (Iturribarria, 1943).

This city coexisted peacefully with the populations established around it, whether they were indigenous villages, ranches or small rancherías with scattered hamlets. These communities were located on the margins of perennial rivers, fed by runoff and seepage from the Sierra

Norte. Water was mainly used to satisfy both human and productive consumption: pack animals and agricultural activities (Ohmstede & Topete, 2020). The impact on the water level was minimal, and almost never affected the needs and activities of neighboring populations located downstream. However, in the activities of the Spaniards, a hoarding in its use began to be observed, a practice contrary to the Mesoamerican vision that appreciated water as a collective good.

During the sixteenth and seventeenth centuries, intensive cattle raising activity was developed in the towns surrounding the city. Likewise, the arts and industry of the time: mining, blacksmithing, weaving and spinning, among other economic activities, were the main consumers of water in the central valley area (INSO, 2014). For their part, the indigenous people carried out agricultural work, which barely satisfied the demand of the area, so they also dedicated themselves to the care and raising of herds of small species (Taylor, 1973).

By the beginning of the 17th century, the Spanish cattle ranches began to transform into haciendas, which gradually became cacicazgos (Taylor, 1970). The hacienda was a political and economic unit that grouped agricultural, livestock and secondary activities such as textiles and blacksmithing, among others. In 1643 there were more than 40 haciendas that supplied the small markets of the existing towns in the valley (Taylor, 1973:293).

Being self-sufficient units, the haciendas of the time consumed a large amount of water for irrigation, livestock and human use. In order to maintain their production, small masonry dams were built, as well as silting for crop irrigation. Territorially, these haciendas were concentrated

in the south and east of the central valley (Figure 5); while to the north, in the Etla area, there were a dozen (Topete, 2021:36).

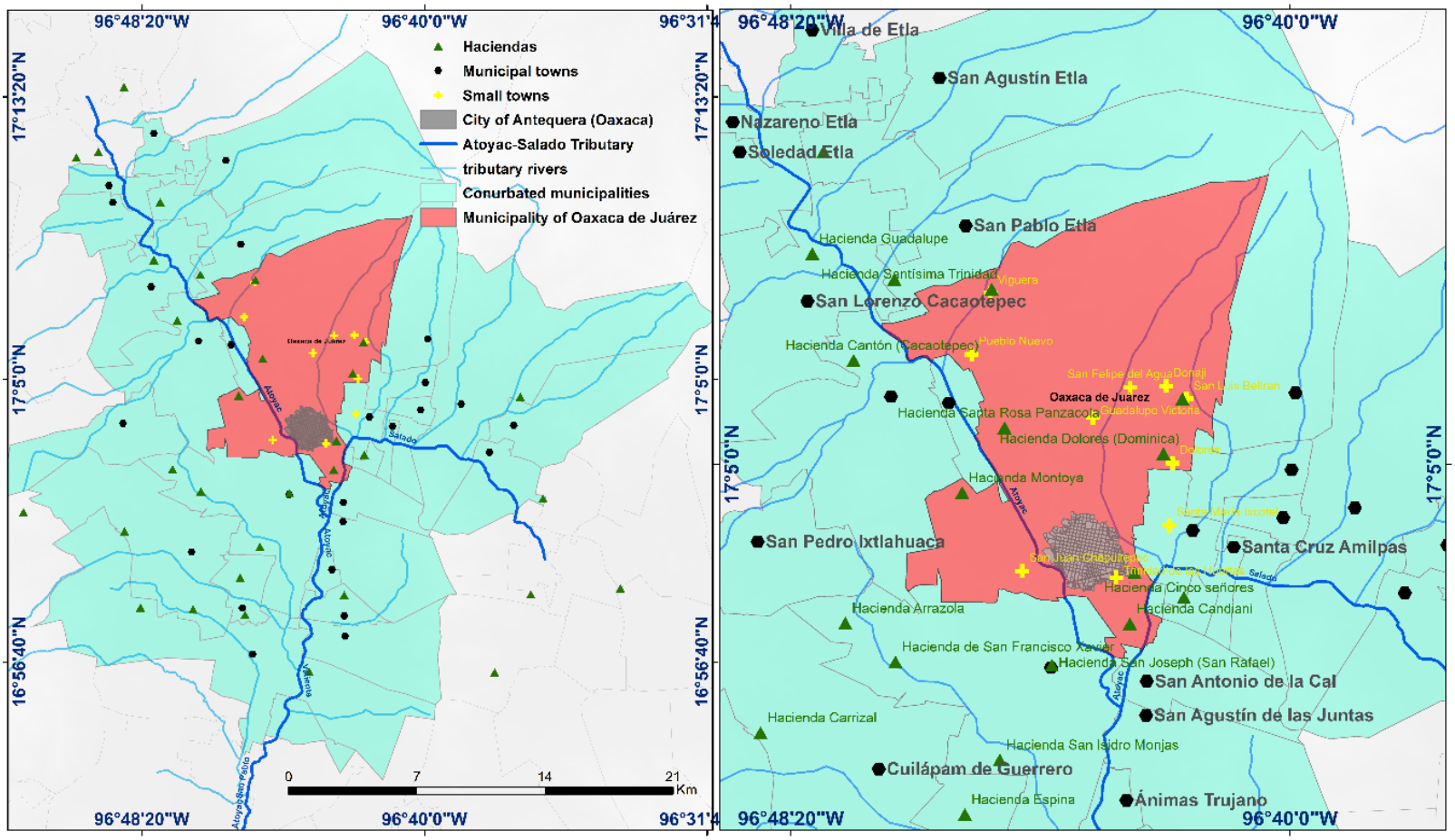

Figure 5. Haciendas, municipal towns and the city of Antequera.
Source: Own elaboration based on Taylor (1973) and Topete (2021).

b) Conflict of two different cultural visions: *Mercedes versus* Mesoamerican common use

In colonial times, all existing resources in the conquered territories belonged to the sovereign in turn. The King of Spain ceded possession rights over water, a situation that contrasted with the Mesoamerican vision where the sense of community did not permit restricting access to water (López-Austin, 1999). The coexistence of these two logics generated conflicts over the use and regulation of water.

On the one hand, Spanish law established that the ownership of water was part of the rights that the kings ceded through *"mercedes"* to their representatives (Taylor, 1973). The native peoples of the area were unaware of this precept, since, for them, water was a shared element of common use, and therefore its management was based on individual or family demand, without restricting its use to others. Due to these circumstances, the combination of such regulation approaches led to various conflicts over water control between the city of Antequera and its surrounding communities (Rojas, 1988).

c) Intercultural power arrangements

Based on the hydropolitical approach, a conflict between two opposing cultural visions can be observed: the perspective of the Spanish Crown versus the cultural logic of Mesoamerica. In this case, the conflicts were the result of the confrontation of two encompassing cultural myths (Panikkar, 1990). The Mesoamerican myth was based on community, with a shared sense of access and enjoyment, without the concept of private

property, since from their worldview water cannot be captured, because its flow provides a common balance society-nature (López-Austin, 1999). While the other, the European, was based on possession through power. Evidently, the Spanish form was the prevailing one. The power of the conquistadors was imposed and spread in a cultural key. The concession of *mercedes* became an institutional way of solving water problems, in terms of access and control.

It is important to point out that, in the colonial period, the *mercedes* functioned as a hydropolitical arrangement that organized the productive structure of the territory, encompassing the cultural sense of the dominant logic. At the same time, they represented an element of power that was transformed over time, through legislation that granted property and/or usufruct rights, whether to individuals, companies or government administrations.

Second process. Beginnings of municipal hydraulic construction

Since the middle of the 16th century, the Dominican friars built hydraulic works that allowed the capture, storage and distribution of water to different strategic points of the ancient city of Antequera (Riley, 1996). However, it was not until 1755 that an aqueduct was built from the San Felipe Mountain, which distributed water to five fountains located in churches or public parks, within the semi-urban area of the city. It is noteworthy that the sense of collection and linear supply, typical of the Spanish Crown, was transferred with the construction of this type of works

made of masonry. **The San Felipe aqueduct** helped to increase the supply to a larger population, which mainly used the water for consumption, as well as for domestic and agricultural activities. However, during the dry season it was still in short supply because the aqueduct's flow decreased to such an extent that it was insufficient for most of the population.

During the transition from the colonial period to the independent period (1750-1850), the *water-society* relationship was gradually transformed. In 1821, the city of Antequera changed its name to Oaxaca (INAFED, 1988). According to the *Instituto de la Naturaleza y Sociedad de Oaxaca* (INSO), during this period the demography and extension of the city increased considerably. Three important hydraulic constructions were built. The first was the diversion and containment of the Jalatlaco River. The second was the detour of the Atoyac River to avoid flooding, as well as to create more cultivation areas. The third was the progressive desiccation of floodable soils; this action was inadvertent, because it was carried out in a gradual and staggered manner (INSO, 2014). It should be noted that, the edification of this hydraulic infrastructure helped to maintain and increase the population growth of the city of Antequera (Iturribarria, 1943).

By 1850, the inhabitants of the city of Oaxaca began to settle in contiguous areas, which at that time were politically separated population entities. Little by little, various population centers were formed, either indigenous or mixed villages. Around the city of Oaxaca there were several ranches, rancherias, trapiches or mills that contained small self-sufficient population communities. Approximately 14 municipalities

(including the state capital), 28 municipal agencies, 33 villages, 24 haciendas, 4 parishes, and 4 ranches coexisted in the vicinity of the Oaxacan capital (Ohmstede & Topete, 2020). In access to water, there was competition for control of water among the different types of communities in the area. However, a fundamental fact was that the towns already outnumbered the *ranchos*, *rancherias*, and *haciendas* in population.

a) Water as an exchange: Construction of the San Andres Huayápam aqueduct

By the mid-19th century, gradual changes in water supply were introduced. Little by little, technological elements were adopted that in the future helped to satisfy the city's water requirements. From this perspective, and with the objective of no longer depending entirely on water captured through rainfall, the city of Oaxaca sought new and stable sources of water supply. Therefore, the municipal government established agreements with other municipalities to supply itself with water. It replicated what had been done in the colonial period and planned the construction of another aqueduct from San Andrés Huayápam.

In 1862, the state government issued a decree that allowed the municipalities to hold water rights, and thus obtain some kind of income from the leasing of spills. The income obtained was to go to the municipal fund. In 1873, a new decree was issued that legislated the legal water easement; it was established that the right of ownership of water was essentially the responsibility of the government. Therefore, the

administration and management corresponded to the city council, which would have the power to make agreements, leases and agreements with businessmen, landowners or other types of individuals who could obtain a private use of water (Sánchez & Sandré, 2011; Topete-Pozas, 2017).

In 1876, given the water shortage suffered by the state capital, the municipalities of Oaxaca de Juárez and San Andrés Huayápam agreed on a contract to supply the state capital with water from the springs of Huayápam (Tamayo, 1950; Topete-Pozas, 2017). It should be noted that, given the debts that the municipality of Huayápam had with the municipality of Oaxaca, **the water was used as a bargaining chip**; therefore, a contract was signed in which the municipality of Oaxaca de Juárez agreed to pay the expenses generated by the connection works, as well as to cover an annual fee of 40 pesos for receiving half of the volume extracted by the municipality of Huayápam (AMCO, 1876; Topete-Pozas, 2017).

In 1879, construction began on the nine-kilometer aqueduct - much longer than the four-kilometer San Felipe aqueduct - which channeled a large amount of water from Huayápam to the state capital. By 1880, studies were conducted to help transport the water along the San Luis Beltrán route. Finally, the constructed aqueduct reached the old Guadalupe convent (AGEO, 1912).

b) Infrastructure problems: Lack of maintenance of the aqueducts

It is important to note that the municipality of Oaxaca did not have sufficient resources to carry out constant maintenance of the aqueduct, so restoration work was frequently postponed. Despite its construction, the population continued to suffer shortages during the dry season. The volume supplied by both aqueducts decreased until their degradation obstructed the flow of water, which affected the supply of 43 public fountains, 28 private fountains, 27 ponds, as well as seven public bathhouses (AGEPEO, 1888).

The problem of water service in the city was not only the supply, but also the unhealthiness of the water, since it contained impurities and a high degree of contamination. The aqueducts of San Felipe del Agua and Huayápam were largely uncovered. It was common for them to carry dry foliage, dead animals, and excretions from the population (AMCO, 1876; Iturribarria, 1943).

c) Introduction of the pipeline system in municipal water management

By 1900, an attempt was made to update water management through the construction of public works that would change the linear system of water inflow and outflow to a network system. As a distinctive feature of the colonial hydraulic layout, the linear system was formed by means of a basic structure of canals and uncovered aqueducts, which favored

contamination and evaporation of the supplied water. In this way, the basic requirements of sanitation and supply for the inhabitants were barely obtained (Gardida, 2007; Topete-Pozas, 2017).

With the construction of a **network system**, the aim was to provide an equitable distribution, along with a greater volume of water to the general population. The construction of this system consisted of laying a subway network of pipes connected to different public and private terminals. The process was based on splitting the supply by independent clusters, so that if one supply sector was damaged, the others would not be affected. In addition, this network process made it possible to expand the system in a controlled manner, since the continuous supply of water was not cut off during its construction (Gardida, 2007).

d) Regulation and issues in residential supply

In this stage of construction, the city of Oaxaca had two main problems. The first was due to confusion as to which level of government would be responsible for executing these public works. The second was the lack of resources for the construction and installation of the subway piping required for the networked system.

In 1913, the government of the state of Oaxaca issued a Regulation for the Sanitation and Provision of Water inside houses (RSPA, 1913; Topete-Pozas, 2017). This normativity pointed out instructive aspects on the connections of the pipe network, as well as indications for connecting this supply network to the city's dwellings, and installing toilets and latrines inside them. The application of these regulations was not easy.

The lack of adequate infrastructure, the continuous contamination and intermittent supply of water forced the government of the city of Oaxaca to look for new sources of supply, which would help increase its volume of supply (Topete-Pozas, 2017).

Third process. Legislation, agreements and inter-municipal conflicts

In the course of 1800 to 1900, the legal control of water was under the management of the state and municipal administrations of Oaxaca. Within their constituency, these governments held the power to grant rights and concessions —formerly *mercedes*— to individuals (Topete-Pozas, 2017). With the decree of 1862, the state government granted common water rights to the municipalities. Therefore, within their circumscription, the control of water remained under their jurisdiction. In 1873, a new decree was issued that legislated the legal easement of water; it was established that the right of ownership of the water essentially concerned the government, without prejudice, of course, to the previously agreed upon arrangements with private parties. Therefore, the administration and management now corresponded to the city council, which would have the power to enter into agreements, leases and contracts with businessmen, landowners or other private individuals who could obtain private use of the water (AGEO, 1879).

By 1890, a state regulation was issued that noted that, upon assignment of a communal parcel, water control remained in regulation of the municipal government, under approval of the state administration

(Topete-Pozas, 2017). Until 1905, the state government established a Law on the Use and Development of Water (LUAA) with the objective of regulating and legitimizing the authority and domain of water within the municipal and state spheres (AGEPEO, 1905). In this way, the town councils of the state of Oaxaca and their municipal agencies obtained the legal power to administer the water emanating within their political circumscription.

a) Inter-municipal agreements

The importance of the LUAA was to give priority to the public utility of water, taking power away from private interests. The municipal councils could distribute their water for the benefit of the common supply, allowing possible concessions between municipalities. In this scenario, two negotiation processes took place with the towns of San Andrés Huayápam and San Agustín Etla. It should be noted that these negotiations were not free of distributive conflicts. However, for the first time, inter-municipal agreements were developed between different local administrations converging within the public sphere of the Oaxacan capital.

The drafting and approval of the LUAA in 1905 represented a turning point in the process of water control and management in Oaxaca. For the first time, a metropolitan water government was officially and legally recognized, since a complex intermunicipal supply system was structured from the coexistence of local actors with interests and relationships based on uses and customs. However, due to differences in the way water is valued among neighboring communities, a distributive conflict developed with the municipality of San Agustín Etla.

b) Water catchment from San Agustín Etla

In 1907, based on the LUAA, the municipal government of the city of Oaxaca took the necessary steps before the state government to build water supply and sanitation infrastructure. These works focused on the installation of a supply and drainage network, as well as the subsequent paving of the city's main avenues. In response, the state government issued a decree, which allowed the state executive to carry out financial and administrative procedures in conjunction with the municipal government to build works that would allow the supply and sanitation of water in the state capital (Topete-Pozas, 2017).

It should be noted that, in order to develop the project, the use of water from the aquifers adjacent to the Atoyac River was contemplated; however, this proposal turned out to be unfeasible due to the high costs involved in its execution. After a joint analysis between the state government, the city council and various "investors", it was decided that the most viable option was to transport water from the "San Agustín" river, located in the municipality of San Agustín Etla and coming from the Etla Valley (Iturribarria, 1943).

c) Change of jurisdiction and federal control of water within the municipalities

In the Etla Valley, there are several sources and bodies of water such as aquifers, streams, springs and rivers that came under the jurisdiction of the municipal government. However, despite the decrees, regulations and

laws established for the municipality to have control over water, the concessions granted prior to the creation of these legislations persisted (AGEO, 1879). In such a way, the property rights of the spills (formerly *Mercedes*) could be leased between individuals. In 1910, the government of Oaxaca de Juárez entered into a contract with the landowner Rafael de Cajiga Toro, who ceded for fifty thousand pesos of the time, the rights he had over a portion of the water volume of the San Agustín River (AHA, 1928).

The population and the municipality of San Agustín Etla were not satisfied with the agreement between a private individual and the capital city council (Topete-Pozas, 2017). Because of this situation, there were problems in the construction works to transport water from San Agustín to the city of Oaxaca, which were also delayed due to the violent political situation generated by the revolutionary movements in the country.

It is important to mention that with the establishment of the Political Constitution of the United Mexican States (CPEUM) of 1917, there was a drastic change in the jurisdiction of municipal water rights and their legal status. In the CPEUM, Article 27 stated that the ownership of water became the property of the nation, so that its jurisdiction and authority was left to the federal level, which was the only one empowered to administer, manage and, on certain occasions, grant concessions (Aboites, Birrichaga, & Garay, 2010).

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d) Ecological-distributive tensions and conflicts with the municipality of San Agustín Etla

In 1928, a delegation of San Agustín Etla requested the Secretary of Agriculture and Development (SAF), the reincorporation of their rights of possession over the waters of the San Agustín River. For the inhabitants of Etla, the water of said river belonged to them, so they had the right to use it for their domestic consumption and use. In addition, they argued that the municipal government of Oaxaca did not have the power to carry out works in federal bodies of water. Therefore, they requested the suspension of the channeling and piping works to the city of Oaxaca (AHA, 1928; Topete-Pozas, 2017).

In response to San Agustín Etla, the government of the city of Oaxaca claimed to have a contract covering the use of water from the San Agustín River, and that the channeling of water for the city of Oaxaca was indispensable. The state government and the National Agrarian Commission (CNA) approved the work. A "distribution box" was built to channel water to the city of Oaxaca, reducing by two thirds the supply capacity of the "La Soledad" tank, which supplied the inhabitants of San Agustín Etla (AHA, 1928). Due to these facts, a distributive conflict arose between the two municipalities in question, so the SAF had to intervene. It commissioned Engineer José Santos to prepare a report to resolve the controversy. In that document, it is pointed out that the river is of federal competence and that the inhabitants of San Agustín Etla had the right to one third of its spills (AHA, 1928; Topete-Pozas, 2017).

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Oaxaca's right to two thirds of the total volume of water is indicated. It was suggested that it was not necessary to collect and pipe all of the water, since there were other sources of supply from the springs and aqueducts of San Felipe del Agua and San Andrés Huayápam (Figure 6) (AHA, 1928). In this document, the demographic importance of supplying the basic needs of the capital's population is also noted, so the use of water for the population of the city of Oaxaca was favored (Topete-Pozas, 2017).

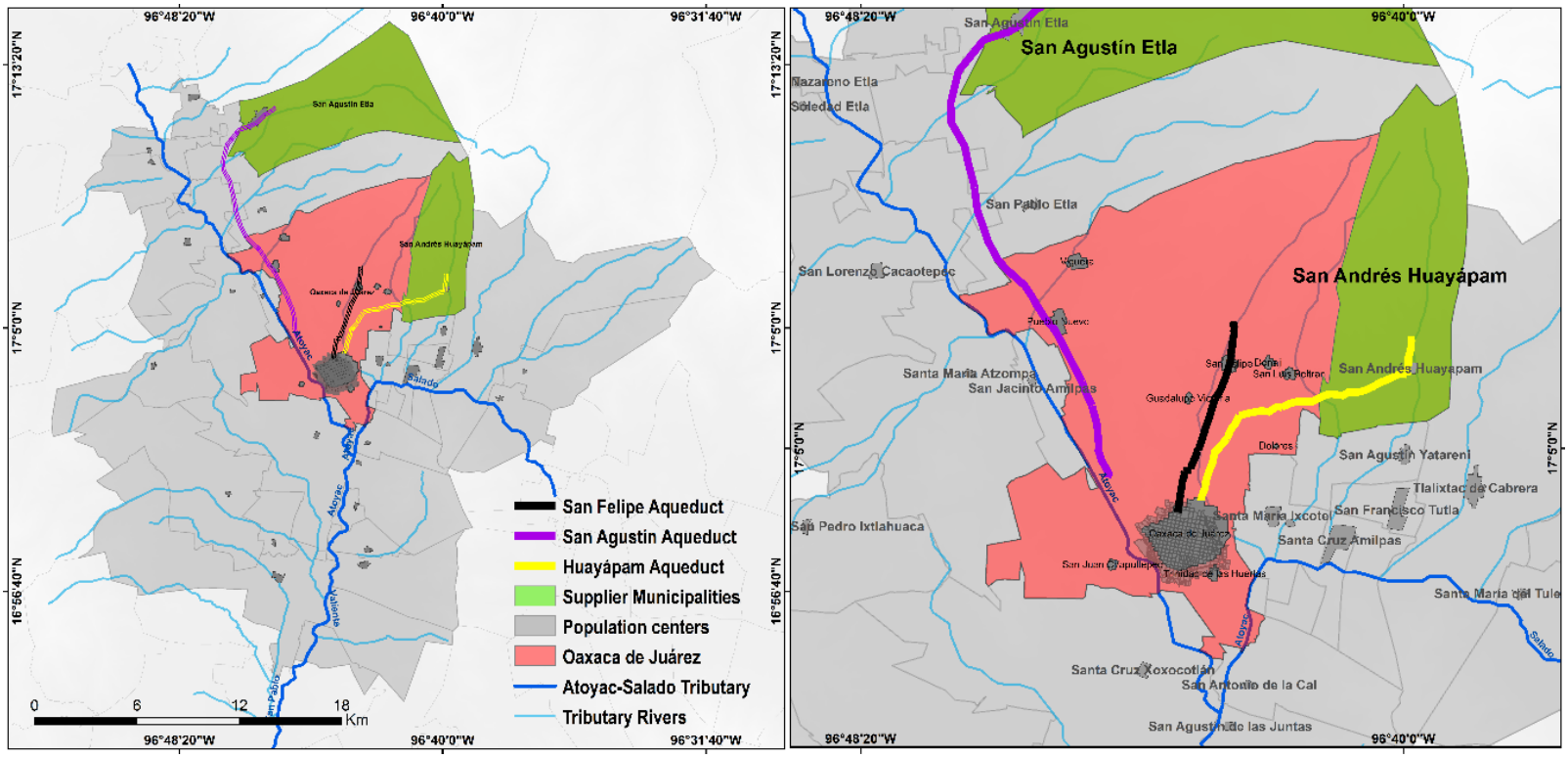

Figure 6. Watercourse of aqueducts and supplying municipalities. Source: Own elaboration based on AGEO (1912) and Topete-Pozas (2017).

In these years, the demographic increase of the city of Oaxaca demanded a greater supply than it was able to provide based on its catchment sources. From the perspective of Political Ecology, we can reflect on this case as an ecological-distributive conflict, derived from a greater demand for water from the city of Oaxaca due to the hydraulic growth of the network system that adapted and distorted the legislative water evolution in the state of Oaxaca (Martínez-Alier, 2006).

Regarding the inhabitants of San Agustín Etla, they faced an environmental injustice, since they were harmed by the agreement made previously between a private individual and the Oaxaca City Council, and their demographic and economic minority did not represent a great influence on the political decisions of the state government in office. Therefore, they could do little to "defend" the supply of "their water" to other areas with greater population and political power.

The dilemma is not in determining who was guilty of provoking this environmental injustice, whether it is the illegality of the municipality-particular agreement that allows the extraction of water in San Agustín Etla, or the illegitimacy that this agreement has generated in the inhabitants of San Agustín itself; but rather in understanding the geopolitical variables (demography and hydraulics) that generated this distributive conflict of water. It is a fact that this supply route has benefited commerce, labor centers, tourism, as well as a large percentage of the population. This leads us to ask ourselves if the conflict between San Agustín Etla and the municipality of Oaxaca can be explained on the basis that its distribution to Oaxaca represents a great utility of public

supply for a metropolitan entity that has no defined limit in terms of its urban growth? At the same time, have the water needs of San Agustín Etla been subordinated because economic development demands it? At the end of the day, and despite the mediation of the federal government, problems, tensions and conflicts continued to arise over the dispute of this liquid between the two municipalities. This problem continues to this day.

Fourth process. Interurban conformation of the municipal water system

a) Beginnings of the municipal water system of Oaxaca

The current municipal hydraulic water system has its origins in the *Juarista* administration of 1858, where water from water bodies was channeled through aqueducts and a rainwater collection system was implemented, which was gradually replaced by an incipient drinking water network. This municipal system was supplied by the Atoyac and Jalatlaco rivers; as well as, from the water coming from San Felipe del Agua, San Andrés Huayápam and later San Agustín Etla (INSO, 2014).

In 1900, the municipal area of Oaxaca de Juárez included one city, 27 towns, 3 villages and 11 haciendas (SFCI, 1906). Most of these communities were located along the banks of the Atoyac and Salado rivers. By 1913, the formal construction of the municipal water network was initiated by means of steel, ceramic or iron pipes, which at first distributed water within the central areas of the city. However, this

system was developed in a limited way, since the supply was only provided to residences belonging to the elite, while for the lower classes the supply was through public fountains (Riley, 1996).

b) Contemporary development of the municipal water system from 1930 to 1990

The consolidation of water service began at the beginning of what we call the contemporary era. During this 60-year period, municipal water service experienced an exorbitant urbanization process and was extended to the vast majority of homes in the municipality of Oaxaca (INSO, 2014). In demographic terms, from 34 839 inhabitants at the beginning of 1930, the city increased its population more than six times (6.23) by the end of this stage, as it reached a total of 213 985 inhabitants by 1990 (Table 2). At the same time, the municipal surface area increased by 11.71 km^2, from 77.82 km^2 to 89.54 km^2 (INEGI, 1991).

Table 2. Population growth of Oaxaca de Juárez in the 20th Century.

Year	Population			Surface area (km^2)	Population density
	Men	Women	Total		
1900	16 803	18 246	35 049	77.82	450.39
1910	17 389	20 622	38 011	77.82	488.45
1921	12 581	16 444	29 025	77.82	372.98
1930	15 838	18 480	34 318	77.82	440.99
1940	14 361	17 478	31 839	77.82	409.14
1950	23 000	26 953	49 953	85.48	584.38
1960	37 647	40 992	78 639	85.48	919.97
1970	54 949	61 439	116 388	85.48	1 361.58
1980	74 924	82 360	157 284	85.48	1 840.01
1990	99 863	114 122	213 985	89.54	2 389.83
2000	119 439	136 691	256 130	89.54	2 860.51

Source: Own elaboration based on data obtained by SFCI (1906), SAF (1918), DEN (1927), SEN (1936), SEN (1948), SE (1953), SIC (1963), SIC (1973), INEGI (1984), INEGI (1991).

According to the hydropolitical approach (collection, supply and control), three specific periods were identified that triggered the metropolitan conformation of the municipal water system.

1. From 1930 to 1950: Population readjustment and expansion of the water system. By 1930, the city of Oaxaca began a period of great demographic and spatial expansion. The municipal area experienced a population readjustment, where the inhabitants who

previously resided in rural areas, gradually settled in the outskirts of the urban area of the capital city. The water system suffered a great impact that forced it to transform its management and supply capacity inside and outside the territorial area of the capital municipality.

From this period on, the municipal water supply system gradually became "popularized". New distribution networks were installed that supplied, in a few decades, a large number of household connections in the city of Oaxaca. In these years, the foundations were laid for the newly built drinking water system of Oaxaca City to have a progressive and significant development (INSO 2014).

An incipient drainage infrastructure was also built, with the construction of canals, pipe networks and sewers that conveyed rainwater and wastewater from public and residential intakes in the downtown area and its surroundings. However, the establishment of this nascent drainage network represented a detrimental fact for the Atoyac River and its tributaries; as well as for the micro-watershed of the San Felipe and Jalatlaco rivers, since, most of the water collected by the drainage was going to end up in these rivers (INSO, 2014). In these years, deterioration began to be observed in the piping and drainage network of the first central homes that were connected to the municipal water system. It was common to observe seepage and wastewater leaks.

2. From 1950 to 1970: Conurbation and consolidation of the water system. The construction of public infrastructure helped to urbanize almost the entire municipal territory. In general, the city of Oaxaca experienced a phase of great urban expansion, where settlements that were previously far from the city center were now annexed to the growing urban sprawl.

With respect to the municipal water system, a better terrestrial connectivity was sought, so the course of the Atoyac River was again modified through a series of rectifications that diverted its trajectory towards areas that were less traveled at the time. The result was that the water began to suffer acute contamination, since it received rainwater mixed with drainage from domestic outlets, commercial and hospital waste, as well as toxic substances dumped by the Central de Abasto, mechanical workshops, local markets among other types of businesses (INSO, 2014).

With the task of consolidating the urban infrastructure, the city council enabled different access roads that in the future allowed the gradual regulation of the conurbation areas of the city of Oaxaca. The most remote areas began to be inhabited informally, turning the city into a central area of a nascent metropolis. However, these newly inhabited areas did not yet have access to municipal water service.

3. From 1970 to 1990: urban strengthening and metropolitan roots: In 1990, 81.7 % of the population (174 940 inhabitants) resided in homes with access to public water service (Table 3), while 63.5 % (1 359 319 inhabitants) had sewerage in their homes (INEGI, 1991).

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Table 3. Relationship of water and sewage services in Oaxaca de Juárez.

Year	Housing					Inhabitants				
	Number	With water service	No water service	With drainage	No Drainage	Number	With water service	No water service	With drainage	No Drainage
1960	15 883	10 128	5 755	9 298	6 585	78 639	48 476	30 163	44 694	33 945
1970	21 640	13 011	8 629	10 645	10 995	116 388	68 804	47 584	57 102	59 286
1980	29 898	19 721	10 177	13 351	16 547	155 130	ND	ND	67 237	87 893
1990	43 672	36 554	7 118	28 960	14 712	211 974	174 940	37 034	135 931	84 043

Source: Own elaboration based on information from SIC (1963), SIC (1973), INEGI (1984), INEGI (1991).

It is evident that these figures represent the peak and consolidation of the water system within the city. However, it should not be forgotten that it is also necessary to estimate the population, housing and water service in the areas surrounding the municipality of Oaxaca.

From 1970 to 1990, the municipality of Oaxaca underwent a socio-demographic transformation that went beyond its territorial limits, as its territorial area developed an urban strengthening that exceeded its political-administrative jurisdiction, disrupted contiguous zones of other municipalities, and gave roots to the metropolitan phenomenon (Table 4).

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Table 4. Population growth and distribution in the OMZ.

Area	Population			Percentage distribution of the population			Periods of percentage growth		
	1970	**1980**	**1990**	**1970**	**1980**	**1990**	**1970-1980**	**1980-1990**	**1970-1990**
Oaxaca de Juárez	116 388	157 284	213 985	96.4	93.8	59.5	35.1	36.1	**83.9**
Conurban area	4 371	10 323	145 566	3.6	6.2	40.5	136.2	1 310.1	**3 230.3**
OMZ	120 759	167 607	359 551	100	100	100	38.8	114.5	**197.7**

Source: Own elaboration based on data from Negrete and Salazar (1986), INEGI (1984), INEGI (1991).

The city's public infrastructure was extended to the peripheral areas, which led to an increase in the number of inhabitants in these areas. Based on these facts, it can be observed that by these years there were already certain intermunicipal indicators that turned the city of Oaxaca into a metropolis that grouped together the conurban areas of the center of the state (Figure 7).

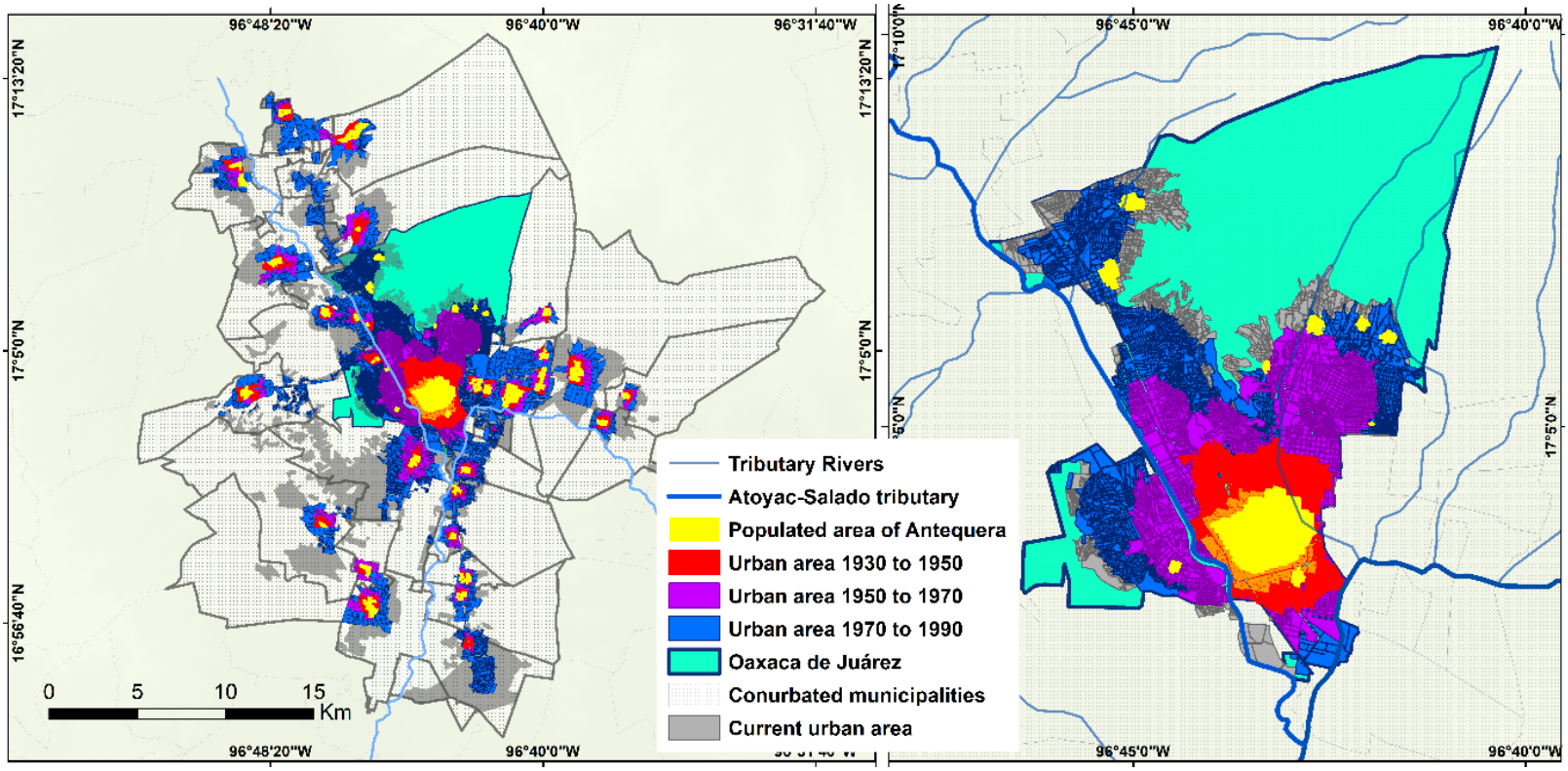

Figure 7. Metropolitan development of the water system in Oaxaca de Juárez. Source: Own elaboration based on INSO (2014) and INEGI (2020).

Fifth process. Metropolization of the water service

Historically, the beginnings of the metropolization of municipal water services can be traced back to the early 1980s. Beginning in 1981, major changes in the country's administrative water services took place. At the national level, water legislation was decentralized, whereby the federation transferred its rights and obligations to the federative states; so that they could legislate regulations on water in their jurisdiction. With this resolution, the states were empowered to directly administer, manage,

conserve and build the hydraulic works that would help with the collection, conduction, potabilization, distribution and supply of water and sanitation services (Aboites *et al*., 2010).

a) Municipalization of the water system of Oaxaca

Based on the facts described above, on December 12, 1981, decree number 56 was published in Oaxaca, on a new water law, which would regulate the operation and provision of drinking water and sewerage services in the entire state of Oaxaca (SAPAO, 2022). As a result of these changes, in 1982 the Administración Directa Local de Obras y Servicios de Agua Potable y Alcantarillado de la Ciudad de Oaxaca (ADOSAPACO) was established. This institution immediately took charge of the management, administration, operation and maintenance of water services in the municipality of Oaxaca de Juárez (SAPAO, 2022).

In 1983, the federation made the municipalization of drinking water services official. In the reform to article 115 of the constitution, approved on February 3, 1983, it was established that the municipalities acquired primary responsibility for drinking water and sewerage services (Pineda, 2002). For the municipality of Oaxaca de Juarez, these administrative changes in water management did not result in an improvement in the management of water services by ADOSAPACO. The municipal water system was in frank growth, but municipal management continued to be limited, and triggered an insufficient distribution of water with respect to the large number of inhabitants of the city (INSO, 2014).

b) Changes in Oaxaca's water legislation

In 1989, with the creation of the National Water Commission (Conagua) and in 1992 with the establishment of the guidelines of the National Water Law (LAN), the water legislation of the country's states underwent modifications. At the beginning of 1993, the Law of Potable Water and Sewerage in the State of Oaxaca -still in force- was published (LAPAO, 2005). This law established that municipalities would be in charge of water and sewerage services through the administration (management, administration and collection) of Municipal Water Operating Agencies (*Organismos Municipales Operadores de Agua*, OMOA). These agencies would have the capacity to establish inter-municipal cooperation agreements regarding contiguous supply and sewerage (LAPAO, 2005). Thus, governmental actions were oriented towards the construction of hydraulic works to supply water to the expanding urban areas, as well as the foundation of drainage collector networks for the new population buildings. However, from this legal management scenario, the responsibility for wastewater discharges was omitted with the construction of water treatment plants, something characteristic in areas of metropolitan expansion (Campos, 2013).

c) SAPAO and the metropolization of the water system

In 2013, as of decree number 2070, the Law of the Public Operating Agency (LOOP, 2013) was published. In this law, the Public Water Operator Agency called *Servicios de Agua Potable y Alcantarillado de Oaxaca* (SAPAO) is officially created, with its headquarters in the city of

Oaxaca de Juárez, with its own patrimony, autonomy in the operation of the service and above all with its own legal personality (LOOP, 2013). Its official jurisdiction is established in the municipal area of Oaxaca de Juárez; but it can extend its competence in metropolitan areas belonging to other municipalities adjacent to the capital of Oaxaca. In this way, SAPAO supplies not only the city of Oaxaca, but also ten suburban municipalities.

In total, SAPAO supplies 356 neighborhoods distributed in eleven municipalities of the OMZ. As an interurban operating agency, it supplies the municipality of Oaxaca de Juárez, along with the suburban areas of ten other metropolitan municipalities: San Agustín Yatareni, San Andrés Huayápam, San Antonio de la Cal, San Jacinto Amilpas, San Lorenzo Cacaotepec, San Pablo Etla, San Sebastián Tutla, Santa Cruz Xoxocotlán, Santa Lucía del Camino, and Santa María Atzompa. It should be clarified that its management does not cover all of these ten municipalities mentioned, but only the areas adjacent to the capital of the state of Oaxaca (Figure 8).

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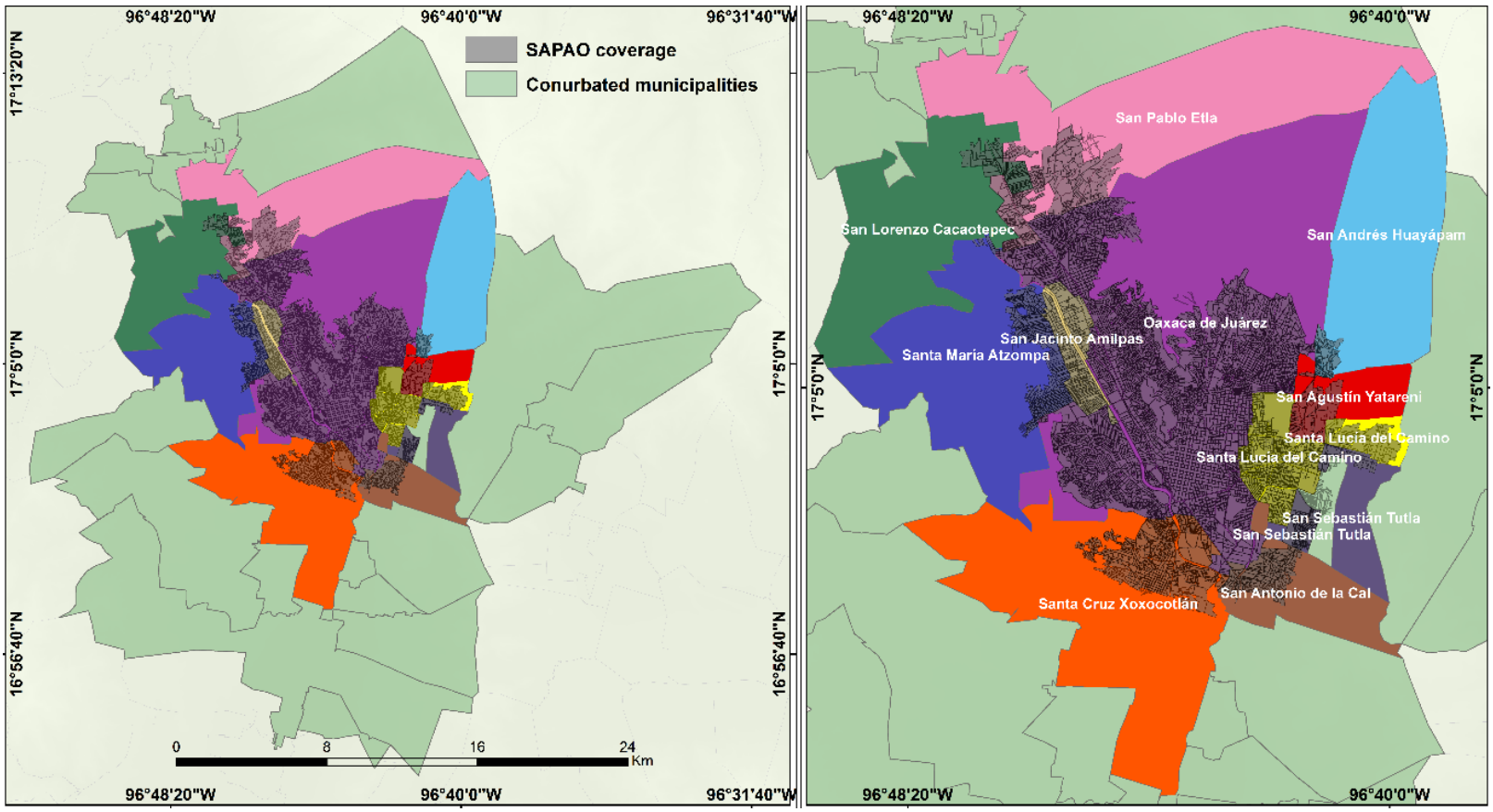

Figure 8. SAPAO coverage. Source: Own elaboration based on INSO (2014) and INEGI (2020).

d) Current problems with water metropolization

SAPAO relies on an aqueduct located in San Agustín Etla, as well as 38 deep wells that are insufficient for water supply (SAPAO, 2022). SAPAO's management is inefficient, with large urban areas without supply, or with prolonged periods of shortages, high maintenance costs and high fees (Bessi & Navarro, 2021). In addition, public infrastructure is deficient, since, in decision making, the extension of the water system is more

important than its rehabilitation (Peña, 2013). This has resulted in: leaking pipes, poor maintenance, reduced water pressure and high levels of contaminants (CNDH, 2020). Within the municipality of Oaxaca, various types of wastewaters are discharged; its localities have no or low sanitary control indices, due to deterioration or lack of water treatment plants (Semaedeso, 2022). Waste is also generated, which makes the water that is used not only by the population of the contaminated area, but also by other communities, dirty and unhealthy.

From a hydro-social perspective, the OMZ is a voracious and insatiable interurban entity, which not only consumes and transforms the water from which it is supplied, but also irresponsibly wastes its wastewater (Peña, 2013). Insufficient sanitation, population growth and increased urban sprawl have caused great environmental damage to the Atoyac-Salado tributary, which no longer has the capacity to self-clean itself in its natural process, due to the large amount of pollutants that are discharged by the municipalities through which its course crosses (Conagua, 2021). In its path through urban areas, the presence of high levels of ammonia and nitrogen, as well as other pollutants, has been detected (Soriano-Hernández *et al*., 2017). Therefore, together with wastewater discharges from local settlements, the water of the Atoyac River constitutes a great risk, not only environmentally, where the biodiversity of the environment is endangered, but also represents a threat to the health of the population of the municipality of Oaxaca that consumes water from this river (TLA, 2016).

In 2017, civil society organizations requested the attention of the National Human Rights Commission (CNDH) for the responsibility and

omission of public servants of the three levels of government, due to the excessive contamination of the Atoyac and Salado rivers. In 2020, the CNDH issued Recommendation No. 57/2020, where it pointed out the irresponsibility of the three levels of government (among them 56 municipalities), for the water deterioration of the sub-basin, which violates the human right to water and a healthy environment (CNDH, 2020). So far, no actions have been taken to address the terrible water-environmental devastation of the Salado-Atoyac tributary, the main recipient of wastewater and urban excreta. Likewise, there is no joint planning that considers the environmental, political and social requirements of the sub-basin (RH20AC) of the Atoyac-Oaxaca River.

e) Hydropolitical perspective of water metropolization

Currently, a new hydropolitical process based on a dynamic of exclusion is becoming visible. The metropolization of the water system causes tensions that not only disrupt contiguous systems, but also distorts the water service based on the demand of a new floating population. Gentrification has originated housing expulsion phenomena in the central areas of Oaxaca City. Tourism, rentals, commercial zones and the new digital work culture generate a systematic expulsion of locals by tourists and external residents with high purchasing power (Escobedo, 2022).

In terms of supply, two main problems arise. The first is a growing water demand for tourist areas, which have a preference for supply. The second problem is the maintenance and lack of creation of hydraulic infrastructure to supply the displaced population, which no longer settles in the conurbation municipalities, but in peripheral zones of the suburban

areas, evidencing a lack of planning to address the shortages in these new peripheral belts (Campos, 2013). For this new population, *water stress* is experienced, a state of anxiety due to the continuous lack of water service (Gutiérrez, 2013). This water shortage is generated by a decoupling where the demand for water exceeds the municipal supply capacity, so that the cycle is repeated for the government in office and it becomes essential to resort to other more distant external sources (Peña, 2013).

Faced with this complex situation, arrangements have been proposed with other more remote municipalities, seeking to establish alliances and agreements that allow them to extract and channel the liquid from other municipalities to the state capital. Since the 1990s, hydraulic transfers have been projected, such as the "Paso Ancho Dam" at 74 km, in Sola de Vega or "*Paso de la Reina*" at 129 km, in Santiago Jamiltepec; which seek to increase the availability of water in the city by carrying large volumes of water from other basins (INSO, 2014). However, these agreements have not always been carried out by mutual consent, but rather have been the result of resolution processes that are not free of controversy and ecological-distributive tensions that still persist.

Conclusions

Based on hydropolitics, this article reviewed the problems caused by the control approaches empowered by water ordinances and legislations, which originated multiple tensions and intermunicipal conflicts (hydropolitical processes), which gradually structured the current water

system with metropolitan features. Five hydropolitical processes were identified, which expose distributive ecological conflicts, *where tensions over water show us how power is imposed.*

Each process presents specific findings: In the first, the meaning of the *las mercedes* as an element of conflict with respect to the different worldviews of water, in this case, the monopolization by Spanish residents and the communitarian sense of the original population, is reflected upon. In the second process, water is examined as *an element of political exchange in the hydraulic construction of the city*. In the third process, water was detected as a *political booty*, which functions as an element of intermunicipal negotiation. In the fourth process, a chaotic urban transformation was evidenced, where *the demand for water expanded to levels that the system itself could barely meet with the supply coming from other municipalities*. Finally, in the fifth process, the legislative, demographic and conflictive contexts that gave rise to the current phenomenon of water metropolization were glimpsed.

From a joint analysis of the hydropolitical processes in Oaxaca, it was identified that *the main hydropolitical tension for water supply lies in the fact that the necessary territorial integrality that means the use of the sub-basin (RH20AC) of the Atoyac-Oaxaca River, as the main water entity that recharges and distributes the water that has historically allowed the creation of the current metropolitan political entity, has not been understood or incorporated*. Under this logic, the political has been above the physical, excluding the hydrological reality of the space. In this case, the water system of the municipality of Oaxaca has been shaped without valuing the water connection it has with the other municipalities of the

OMZ, through the Atoyac-Salado tributary and the Central Valleys aquifer. In this sense, it has not been considered that a local water problem involves the region, since the decisions of an upstream municipality affect other downstream municipalities.

In the development of water metropolization in Oaxaca de Juárez, it was concluded that it is necessary to understand that water management cannot be limited to its political boundaries, since the water from which it is supplied crosses other districts. On the one hand, it is necessary to reach intermunicipal agreements to solve the consequent problems of catchment, supply and discharge of each municipality, in order to achieve an integrated management of the RH20AC sub-basin. On the other hand, it is urgent to make the population aware of the ecological problems of water supply in the OMZ so that they will incorporate eco-technologies for a more efficient use of water. Finally, hydropolitical problems have been generated by the supply, relegating to a second place, and without any notion of responsibility, the problems of discharge and contamination. In this sense, organizational actions have not been preventive, but corrective, so that the ecological and social costs will be aggravated in the progressive conformation of the metropolitan water system in Oaxaca de Juárez.

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