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COMPARED WATER GOVERNANCE[1]

GOVERNANÇA COMPARADA DA ÁGUA

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Abstract
It is essential to think of the water crisis as being on a global scale, in the context of an environmental crisis that is also global. In this way, the present work looked at the issue of comparative water governance by randomly selecting some models from countries other than Brazil. Therefore, the objective pursued here is to describe and analyze the water governance models of Israel, South Africa, Mexico, Australia, Spain and the United States, as part of a larger survey that was conducted recently. It used the deductive method, with document analysis and bibliographic study and bibliographic review. The complexity of water governance was verified due to its multiple uses and because there are several public and private actors involved. The problem of scarcity, whether due to the absence of water or to its existence in a polluted form, is a fact in several nations requiring the application of integrated and supranational solutions.
Keywords: water crisis; water governance; environment.

Resumo
É fundamental pensar na crise da água como sendo de escala planetária, no contexto de uma crise ambiental também global. Assim, este trabalho debruçou-se sobre a questão da governança comparada da água selecionando aleatoriamente alguns modelos de países que não o Brasil. Portanto, o objetivo aqui perseguido é descrever e analisar os modelos de governança da água de Israel, África do Sul, México, Austrália, Espanha e Estados Unidos, como parte de uma pesquisa maior, que foi realizada recentemente. Utilizou-se o método dedutivo, com análise documental e estudo bibliométrico e revisão bibliográfica. Verificou-se a complexidade da governança da água em virtude de seus múltiplos usos e por haver diversos atores públicos e privados envolvidos. O problema da escassez, seja pela ausência da água, seja por sua existência em uma forma poluída, é fato em diversas nações, sendo necessária a aplicação de soluções integradas e supranacionais.
Palavras-chave: *crise da água; governança da água; meio ambiente.*

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Introduction

One of the crucial issues that managers and decision makers face in general is the need for planning and governance of contemporary crises. In the meantime, it is possible to list a serious environmental crisis marked by the process of climate change. Parallel to this major crisis, or forming part of it, we find the water crisis, expressing itself specifically in its scarcity, quality, and distribution.

The goal of universalizing access to this vital liquid is far from being achieved, mainly considering the challenge present in the Sustainable Development Goals (SDGs), in the 2030 Agenda of the United Nations (UN), namely: to provide water for all people on the planet, especially for about 3 billion people who currently find themselves without access to water, a difficult goal to be achieved by 2030.

However, the goal exists to guide the political actions of rulers. Moreover, from the studies developed with the master's degree in Management and Regulation of Water Resources and funded by the National Council for Scientific Research (CNPq), understanding how water management and governance occurs in other countries is essential for the development of effective strategies; the countries were randomly chosen for the development of a bibliographic and documentary research, which aimed to guide the decision of members of the National Water Resources Management System (SIGREH).

Therefore, it is possible to think about governance in general and its adaptive contemporary character and reflect on models of public water governance. Thus, we will describe the main points of the models of Israel, Mexico, Spain, South Africa, Australia, and the United States of America, ending with the model adopted by Brazil. These countries were chosen because of their regional importance and their direct relationship to water problems. Furthermore, we will discuss the imprecision of the concept of governance as the cause for some problems in the implementation of environmental policies and, more specifically, water policies, that is, elements to build a governance model.

It is important to emphasize that the intention is not to present a closed model that is successful and unquestionable, since one can already start with the premise that models that can adapt to all social, political, economic, legal, and environmental contexts are not credible; however, it is possible to extract guidelines from these experiences for the construction of appropriate governance models, with adaptations and possible course corrections, according to geographical, climatic, social, environmental, political, legal, and economic factors. Thus, seven models were chosen, considering Brazil, to produce a relevant and robust comparative

study for reflection and decision-making in the fields of law and of water and environmental management. The criterion used was the relevance of the country regarding the regional context in the face of water resources, with a deductive and hermeneutic approach method, using bibliometric study and document analysis. This article was organized with a view to fulfilling its central objective, which was to discuss the Israeli, Mexican, Spanish, South African, Australian, and North American models, ending with the final considerations.

1 The Israeli model

Israel is always mentioned in the media as the center of a centuries-old dispute with the Palestinians. It is an important commercial and technological center of the East and has very close international relations with North American politics. In addition to this context of conflicts, this region suffers from a shortage of water, characteristic of a territory with low rainfall. Israel has 20,325 km² of territory, with the North being the wettest region. It should also be noted that more than half of the territory is desert and has only 17% of arable land (GILAD; MENAHEM, 2013), and more than half by irrigation. An important point is precisely the control over water resources in the region, besides that the scarcity and distribution of existing water is the cause of the dispute between the communities of the region.

The four main sources of water for Israel are the Sea of Galilee, the Jordan River Basin, the aquifer in the mountains, and the coastal aquifer (BECKER, 2013). Therefore, Israel's water availability is distributed in this way, and its use for the urban water cycle and also for agriculture is the subject of this conflict. Abu-Baker (2017), in turn, points out the existence of a violation of the human right to water of the Palestinians, to the extent that obstacles to access are created.

Israel distributes water using a transposition – an aqueduct that carries water –, which is mainly used for agriculture, industry, and domestic consumption. Becker (2013) justifies why the case of Israel can be considered unique:

- **It unites public and private aspects**: water is consumed by households, farmers, and industry. For the latter, water certainly represents an added value for the productive system. Nonetheless, how can this be reconciled by the free market? This inquiry requires deep reflection and suggests a difficult resolution, which highlights the need for a strategy and a policy that establishes water justice;
- **Water as a social good:** despite the fact that water can be seen as a commodity,

it is also a tool for achieving social goals that cannot be quantified. These goals have no direct value, but serve as constraints. For instance, we have the water diverted to the periphery, to support the living conditions of the settlers; water for farmers, in a minimum amount to support their heritage; and water as a basic good, in which every person has the right to a minimum amount;

- **Problem of the common property resource (CPR):** the main sources of water in Israel can be characterized as CPR. In these resources, there is the problem of quasi-public good. Therefore, the consumption of the good is private (you get what you pumped), but the cost of extraction and the quality of the resource are determined by the action of all users involved. In such a situation, there is a market failure known as the tragedy of the commons. Thus, without a government policy, there would be inefficiency, which can result in higher extraction costs and mortality from increased pollution that is not regulated;
- **Increased return to monopoly scale:** most of the extraction and diversion of water resources, as well as distribution, is associated with large infrastructure facilities. Moreover, an unregulated market can result in many businesses operating at high upfront costs. Natural monopoly is characteristic of water activities; however, without public regulation, a natural monopoly will act as a regular monopoly;
- **Change in demand and supply:** it has been occurring very rapidly in Israel over the past two decades. On the demand side, a large increase in the urban population and standard of living can be observed; a change in preferences is also observed, which results in the growth of the relevance given to water aimed at nature conservation. On the supply side, in turn, a decrease in the level of precipitation is observed annually. Therefore, the difference between demand and supply increases dramatically on both sides. Although in a regular market this is not a cause for concern (from a policy point of view), since the price increase is adjusted, this would not be the case here. The market is regulated, so price does not necessarily reflect scarcity, and as such, policymakers must decide what is best to do;
- **Uncertainty**: water can be thought of as a flow variable, but also as stock. The three main sources of water in Israel are being used as buffers. As such, they can be used to smooth out fluctuations in supply to meet a steady demand as much as possible. However, water stock depletion does not come without a cost. Thus, a good policy should foster some well-defined rules that can associate the extra use of water with the cost;
- **The international dimension:** a significant amount of the water Israel uses

originates from disputed areas. Israel is not an isolated island (paying attention to the water policy that does not take its neighbors into account), and this does not contribute to the overall assessment of efficiency, fairness, and justice. The Hashemite Kingdom of Jordan and the Palestinian Authority are fighting over water in conditions more stressful than Israel. Some of Israel's water resources are shared with these neighboring entities and are expected to improve as peace progresses.

According to Feitelson (2013), Israel's water policy, which includes management, briefly includes four stages: (1) the period of the hydraulic mission; (2) the moment of a more rational management; (2) the stage of reflective decisions; and last, (4) desalination and privatization. Information is fundamental to draw lines of governance, and with Israel it was no different, since the first stage consisted of a vast investment in collecting information about the extractive potential of water, to, from this, have conditions for planning the urban and agricultural water cycles. It is important to say that desalination was not a first option due to its high cost (FEITELSON, 2013).

These steps were followed by an intense discussion about the existing system and about the quality of the water and the possibility of reuse. In the 1980s, successive droughts pressured public debate about water use, particularly its cost in agriculture and government subsidies. With the great drought of 1999-2001, the door to desalination was opened.

The subsequent climate crises, which were part of Israeli daily life, pushed for steps to develop a governance model. Thus, they began to adopt an Advocacy Coalition Framework (ACF), consisting of the union of several arenas of interest groups in water management, direct users, who began to think about a normative framework to face the issue of water governance in the context of scarcity (GILAD; MENAHEM, 2013). However, Gorostiza (2000) points out that water management in Israel was marked by a strong lobby of agricultural producers.

Water governance in Israel is centralized and based on the 1959 Water Law, with water considered a public property and divided into three entities: Tahal, Mekorot, and the Water Commission. Continuous water use planning for the entire country is carried out by the public entity Tahal (Water Planning for Israel, Ltda), assisted by the Water Commission of the Ministry of Agriculture. Based on its guidelines, the executing arm – which carries out effective day-to-day management – is the National Water Company (Mekorot), created in 1937 and currently state-owned. Mekorot works with extraction, plant construction, desalination, transportation and distribution, purification, P&D (Production

and Development) activities, etc. Since 1994, Mekorot has been obliged to self-finance its activities without relying on the public budget. Gorostiza (2000) lists the following pillars of water governance, which he considers positive:

1. The establishment of water use quotas for each sector, that is, for agricultural producers, for industry, and for urban users, with penalties for excessive use, as well as for non-use of the authorized resource;
2. Charging is a fundamental vector, having different values according to the type of use, which does not vary according to the distance of the user to the source or the place of distribution of water. Therefore, it is a system of "solidarity", in which the North is subsidizing the cost of water for the center and, especially, for the south of the desert.

However, it is important to mention the three arenas of Advocacy that exert pressure and affect the decisions of this policy: the hydroagricultural coalition, the coalition of professional economists, and the coalition of the new environmentalists. Since the formation of the country in 1948, the first coalition to be structured to direct and coordinate water policy in Israel was the hydroagricultural one, which ended up being hegemonic due to its economic importance for the entire territory of Israel. Both the Water Council and the Parliamentary Committee for Water, two other key actors in the construction of this policy, had a majority of their members coming from the agrarian environment. Gilad e Menahem (2013) point out that this management design has provided a greater allocation of available water to the agricultural sector, a logical consequence of this whole process.

The overriding values of national security, sovereignty, and land settlement were related to other core beliefs of the hydroagricultural coalition: the need for central government involvement in natural resource development and in large-scale public programs; a centralist approach to planning, development, and management; primacy of the public sphere over the private; and a view of natural resources, including water, as strategic assets in the national and nature struggle as a reservoir of resources to be utilized for human use and economic development (GILAD; MENAHEM, 2013).

During the 1980s, the participation of professional economists linked to the Ministry of Finance and academia started to have prominence in this sector of water management, influenced by the search for economic efficiency. This meant moving forward in the pursuit of efficiency, privatization, and less government intervention. These core beliefs were based on a paradigm of efficient management of the public and private sectors, with the entire national development plan based on a logic of cost and benefit.

They defined the water demand mismanagement, suggesting that excessive

and irrational use are the source of the problem; their policy solution, therefore, was to adopt optimal water allocation based on pricing and cost-benefit analysis rather than investing in projects to improve supply. As the hydroagricultural coalition saw regulation as the main mechanism of taxation, the coalition of economists relied on economic incentives, using prices as the main mechanism of taxation.

The 1990s were marked by the entry of a new "player" in this water management scenario. The environmental sector starts to gain more prominence and influence with an agenda of protecting natural resources and preserving these resources for future generations. In the case of water, the defense of this group was around the conservation of water and its production, without neglecting the reuse of the waters used. Consistent with environmental coalitions in other parts of the world, this one shared some of the policy preferences of the hydroagricultural and economist wings, but its motivation set it apart from the others. However, despite the importance of the object of this coalition, it did not exert so much influence on decision-making.

Furthermore, on the dynamics of water governance in Israel, Ash and Lavee (2013) pointed out the need to insert new instruments, because the use of water, the population, and the demand for food increase, requiring the reuse of water, as well as its insertion in the scope of governance, intertwining three important variables: quantity, quality, and technology. The use of wastewater can have many applications. In the meantime, Ash and Lavee (2013) justified this use on two principles:

1. **For closing the water balance:** treated wastewater can be considered a new water resource and replaces conventional water (drinking water) used for irrigation and other purposes. This can help close a positive water balance in a country where all conventional water resources are exploited to their maximum capacity;
2. **For protecting water resources from pollution:** water resources exploited to their maximum capacity result in small water bodies and short retention times, often accompanied by deterioration in water quality and pollution. The reuse of wastewater improves the quality of conventional water resources.

The reuse of wastewater has become a very important element in water governance in Israel. This finding reflects the fact that the country manages to reuse 75% of its waters, the highest percentage in the world, in which most of this volume is used in agriculture (ASH; LAVEE, 2013). This is an important feature for contemporary water governance, especially with the increasing use by agriculture, in addition to climate change. Nevertheless, despite the amount of reuse, quality

is fundamental in water governance, including for wastewater.

This standard has helped reduce environmental and health impacts from the use of wastewater. However, the treatment plants of these waters in Israel continued to discharge effluents containing various pollutants and high levels of salt, raising several issues that led to the need to introduce stricter standards.

Another dimension to be considered complementary is the desalination process as another alternative to be inserted in the water governance system. The motivation behind seawater desalination in Israel stems from the fact that current demand and projected future demand cannot be met by natural freshwater sources alone, a disparity that results from population growth, overconsumption, misallocation, and pollution (LIPCHIN; SPIRITOS, 2013).

This is being made possible by the development of technology and the increase in the scale of production of this water, which causes the value of the cubic meter of desalinated water to fall from $ 2.50 per cubic meter to $ 0.50. This is a decisive factor for influencing the decision-making process and the elaboration of standards for the industry. Basically, the treatment of such water originates from underground reservoirs (brackish water) and the sea itself. However, another important variable that must also compose the context of governance and decision-making is the energy supply required for desalination, which is high. Most of the energy produced in Israel comes from coal and natural gas, about 90% of the total produced, supplementing with the use of diesel (LIPCHIN; SPIRITOS, 2013). Another promising possibility of energy production for desalination is the solar system. However, the environmental arena has moved towards measuring the impacts of this extraction of seawater for marine ecosystems.

In this centralized water governance model (Israel Water Authority – IWA) in Israel, the partnership with the private sector is present, although its water law states the following: "The water resources of the State are publicly owned, subject to state control and intended for the needs of the inhabitants and the development of the country" (ISRAEL, 1959). This does not prevent the establishment of public-private partnerships, especially in desalination plants (LIPCHIN; SPIRITOS, 2013).

Abbo and Furman (2013) observed, however, that this governance model has been obtaining failures that are still being evaluated and studied, resulting in falling levels of aquifers and their contamination, especially their salinization and nitrate concentration. This is a problem of quantity and quality that may make the use of these sources unfeasible in the future. The authors set the tone for the complexity of the governance of this groundwater, even with the entire apparatus of Israel:

> We have seen also how intensive urbanization over a phreatic aquifer rapidly leads to its pollution. Knowingly and unknowingly, industrial and domestic activities at all levels may and do cause pollution of the aquifer. Aquifer management is not only the appropriate control of pumping operations but also regulating agricultural, domestic, and industrial on-surface activities, monitoring, and remediating existing problems.(ABBO; FURMAN, 2013, p. 135).

Livshitz and Issar (2013) point out another variable that should raise the quality of public water governance to a degree of extreme need, since water stocks are declining and the prospect is of decreased rainfall, and it is likely that water consumption in Israel will be based on desalination and reuse of wastewater. Livshitz and Issar (2013) point out the following scenarios to be taken into account by public water governance:

1. Rising global warming will dominate, and thus lead to regional aridization that may result in a series of droughts.
2. A decrease in the number of sunspots until their complete disappearance, followed by cooling of the globe, causing an abundance of rains and floods in the Middle East.
3. "The wave scenario" as a result of a combination of the previous items. The waves will bring several hot years of severe drought, alternating with a period of cold, rainy years and, accordingly, floods.

One factor that can bring together all the aforementioned points is the development of a basin management methodology, fundamental for any reality of public water governance, no different in Israel (LIVNEY; LASTER, 2013). The solution found for a water basin management was to think and design an integrated management of the resources of this basin. According to Livney and Laster (2013), forward-thinking countries have developed a more comprehensive approach to surface water management, known as Integrated Water Resources Management (IWRM).

The idea behind this approach was to try to develop the full potential of the river. IWRM begins with the premise that, to manage human activities in a basin, one must understand and "control" these activities in favor of a better basin environment. Its objective is to improve the basin from a combined economic, environmental, historical, cultural, social, and legal perspective. Thus, Livney and Laster (2013, p. 229) emphasize that:

> Achieving a balance of all these interests brings all stakeholders to the table, each with its own "dietary" requirements, to hear and be heard. This is a never-ending process and, depending on the size of the basin, an overwhelming one. Everyone and everything is a stakeholder. But that, of course, is what is ingenious about the process; it is grassroots democracy in a world based on far removed democracy. It

> also requires recognition by scientists and policy makers that those living in the basin also understand its workings and have their own vision of its future for themselves and their children.

Therefore, a mapping, including the performance of the actors, their location, and their influence on the basin, is essential for this governance in an integrated perspective. One should bear in mind that the water economy impacts the development of the state of Israel and should serve as a means for achieving national goals, such as peace agreements with neighboring countries, development of agriculture and the periphery, as well as the improvement of the country's settlement and the conservation of the environment and landscape (FEINERMAN; FRENKEL; SHANI, 2013). The latest data shows that 40% of the water consumed in Israel comes from lakes and aquifers, 25% from desalinated water, 25% from treated wastewater, and 10% from other sources (SZKLARZ, 2019).

2 The Mexican model

Another region that needs water scarcity management is Mexico, a very important country in the global and regional context, representing a strategic territory for the region's economy. It is important to point out here that the indigenous pre-hispanic ancestors, the Mayans and Aztecs, had a spiritual connection with water, since they saw it as a transcendental characteristic of the creation of man, supplanting the perception that water would be fundamental for human development (ROJAS, 2019). The Mexican territory is marked by differences in its climatic constitution, being more arid and semi-arid to the north, temperate to the center, and more humid to the south, which is the rainiest region (SALMÓN-CASTELO; ARIAS-ROJO, 2019; SERRANO, 2007).

As for Israel, groundwater is fundamental to Mexican economic development. However, it seems the exploration has been conducted without adequate planning, as has been done in Israel – with the projection of future scenarios –, with drastic decreases in the pumping potential of these aquifers having been presented as results, also reaching the urban consumption of one of the most important metropolises in the world, Mexico City, the country's capital (SALMÓN-CASTELO; ARIAS-ROJO, 2019).

There are 653 aquifers that represent about 20% of the water supply. This exploration began in 1940 and became the basis of local and regional water security. In 1975, there were 32 over-pumped aquifers; in the 1980s, there were 80. Currently, there are 105 water-stressed aquifers lacking water, of which 17 already have saline intrusion and 32 are responsible for soil salinity and/or with low quality regimes (SALMÓN-CASTELO; ARIAS-RED, 2019). In addition, 94% of the rivers have a contamination index (FLORES, 2008).

Flores (2008) already pointed out that this crisis was being caused mainly by exploration, that is, 77% for agricultural use, 9% for industry, and 14% for public supply. The Comisión Nacional del Agua (CONAGUA, 2016) has warned about the substantial decrease in water stocks year by year. To further complicate the panorama for a public water governance, the population is mostly located in the North and Center regions, representing a substantial part of the national economy, with 31% of water availability and 77% of the national population. In 2007, the World Bank warned of the high vulnerability of Mexico in the process of climate change.

Mexican governance, based on legal rules, is not so recent, since it dates back to 1926, with the Irrigation Law and the Water Law, of 1929, which were the first related to the water issue (MORAES; LICEA, 2013). The Mexican Constitution states that all surface waters are the property of the nation (art. 27). The Mexican Water Law (MÉXICO, 1992) regulates Article 27 of the Constitution, presenting the concept of environmental flow, which is a very important legal-environmental element for the definition of governance and planning of water basins. Articles 4[2], 27[3], and 115[4] of the Mexican Constitution are fundamental to establish the water policy of the country.

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2 Everyone has the right to access, dispose of, and sanitize water for personal and domestic consumption in a sufficient, healthy, acceptable, and affordable manner. The State will guarantee this right and the law will define the bases, supports, and modalities for the equitable and sustainable access and use of water resources, establishing the participation of the Federation, the Federative Entities, and the municipalities, as well as of citizens, to achieve these purposes (free translation).

3 The waters of the territorial sea to the extent and on the terms set out by International Law are the property of the Nation; coastal waters of the interior; the lakes and rivers that communicate permanently or intermittently with the sea; the lakes in the interior of natural formation that are directly connected to constant currents; the rivers and their tributaries, whether direct or indirect, from the point of the channel where the first permanent, intermittent, or heavy waters begin, to the mouth on the ocean, lakes, ponds, or estuaries of national property; the constant or intermittent currents and their direct or indirect tributaries, when their channel, in its entirety or in part, serves as border to the national territory or to two federative entities, or when it passes from federative entity to another or crosses the lines of division of the Republic; the lakes, ponds, lagoons, or estuaries in which the vessels, areas, or edges are crossed by the border lines of two or more entities, or between a Republic and a neighboring country, or when on the edge of banks serves as the border of the two federative entities/the Republic with a neighboring country; the springs on the beaches, sea areas, channels, boats or along the margins of lakes, ponds, lakes, or rivers of national property, and those extracted from the mines; and the channels, beds, or banks of lakes and inland streams to the extent required by law. Groundwater can be freely extracted by artificial works and appropriated by the owner, but when required by the public interest, the Federal Executive can regulate its extraction and use and, also, establish closed areas, as in other waters of national property. Any other waters not included in the above enumeration should be considered an integral part of the ownership of the lands through which they flow or where their deposits are located, but if they are located on two or more properties, the use of these waters will be considered of public utility and will be subject to the provisions dictated by the states (free translation).

4 III Municipalities shall be responsible for the following public functions and services: Drinking water, drainage, sewage, treatment, and disposal of their waste water; […] (free translation).

However, it is considered that, from the point of view of an environmental governance closely integrated with a water governance, Mexican legislation has added the concepts of "environmental use" or "use for ecological conservation" in its water policy by the general water law, reformed in 1992, which established, in Article 3, LIV, that "the minimum volume or volume required in the receiving bodies, including currents of various types or reservoirs, or the minimum natural discharge rate of an aquifer, which must be conserved to protect environmental conditions and the ecological balance of the system (free translation)"[5] (MÉXICO, 1992). Expressly, ecological protection is part of the water governance in Mexican territory, establishing a minimum quota for the maintenance of life of the various species that depend on water. This will inevitably have to be in the planning of the basins.

The model of public water governance in Mexico is also based on the centralization of the organization of the system composed of 12 hydrographic regions and a decentralization of water regulation and its multiple uses to basin committees, which are the basic collegiate agencies in the public water governance system (MORAES; LICEA, 2013). The centralization of the system is represented by the National Water Council (CONAGUA). Moreover, the water basin ends up being a natural territorial unit that exceeds the geographical limit of many municipalities and states (FLORES, 2008).

In this sense, the Constitution established the priority of water management and programmatic actions for the implementation of governance and delegated to the infra-constitutional legislator the responsibility for drafting a general law of water that establishes the governance system and the assignments of its components. The basis of this governance is the participation of stakeholders, the users, and it is important to remember that, for a governance to be successful, it initially needs to be fair and balance the potential of the parties (LÓPEZ, 2016). One must know that water can be a natural resource, with its biochemical and ecosystem maintenance value, as well as a political resource. Thus, López (2016, p. 37-38) points out that:

> Water as a natural resource has a series of biophysical and service roles for natural and anthropogenic activities. It is in the case of the manipulation of behaviors, actions, and activities that we see that certain actors seek to control access to the supply, distribution, and consumption of the vital liquid, to exert a control effect on some social groups. For instance, many authors have documented fights for control

5 El caudal o volumen mínimo necesario en cuerpos receptores, incluyendo corrientes de diversa índole o embalses, o el caudal mínimo de descarga natural de un acuífero, que debe conservarse para proteger las condiciones ambientales y el equilibrio ecológico del sistema.

> of the distribution of water resources in agricultural contexts. In the case of food production activities, it is essential that farmers have access to an adequate volume of water in sufficient quantity and optimal quality for the production of fruits, vegetables, fodder, and animals. Therefore, this requires a robust regulatory framework that ensures access to the vital liquid by precisely laying down rules and regulations on how water should be distributed in the heterogeneous areas throughout the territory of Mexico (free translation)[6].

The governance model will depend a lot on the balance of factors and in what way water is recognized by the decision maker and the other stakeholders, public and private. In the meantime, there is a process of conflict of interest, added to a multiplicity of uses of water and its essentiality for human and economic development, which helps to transform interest groups into arenas, with great potential for conflict. Thus, the following paradigms of water governance in Mexico can be pointed out (LÓPEZ, 2016; FLORES, 2008; MORAES; LICEA, 2013; PACHECO-VEGA, 2014; JACOBI *et al.*, 2014; SOARES, 2007):

- it has a centralized control model for organizing the system itself;
- it has a participatory basis in the water basins with its committees;
- two issues that cause conflict: water being a common resource and scarcity;
- there are two views that can be found, a technical one that claims that technology is the way out of water governance problems, and a sociotechnical one, which considers technology, but prioritizes the inclusion of people, especially the most vulnerable users;
- the diffuse communities, people living in the countryside and indigenous people still have access problems;
- it is necessary to adapt the current model to another that considers in its actions: the use of rainwater, the reuse of water, and that allows several solutions;
- the model seeks to manage demand;
- the search for physical and institutional integration;
- decentralization often remained only on paper and did not occur in a multilevel manner;

6 El agua como recurso natural tiene una serie de funciones biofísicas y de servicio para las actividades tanto naturales como antropogénicas. Es en el caso de la manipulación de comportamientos, acciones y actividades donde vemos que determinados actores buscan controlar el acceso al suministro, distribución y consumo del vital líquido para con ello poder tener un efecto de control sobre algunos grupos sociales. Por ejemplo, muchos autores han documentado las batallas por el control de la distribución del recurso hídrico en contextos agrícolas. En el caso de las actividades productivas de alimentos, para los agricultores es fundamental tener acceso a un volumen adecuado de agua, en cantidad suficiente, y de óptima calidad para la producción vegetal tanto de frutas, verduras, forraje, como animal. Por ende resulta prioritario que exista un marco regulatorio robusto que garantice el acceso al vital líquido, precisamente estableciendo reglas y normas sobre cómo debe de distribuirse el agua en zonas tan heterogéneas como las que se tienen a lo largo del territorio en México.

- the State has fundamental importance in governance, but does not always exercise it;
- the Mexican experience shows the need to implement what is in the norm, because otherwise the decentralization of governance will not have an effect.

Pacheco-Vega (2014) points out the need for strong institutions to adopt efficient water governance. Perhaps this was the problem of Mexico, whose model did not achieve good results. Mexico has a serious problem to face in the coming years: drought and low rainfall in the north, the region that most concentrates the population in the country, about 77% of its people (FLORES, 2008). This leads to a panorama of low water stocks, especially in Mexico City, which depends in particular on groundwater, whose exploitation has caused a phenomenon of lowering the city's ground level. The urban perimeter suffers from a rearrangement of the soil due to the withdrawal of water from the subsoil and the geomorphological constitution of clay soil, since the city was built on a lake surface and the basin is heavily damaged by urbanization and extraction of water resources. This same process is taking place in Tehran.

Soares (2007) also pointed out the following needs for public water governance in Mexico: operational viability; legitimacy and accountability; transparency in technical and financial processes; financial sustainability; independent regulatory system.

Soares (2007) assesses that the governance model suffers pressures for changes as the concept of water as a common good changes to a resource that has economic value. In addition, the general water law of Mexico, of 1992, introduced relevant expressions for water governance such as the meaning for public management, in item XXVIII of Article 3:

> Process based on the set of principles, policies, acts, resources, instruments, formal and non-formal norms, goods, resources, rights, powers, and responsibilities, through which, in coordination with the State, water users, and society organizations, promote and implement to achieve sustainable development for the benefit of human beings and their social, economic, and environmental realms, (1) the control and management of waters and water basins, including aquifers, hence their distribution and administration, (2) the regulation of the exploitation, use, or reuse of water, and (3) the preservation and sustainability of water resources in quantity and quality, considering the risks in case of extraordinary hydrometeorological phenomena and damage to vital ecosystems and the environment. Water management comprises the entire governmental administration of water; […] (MÉXICO, 1992, free translation)[7].

7 Proceso sustentado en el conjunto de principios, políticas, actos, recursos, instrumentos, normas

Another expression inserted in this important water law was "integrated water resources management", defined as follows in item XXIX of the same article cited:

> A process that promotes the coordinated management and development of water, land, and environment-related resources, to maximize social and economic well-being in an equitable manner without compromising the sustainability of vital ecosystems. This management is closely linked to sustainable development. For the application of this law regarding this concept, water and forest are mainly considered; […] (free translation)[8].

It seems that the legislator was mistaken in the use of the expressions "public management" and "integration", when not reinforcing the regulation for an effective application of this model. However, it is interesting to note that the term governance goes beyond public management, which passes the understanding that centrality is in the government, when, in the case of water, this management is multicentric, and should involve all stakeholders, who should participate directly and indirectly in governance (RENDÓN; BUSTILLOS, 2019). Mexican law has contributed to greater centralization when, in fact, it should be the other way around. Thus, Rendón and Bustillos (2019, p. 191) state:

> Evidently, any management act can be contained in a broader context of "gestión del agua" and vice versa, but it is important to differentiate acts that belong exclusively to water authorities of those located in a broader context of participation of other actors and sectors with respect to water management. It is in this broader context that it makes sense to differentiate both concepts toward a more efficient implementation of water public policy.

The studies by Rendón and Bustillos (2019, p. 208) forward the following proposals for implementing water governance in Mexico, based on a feasible and financeable model, since the law establishes the structure, but in practice the

formales y no formales, bienes, recursos, derechos, atribuciones y responsabilidades, mediante el cual coordinadamente el Estado, los usuarios del agua y las organizaciones de la sociedad, promueven e instrumentan para lograr el desarrollo sustentable en beneficio de los seres humanos y su medio social, económico y ambiental, (1) el control y manejo del agua y las cuencas hidrológicas, incluyendo los acuíferos, por ende su distribución y administración, (2) la regulación de la explotación, uso o aprovechamiento del agua, y (3) la preservación y sustentabilidad de los recursos hídricos en cantidad y calidad, considerando los riesgos ante la ocurrencia de fenómenos hidrometeorológicos extraordinarios y daños a ecosistemas vitales y al medio ambiente. La gestión del agua comprende en su totalidad a la administración gubernamental del agua; […].

8 Proceso que promueve la gestión y desarrollo coordinado del agua, la tierra, los recursos relacionados con éstos y el ambiente, con el fin de maximizar el bienestar social y económico equitativamente sin comprometer la sustentabilidad de los ecosistemas vitales. Dicha gestión está íntimamente vinculada con el desarrollo sustentable. Para la aplicación de esta Ley en relación con este concepto se consideran primordialmente agua y bosque; […].

services and participation do not work:

- Update the methodology for calculating government fees, considering environmental costs;
- Establish water basin tariffs considering the availability and economic value provided by water for the production of goods and services;
- Start charging government fees for water use in the agricultural sector that currently pays nothing;
- Provide support and incentives to increase macro and micro measurement coverage;
- Improve the capabilities of water authorities for inspection, control, and collection of government fees, which may include signing agreements for the exclusion of certain acts at the state and/or municipal levels of government;
- Develop strategies and methodologies to increase profitability in government fee collection;
- Consolidate a culture of paying government fees and of the economic and environmental value of water;
- Allocate government fees derived from water and its resources for the specific works and actions in the corresponding river basin, by a specific fund to be built in each hydrological region;
- Support an incentive technology transfer to more efficient, clean, and water-saving technologies by deducting other taxes, e.g., income tax; Allocate at least 1% of the total tax or fee collection on water for research and development of the water sector.

3 The Spanish model

Spain was chosen for the fact that it also suffers from the water crisis in a good part of its territory, with a desertification process that affects 70% of its area. There is an irregularity of rainfall, very low in the center, northeast, and southeast of the country. The rains end up being scarce also in the southwest and west of the territory, with the north being the most favorable portion for rains. The driest areas of Spain occupy the equivalent of 2.6% of the country's territory, being Almería, Alicante, and Murcia, with rainfall reaching levels of less than 300 mm.

A large part of Spain is involved in a considerable process of desertification (RUÍZ-PUGA *et al.*, 2013; VALDERRAMA; MARTÍNEZ; IBÁNEZ, 2012). Not differently, Spain is also a country whose greatest use of water is in agriculture and which has an increasing productivity and water infrastructure with an economic focus (GARRIDO *et al.*, 2010).

In this context of scarcity, care should be redoubled with the public water governance model. Thus, Spain followed some guidelines approved in international documents, among them the European Water Charter of 1968, which highlighted the importance of the water basin as a territorial unit for water planning that

would be beyond the established political and administrative limits; and the Dublin Declaration of 1992 (CASAFONT, 2010).

The Charter of Zaragoza, of 2008, was also important for the Spanish context, since it established as a condition for an integrated management to consider the water basin as the most efficient territorial basic unit for managing water and improving the solution of possible conflicts (ESPANHA, 2008). The "water footprint"[9] in the Spanish regions has increased substantially over time (GARRIDO *et al.*, 2010).

There is a fundamental directive to be considered in water governance in this country, the Water Framework Directive 2000/60/CE (COMUNIDADE EUROPÉIA, 2000). This document is essential to understand the bases of water governance in Spain. Item 13 of this directive also confirms the water basin as the water planning and management unit. However, beyond this founding device, it is imperative to emphasize that the European Community is governed by the understanding that water is not an economic good like any other, as it is written in item 1 of this directive: "El agua no es un bien comercial como los demás, sino un patrimonio que hay que proteger, defender y tratar como tal"[10]. All governance actions in Spain took place from this understanding of the nature of water.

It is known, until now, that there are some factors that influence water governance, such as: scarcity, exploitation, climate, economic model, among others. In this direction, participation is another pressure factor that is positive, such as the performance of water defense associations, or even water users, who act directly in governance (IZQUIERDO, 2016).

Spain's 17 autonomous communities have regional governments with great political, economic, and administrative powers. The regional governments have powers in matters of land use planning, environment, agriculture, forests, and other natural areas and are involved, directly and indirectly, in the management of water resources. For the management of water resources, Spain has been divided into 15 water basins or water-planning districts, defined in Water Law of 1985 (Spain, 1985) as "the territory along which waters flow to the sea in a network of secondary watercourses that converge into a main and single riverbed" (Title II, Article 14 of the Water Law of 1985) (ORTEGA; MORA, 2010).

In Spain, the confederations of basins are the basic collegiate agencies that

9 The water footprint of an individual or community is defined as the total volume of freshwater that is used to produce the goods and services consumed by the individual or community.

10 Water is not a commercial good like others, but an inheritance that must be protected, defended, and treated as such.

allow users to take part in monitoring and implementing the water policy; they have an administrative character, which makes them participate in public administration (artículo 22, 1, Ley del Agua), applying the same rules established for other state agencies, and their circumscription should reach the scope of the water basin (ESPANHA, 1985). These confederations have wide power of action in the Spanish autonomous communities, being able to establish pacts and other agreements. In addition to these, there are two government agencies that take part in management, Government Boards and Exploration Boards, which are government agencies that assist in the decision-making and planning process of basin confederations.

There is also the Board of Users and the Distribution Commission, which takes care of the regime of reservoirs, aquifers, and basins, monitoring and respecting the rights of concessionaires, in addition to the Board of Works, a collegiate agency that receives and analyzes the request for new works, and each confederation has a water council of the basin. In addition, it is important to say that the confederation will only exist if the basin crosses more than one autonomous community. In the case of intercommunal basins, the Council of Competent Authorities will work with the assignment of supervision over the others. Nevertheless, the National Water Council (CNA) is at the top of the "pyramid" of Spanish water governance (art. 19, Ley del Agua). Furthermore, we highlight that the Spanish governance adopts the following principles:

1. Management Unit, comprehensive treatment, water saving, decentralization, coordination, efficiency, and user participation.
2. Respect for the unity of the water basin, hydraulic systems, and hydrological cycle.
3. Compatibility of public water management with land management, conservation and protection of the environment, and nature restoration.

Spanish law was careful to make a principled connection with the environment, leaving this interconnection explicit. Along with this, there is the principle of unity of the water basin with the hydraulic systems and the hydrological cycle, which is the origin of this whole process, being essential to the conservation of the elements that participate in this cycle, including in this dynamic the urban cycle by infrastructure. Therefore, water governance is complex and multilevel (IZQUIERDO, 2016).

It is important to emphasize the significant modeling and projection efforts that are underway. However, the impact of climate change on the future availability of water resources is still uncertain (ORTEGA; MORA, 2010). Future water

demand will also be affected by demographic and socioeconomic changes. The trend is to increase consumption, however, there is a need for greater investment in new technologies and regulation (standards and institutions) to improve the urban water cycle.

4 The South African model

The African continent is here included by South Africa. This country has two moments in world history: before and after the *apartheid*. In this political transition, it was necessary to carry out diagnostics and review policies, notably the environmental and water policy (RAMASAR; NASTAR, 2012). As there was a selectivity in the distribution of essential services between black and white people, with water it was the same. Therefore, regulatory frameworks had to be changed. Thus, a new water law was edited and enacted in 1998, revoking all acts that would undermine equality in the distribution of water (ÁFRICA DO SUL, 1998). Thus, Ramasar and Nastar (2012, p. 8) highlight what was the reforming spirit of water policy in that post-apartheid era:

> The significant change brought about by the new legislation was the recognition that water is a scarce and unevenly distributed resource, belonging to all people and no discriminatory law should be established to prevent water access and that sustainability should be the aim in distribution through which all users could derive benefits.

Unlike the other systems analyzed so far, South Africa had to change the entire legal system of the *apartheid*. The entire water governance of the African country was based on a centralized and authoritarian model, based on the right to land, that is, those who had land along water sources, such as rivers, would have greater access to water, resulting in an imbalance of access to water between white farmers and black farmers (FUNKE *et al.*, 2008; RAMASAR; NASTAR, 2012; OLAGUNJU *et al.*, 2019). The water was mainly used for development and agriculture projects. Until 1994, the existing paradigm was the separation between the social system and the ecological system, which changed only with the revision of the post-*apartheid* legislation. It is important to highlight that the model adopted by the legislation was that of command and control, evolving towards the insertion of the principle of sustainability in the legislation, applicable to the use and access to water (FUNKE *et al.,* 2008).

Water governance in South Africa can be divided into three phases. The first was the change of legislation and the inclusion of fundamental rights in the

country's Constitution. The second was to organize the State so as to have the institutional infrastructure necessary for the minimum functioning of water governance. The third phase, in turn, was the acceleration of structural changes; this was marked by the implementation of the principle of decentralization of water governance. In addition, it instituted the principle of reserve, that is, establishing a minimum quota for human consumption and maintenance of ecosystems.

The relocation of water would also be a major issue to be solved, since most of the population did not have access to water and sanitation (FUNKE *et al.*, 2008). Olagunju *et al.* (2019), in a recently published research, point out that the African continent has undergone changes in water governance, based on the capacity of those involved, the coordination of essential factors for the entire process, and the compliance, that is, improving the system of standards, of sanctions for those who are not conforming, thus improving monitoring and being ruthless with corruption.

In addition, the complexity of African culture makes governance more difficult. Moreover, it still suffers from the pressure of uncontrolled urbanization, lack of data, lack of institutional adaptation, and precarious dialogue. Herrfahrdt-Pahle (2010) points out that one of the great difficulties for the implementation of an integrated governance was to implement the administrative and legal logic of the water basin, which is a major barrier. The author also points out the following bottlenecks in water governance in South Africa:

> 1. Incompatibility on the spatial and jurisdictional scale (hydrological *versus* administrative boundaries). The new legislation produced two water governance structures at the water basin level. The result is coherent legislation at the national level, but the division of powers is transferred from the national level to the water basin and local levels;
> 2. Incompatibility on the time scale. The design of the WMAs (Water Management Areas) was carried out without being possible to establish in a timely manner the CMAs (Catchment Management Agencies), as the management organizations (leading to a functional mismatch);
> 3. Rationalities necessarily different from the CMSs (Catchment Management Strategies) (sustainability and water availability) and the WSDPs (Water Service Development Plans) and the need for these documents to interact and develop closely (HERRFAHRDT-PAHLE, 2010, p. 123).

The problems of water management were highlighted concretely with the serious water crisis of the main South African city, Cape Town, which was not only caused by the drought period, but by the precariousness of governance. Ziervogel and Enqvist (2019) point out the problem of Cape Town as being structural,

that is, a dizzying growth of the metropolis, which generated pressure on scarce resources. Actually, *Cape Town* emerged from 25 municipalities existing before the *apartheid*, supplied by dams built around 1800. In 2000, the metropolitan area of Cape Town was practically dry (ZIERVOGEL; ENQVIST, 2019).

The most important region of Africa in terms of population had a major problem based on lack of infrastructure, high demand, and technical unpreparedness to solve the issue. Water use in South Africa is regulated by the National Water Act and the Water Services Act (ÁFRICA DO SUL, 1997; 1998). The first determines how water from a particular source can be accessed and used, while the second focuses on what services should be provided to citizens and by which authority (ZIERVOGEL; ENQVIST, 2019).

The main authority, DWS (Department of Water and Sanitation), is responsible for policy development, implementation, regulation, monitoring, enforcement, and administration. The country's water sources are managed at the water basin level; in addition, water is allocated to the municipality as needed by a permit or grant system.

In the imminence of major disasters with the process of climate change, heavy rains, floods, and droughts, the Disaster Management Act was edited in 2002, which sought to implement an integrated system in water governance and management. The attempt was to adopt existing best practices from international documents (ÁFRICA DO SUL, 2002). However, a bottleneck of water governance in South Africa is precisely the participation of society.

In this regard, the population participates at the municipal level by user associations, but there are no basin committees. There are three spheres of water governance in South Africa: National, Water Basin, and Municipal. In the water basin and municipal spheres, society is included, with the existence of the regional water and sanitation forums and the basin management forums.

The most recent drought has put this governance system to the test in three phases, moving from a less critical to a more critical degree. These actions had in rationing their main instrument of governance, since the six dams of this metropolitan region came to have about 13.5% of their total volume of 900 million cubic meters of water. And, if it reached 10%, it would no longer be safe to extract the water, passing it on to other reservoirs, notably underground (ZIERVOGEL; ENQVIST, 2019).

This crisis served to show the fragility of water governance and that the greatest suffering was left to the most vulnerable groups of the population, especially

those of indigenous origin, with little or no access to water. Ziervogel and Enqvist (2019, p. 12-13) point out the lessons that can improve governance in situations like these of South Africa:

> 1. governance needs to consider the development of water sources specifically and the city in general. New sources of supply, as well as the regular provision of services, need financing. Water governance would benefit from a systemic approach with attention to the entire water cycle, including sustainable urban drainage, wastewater treatment and reuse, and diversified sources to accommodate seasonal and year-on-year fluctuations in precipitation;
> 2. water governance requires coordination across sectors and scales. Cape Town's floods and droughts illustrate links to, for example, housing, ecosystem management, agriculture and tourism, and with important functions being performed from the national scale up to the domestic level;
> 3. water governance needs to be inclusive. The city's strained relationship with many communities, damaged by the lack of trust generated by unfair policies of the past and fueled by the failure to fix them in the present, is arguably the most critical area for improvement. This requires more proactive, coordinated, and transparent communication, which Cape Town has improved during crisis management. The lesson is that water governance is not limited to keeping taps running, but also to daily meeting sanitation needs and security against seasonal flooding. In the future, policymakers, academics, and professionals need to build knowledge and skills about how governance processes can be designed to foster public trust and collaboration, recognizing context-specific challenges faced by residents.

5 The Australian model

Australia is another interesting case to understand the assumptions of public water governance, mainly because it is the driest inhabited country on the planet, which is permeated by great climatic instabilities, marked by droughts and heavy rains. The Constitution of the Australian Federation holds the State and territorial government responsible for land and water, but water is owned by the crown and its management is the responsibility of the government (HART; DOOLAN, 2017).

Australia is a highly urbanized society, with approximately 90% of its 24.2 million inhabitants living in cities and towns and about 60% living in cities with more than 1 million inhabitants. Between 2014 and 2015, rainfall was 10% lower than the national average, about 16,700 GL[11]. Of it, 75% were used for irrigation, 19% for urban use, and 6% for mining and power generation (HART; DOOLAN, 2017).

The model of water governance in Australia between 1901 and 1970 was based on the construction of infrastructures for water storage to supply the cities that were being born and structured, as well as sustain the mining activity at the

11 1 gigaliter is equivalent to 1000,000,000 liters.

time, with a total water storage of around 240 GL at the beginning of the century, rising to 7,200 GL, then, in 2005, to 84,800 GL (HART; DOOLAN, 2017). Mackay (2007) pointed out that the indicators for good governance are as follows: consensus-oriented, accountable, transparent, responsive, effective and efficient, equitable and inclusive participation, and following the rule of law. According to him, until 1994, the public power had hegemony in the water sector; from then on, the sector opened up to private capital, and the government focused its efforts on two roles: one regulatory and the other of assessment and containment of environmental impacts.

Governance arrangements for water in Australia are complex, with more than 14 different types of legal forms of water improvement business. The governance structure is composed as follows:

1. Regional Council of Local Government;
2. County Council;
3. Municipal or city council;
4. Local public companies;
5. Local governments;
6. Statutory agencies;
7. Corporate companies;
8. Irrigant groups (MACKAY, 2007, p.151-152).

In addition to this structure, there are also other hybrid organizations, which have mixed characteristics. Smith *et al.* (2016) point out that this governance structure is driven and forged under intense crises of lack of water and drought, which forced the Australian government to treat the issue of water as a priority public agenda, under the cloak of a neoliberal policy of opening the water and sanitation sector to the private initiative, as already pointed out. Smith *et al.* (2016, p. 4) highlight the following pillars for the Australian governance reform:

1. prepare transparent and statutory water plans with provision for environmental outcomes and other public benefits;
2. complete the return of all currently allocated or overutilized systems to environmentally sustainable extraction levels;
3. introduce registers of rights and norms of access to water for water accounting;
4. expand the water trade;
5. manage surface and groundwater resources and connected systems as a single resource;
6. improve prices for water storage and delivery;
7. meet and manage urban water demands.

Between 2007, 2009, and 2011, there was a process of reforms on the legal documents that made up water governance. This was accelerated, mainly because

water means an *input* for economic development, especially for agriculture (FITZPATRICK, 2017). The very term "water market" was very explicit in this process of water governance reform in Australia. The following excerpt, extracted from Fitzpatrick (2017, p. 56), denotes well this marketing language for water:

> Irrigation communities recognized that the introduction of water markets in the irrigation districts would move water from low-value uses to high-value uses, often in different locations. Furthermore, they recognized that the value of their entitlements would increase, placing further pressure on low-value uses. Trading rules were introduced in response to these concerns, to slow the rate that water could be traded out of districts to manage the adjustment process in local communities. These rules were sufficient to sustain local support for the market. The market proved particularly effective in managing the effects of drought.

In addition to the use of water in agriculture, the cities, especially metropolises, needed more water and sanitation. A service that was once carried out exclusively by the State began to be regulated according to market rules in the 21st century. White and Chong (2017) address the incitement of a competitive market as the basis for the new "look" of water governance in Australia. This begins with the separation between the system regulator and operator, or water and sanitation services of cities and a system of independent regulation that had as one of the tasks the establishment of the price of water. However, the regulatory power varied from state to state, since the country is a federation. The great drought of 1997 to 2009 put water governance to the test, leading cities to a high level of water stress, that is, little water, high demand, and an extended time of drought. The main strategy was rationing.

The central bottleneck of this Australian context was the investment of high figures to access technology for other systems that could complement those arising from the rain that happened in a scarce way, such as desalination. It was necessary to act on several fronts – investment, technology, and economy – so that the demand did not suck up all the existing stock and to give time to replenish water. The drought has boosted innovative initiatives, mainly around water reuse in urban centers, improving the urban water cycle (WHITE; CHONG, 2017). Since then, Australia has been basing its governance on two important variables for a climate change context: resilience and habitability. Therefore, the principle would be to carry out a governance that prioritizes the reuse of resources, the circular economy of water, the reuse and creation of structures to resist the most severe climate changes, giving conditions of permanence in habitable environments.

For this, the idea of a circular water economy based on reuse and, therefore,

reinsertion of water into the system, is essential, either by recharging the aquifers or the system directly, always depending on the quality of the water, which strongly helps in the preservation and maintenance of water storage. However, the goal of resilience is not easy to achieve, as White and Chong attest (2017, p. 91):

> Building resilience into the water system requires a multifaceted, multiscalar and multistakeholder approach. Urban water systems have the potential to play a pivotal role in increasing resilience, but strengthened coordination and partnerships are needed within the water industry, as well as between the water sector and other sectors, including other utility sectors (energy, waste, transport), planning agencies and local government.

Australia took care to realize that the environmental dimension is indispensable for water governance, that is, ecosystems need water for survival and the crises have shown how weakened they were without water; rivers with high mortality of species, the proliferation of algae that compete for fish oxygen, among others.

As guidance, Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) and the Australian and New Zealand Environment and Conservation Council (ANZECC) have developed a set of national principles to provide policy guidance on how to manage water for ecosystems, with the stated aim of providing water for the environment and, in addition, when necessary, restoring ecological processes and the biodiversity of water-dependent ecosystems.

Environmental allocations have been defined as descriptions of the water regimes needed to support the ecological values of low-risk water-dependent ecosystems (BUNN, 2017). This principle has been incorporated into the water laws of the Australian states. Bunn (2017, p. 100) listed the principles that were adopted by the Australian states, which, in fact, recognized the character of nature as a user of water and with priority:

1. River regulation and/or consumptive use should be recognized as potentially impacting on ecological values;
2. Provision of water for ecosystems should be on the basis of the best scientific information available on the water regimes necessary to sustain the ecological values of water dependent ecosystems;
3. Environmental water provisions should be legally recognized;
4. In systems where there are existing users, provision of water for ecosystems should go as far as possible to meet the water regime necessary to sustain the ecological values of aquatic ecosystems while recognizing the existing rights of other water users;
5. Where environmental water requirements cannot be met due to existing uses, action (including reallocation) should be taken to meet environmental needs;

6. Further allocation of water for any use should only be on the basis that natural ecological processes and biodiversity are sustained (i.e., ecological values are sustained);
7. Accountabilities in all aspects of management of environmental water provisions should be transparent and clearly defined;
8. Environmental water provisions should be responsive to monitoring and improvements in understanding of environmental water requirements;
9. All water uses should be managed in a manner which recognizes ecological values;
10. Appropriate demand management and water-pricing strategies should be used to assist in sustaining ecological values of water resources;
11. Strategic and applied research to improve understanding of environmental water requirements is essential;
12. All relevant environmental, social and economic stakeholders will be involved in water-allocation planning and decision making on environmental water provisions (free translation).

This has deepened and become a practice of protecting environmental or ecological flows in rivers in response to the decline of these conditions, of ecological functions, caused mainly by human interference in the natural regime of watercourses (HORNE; WEBB; STEWARDSON, 2017). It is an integrated process in the stages of planning, implementation, monitoring, and evaluation, considering the technical and social elements. For this reason, it is important that the basin plan is a document structured by the participation of all stakeholders, users, indigenous people, public authorities, private sector, among others (AUTY; TAN, 2017).

6 The North American Water governance model

The United States of America is the largest economic power in the world and the largest country in the Americas, being an important user of water, whether in agriculture, industry, or domestic use. Its geography is very diverse: to the south there is an arid zone on the border with Mexico; to the north, a humid border with Canada; as well as the existence of a region that suffers greatly from water shortages in the west. A variable that should be taken into account at the outset is the North American administrative model based on a federation in which the states have high levels of autonomy, which has a direct impact on water governance, since, in addition to an environmental good, it is a good that has a strategic role in the administration of a country. It is important to consider that more than half of the North American population is a groundwater user (HUANG *et al.*, 2015).

Brown (2010) already pointed out that the management of water resources in North America is permeated by environmental considerations that have emerged since the 1940s, specifically in the face of the use of surface water bodies. Numerous federal, state, and local management structures have been developed to address these concerns. A useful context for applied environmental analysis is the watershed, defined by the United States Environmental Protection Agency as a geographic region within which water, sediment, and dissolved materials drain to a common outlet – a point in a larger stream, a lake, underlying aquifer, or ocean (USEPA, 1996).

In addition, the same document by USEPA mentions that the watershed is a coordinating structure for environmental management, which concentrates the efforts of the public and private sector to solve the problems of highest priority in the geographical areas defined hydrologically, considering the flow of groundwater and surface water (USEPA, 1996).

It is important to clarify that, despite the autonomy of the states, the federal government is also responsible for water governance, notably regarding development projects for larger bodies of water and navigable flow management, leaving local and smaller-scope governance to the states (BROWN, 2010).

It is important to note that the Federal Water Pollution Control Act (USA, 2002) established a major responsibility to the central government in conducting and executing a policy for preserving water sources as a good of the nation, including encouraging the participation of the population, under the supervision of the administrators of the federal government and the state(s) involved.

However, respect for the principle of federative autonomy is preserved as established in item b of Section 101 of this standard:

> It is the policy of the Congress to recognize, preserve, and protect the primary responsibilities and rights of States to prevent, reduce, and eliminate pollution, to plan the development and use (including restoration, preservation, and enhancement) of land and water resources, and to consult with the Administrator in the exercise of his authority under this Act.

However, Berggren (2018), in his research, paid attention to two principles that needed to be in North American water governance: equity and sustainability. As for the first, for a long time, it was considered by the US public administrations and courts of justice as based on the right of property. However, the concept has evolved into the notion of access that seeks equality between users according to their needs and not under the exclusivist mantle of property rights. For him, there are five principles that should be present in the North American governance

model, which can be extended to others (BERGGREN, 2018, p. 25-26):

1. Water is treated as a common good that serves multiple values and when it is not reduced to mere property or an economic commodity that serves utilitarian purposes;
2. When it is mindful of the needs of nonhumans, including plants, animals, places, and habitats, as well as of the inheritance of humans in future generations not yet born. It is on the right path when each new generation is socialized into making equity judgments and when spaces exist to reconsider or reimagine the practice of water equity over time;
3. When decision-making processes are open to broad participation of all affected parties, including through such mechanisms as networks, voluntary associations, and public/private partnerships, and when procedural fairness is as important as making fairer water allocation and distribution choices;
4. When there exists not only shared allocation of rights and benefits but also sharing of the risks and burdens associated with population growth, climate change, and emergent technologies;
5. When imbalances in political and economic power are being redressed rather than simply reproduced in water policy.

In the case of sustainability, it would be linked to an integrated water management, based essentially on four principles: (1) water is a finite and extremely vulnerable resource, essential for sustaining life, development, and the environment; (2) the development of water management should be based on the participation of various stakeholders; (3) women play a fundamental role in this process; and (4) water has economic value and, therefore, should be recognized as an economic good. However, despite these principles, water management and governance in the United States is driven by economic development.

Another point that can be highlighted in North American water governance is the understanding of the hydrological cycle that generates water stocks on the planet. This cycle is nothing more than the process of evaporation of water, formation of clouds, rain, formation of glaciers, processes that occur in a repeating movement, feeding the planet with water. Therefore, these are connected rather than separate waters, under the cloak of the principle of unity of the watershed. In this basin, all waters take part, whether surface or underground.

According to Megdal *et al.* (2015), North American water governance has not implemented these fundamental principles, which essentially consider the unified, systemic, and, therefore, interconnected character of water, and the main problem currently resides in groundwater management. Groundwater governance in the United States is fragmented: multiple government agencies at different levels may have authority over groundwater. Furthermore, there are a number of state and local government agencies responsible for allocating groundwater quantity and for

maintaining groundwater quality. In some states, separate agencies are responsible for different aspects of groundwater, and quality can be subdivided into human consumption and environmental use (MEGDAL *et al.*, 2015; MEGDAL, 2018).

Unlike surface water, regarding groundwater, the states have considerable autonomy for their management, although half of the North American states have not yet instituted their laws to regulate these water sources, which is bad mainly for the control of diffuse pollution arising, notably, from intensive agriculture. The high extraction of groundwater in the United States transforms in the governance model the main point to be achieved by water management, fundamentally by the pressure on these resources that has increased by the agriculture of the states, and the stabilization of the levels of these reservoirs are essential so that there is the maintenance of the productivity rhythm (GRAFTON *et al.,* 2019).

Water governance generally involves the following actors: federal, state, tribal, or local governments; private companies and other businesses; and individuals and non-profit, non-governmental organizations that constitute civil society. Thus, North American governance becomes complex by the high level of autonomy of the states, such as the management of the Colorado River Basin. The allocation of water in this basin is regulated by more than 100 laws, court decisions, operational instructions, and technical rules known as "River Laws" (GRAFTON *et al.,* 2019).

The periods of drought in the Colorado River taught the region to improve the governance model. These extremes of climate will inevitably end up putting pressure on the rearrangement of governance, the establishment of new parameters, although the ideal is preventive action. The North Americans are also thinking about an international cooperation strategy for water supply and sanitation, aiming to have water in quality and quantity. For this, the involvement of several government agencies is fundamental, such as diplomacy; agencies related to resource mobilization; science, technology, and innovation agencies; those related to sustainability services and infrastructure; and others of technical assistance (USA, 2017).

Faced with this systemic and fragmented web of water governance in the United States, the state of California stands out for its population and economic importance and for its context of increasing water scarcity, with governance mechanisms for an increasingly rational use of water becoming very relevant. The center of water governance in California is precisely the need for a more rational water allocation in pursuit of sustainability (VIERS; GRANTHAM, 2014). The combination used in this process is price, quantity, and form of allocation, to

reduce losses and seek efficiency and competitiveness for the system.

Therefore, this state has, since 1914, a water governance system, having created a central agency for regulating water governance, the Water Commission, which is currently the State Water Resources Control Board. The administrators of this agency have the task of analyzing applications for water use rights for their subsequent authorization or not. The assumption of this system is to allocate fairly, by authorizations, the amount that is going to be used. According to Viers and Grantham (2014), the authorization of water use will depend on its availability, the satisfaction of rational uses, and preservation of the environment; a widely used tool for water management and allocation for those who request the exercise of their right over water is the Geographic Information System (GIS) (VIERS*;* GRANTHAM, 2014).

Based on this system, the largest volumes allocated concern corporations and individual use, and this monitoring is fundamental for governance. A very interesting example is also the groundwater governance model, which should not be carried out separately, but together with surface water, since they are part of the same water cycle. Thus, in California, which is in a context of water scarcity and therefore depends on several other sources of water, notably groundwater, some actions are adopted, such as: monitoring, allocation, recharge, withdrawals, mitigation of negative impacts, adaptation, engagement of actors, leadership, and compliance with rules (LANGRIDGE*;* ANSELL, 2018).

Stakeholders are grouped into agencies that will carry out the existing water governance according to the principles already reported. Pannu (2012) pointed out as a great weakness of water governance in California the absence of the right to vote, by the population, directly interested, in their representatives in water agencies. What usually occurs are indications by government agencies, both federal and state. This fragmented, complex model without the participation of society, of ordinary citizens, has allowed very high nitrate contaminations to pass through the waters of certain districts, whether superficial or underground, making it very difficult to recover these contaminated springs (PANNU, 2012).

However, in California and much of the United States, there are remnants of the riparian law, that is, water ownership belongs to the one closest to the water source, as well as the oldest and newest owners who exploited it first, based on the principle of "first to exploit, first to have the right" (SIVAS *et al.*, 2017). In addition to these basic notions of water dominance, California still has a type of water market in which a holder of the right to use water can negotiate it by contract with another entity.

Nevertheless, California, faced with water scarcity crises, has invested in the private management model and in water markets, although quite questionable, diversifying its sources of extraction (SIVAS *et al.*, 2017). This implied investment in water infrastructure and the search for alternatives, such as desalination, although it is still the most expensive, mainly due to the high investment in industrial plants and the high level of energy used to carry out the entire process. In addition, it affects marine life, either in the process of seawater suction or throwing back wastewater.

Final remarks

The comparative study developed here presented the complexity of the governance models of countries that are regional and international reference in water crises and seek solutions in the normative and management field. The models point to the need to implement an adaptive governance, which incorporates local issues connected with a planetary agenda for the sustainability of water systems. At the same time, we highlight the need for a planetary pact around fair water governance with a focus on water quality to maintain health and environmental quality. Another issue that was evident in the models presented and analyzed is a fundamental pillar in this governance process: ecological resilience, which does not dispense with planning that incorporates climate variables.

However, it is fundamental to remember that water resource systems, that is, everything that is dependent on for the supply of water to the environment and that is interconnected, this includes cities as well, is permeated by three characteristics: complexity, conflict, and uncertainty. Complexity calls attention to the need for developing capacities that are increasingly adaptable to the contexts of short, medium, and long-term scenarios. The recognition of the existence of conflict imposes the need not only for a look, but also for cooperative actions, that should be implemented in a coordinated manner, with broad and clear communication. And the uncertainty that marks the current times must be mitigated by a risk management constituted by exhaustive monitoring; by the network relationship of the actors interested in the management of water resources; and a broad connection with sectors of science, technology, and innovation, especially universities, thus forming an ecosystem ready to anticipate problems and equate solutions. These are elements that must be included in an adaptive management.

Bringing the founding forms of governance models, one can see that, even with some disparities, it is possible to point out necessary standards, such as the

participation of civil society and the existence of clear and efficient legal devices to support the necessary arrangements for water management. This, in no way, dispenses with a strong institutionality capable of responding to the new challenges of a postmodernity characterized by a process of advancing climate change that requires increasingly resilient water systems. Therefore, the path to environmental law and public management is to draw guidelines that focus on the quantity and quality of water and its distribution, which is a challenge in the face of geographical factors that prevent access to all, as well as the slowness of governments in responding to overcome these natural obstacles with environmental responsibility.

As it turned out, water scarcity is a systemic event that can become present throughout the planet and that is already affecting thousands of people and ecosystems. Therefore, because it is a global problem, it requires community solutions that go beyond the physical limits of the countries, since there are several water basins that are shared between two or more nations. For this to occur, international and national legal instruments are fundamental to preserve nature and optimize water use in production processes in industries and agriculture. One of these solutions that Spain and Israel already widely use is the installation of wastewater systems, by the implementation of a circular economy logic that makes the most of water and can return it with the necessary quality standards.

With the intensification of climatic events, such as rains and droughts, one must reorder priorities, one of them being how to reuse already available water resources, as well as expand the supply of water, in the face of the growing demand for productive activities and to promote the universalization of access, which is another gigantic issue that has not been solved in any way, given that goal 6 of the Sustainable Development Goals (SDGs), which defends the universalization of access to water and sanitation, will not be met. Thus, there is no easy solution; however, we need a cooperation that translates into a governance capable of producing better management of water resources and, therefore, an efficient distribution for all.

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