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IGNORANCE OR INTEREST: WHY STATES DON'T REGULATE TRANSBOUNDARY AQUIFERS?

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ABSTRACT

Why states do not regulate transboundary aquifers? In addressing the international politics of groundwater regulation, this thesis is concerned with the factors that exert influence on transboundary aquifer's regulation; the processes by which interstate agreements on shared aquifers (if any) are negotiated and the final result, that is, the kind of rules and regimes established and implemented for aquifer's management (how strict is it). The objective is to explore the local, regional or international political forces that facilitate or hinder the coordination of policies between states, and to analyze the strengths and weaknesses of various institutional mechanisms by which states have sought to cooperate in managing and preserving groundwater resources. Considering whether transboundary aquifers will be regulated, and how strict their regulation will be as the outcome to be explained, I will focus on the impact of scientific knowledge about the aquifer, the presence of status quo stakeholders, and domestic political actors in favor of regulating transboundary aquifers.

This Ph.D. thesis introduces this topic from a theoretical framework based on international relations´ approach, and also incorporates International Law and Geological approaches in order to understand why (or why not) states regulate this strategic transboundary resource. The research strategy is based on the study of three cases: the Genevese Aquifer, where transnational regulation between France and the Switzerland has been possible; ii) the Guaraní Aquifer, where transnational regulation between Argentina, Brazil, Paraguay and Uruguay has recently entered into force, after more than ten years since the states signed it, but where states have made no progress since they signed the agreement; iii) the Ollagüe-Pastos Grandes and Ascotán Aquifers, shared between Chile and Bolivia, which have not been regulated.

Using process tracing methodology to analyze the selected cases, it was observed that two of the causal factors are necessary and important to achieve the result: the knowledge about transboundary aquifers and the interest of domestic political actors in regulating shared groundwater resources. If they are absent, there will be no regulation. The presence of *statu quo* stakeholders impacts the outcome, especially when national political actors show no interest in regulating these resources, or these interests are fluctuating and not constant. Finally, the incidence of conflict as a contributing factor is evident in the case of the aquifers shared between Chile and Bolivia.

RESUMEN

¿Por qué los estados no regulan los acuíferos transfronterizos? Al abordar la política internacional de regulación de las aguas subterráneas, esta tesis se ocupa de los factores que ejercen influencia en la regulación de los acuíferos transfronterizos; los procesos mediante los cuales se negocian los acuerdos interestatales sobre acuíferos compartidos (si los hay) y el resultado final, es decir, el tipo de reglas y regímenes establecidos e implementados para la gestión del acuífero (cuán estricto es). El objetivo es explorar las fuerzas políticas locales, regionales o internacionales que facilitan o dificultan la coordinación de políticas entre estados, y analizar las fortalezas y debilidades de diversos mecanismos institucionales establecidos para cooperar en la gestión y conservación de las aguas subterráneas compartidas. Considerando la regulación de los acuíferos transfronterizos -y cuán estricta será- como resultado a explicar, el análisis se centra en tres factores causales aquí considerados como fundamentales: el impacto del conocimiento científico sobre el acuífero, la presencia de actores económicos a favor del *status quo,* y de actores políticos nacionales a favor de la regulación de esos acuíferos transfronterizos.

La presente tesis doctoral introduce este tema desde la perspectiva de las relaciones internacionales, incorporando conocimientos y enfoques provenientes del Derecho Internacional y la Hidrogeología para comprender por qué (o por qué no) los Estados regulan este recurso estratégico transfronterizo. La estrategia de investigación se basa en el estudio de tres casos: el Acuífero de Ginebra, un caso exitoso de regulación transnacional entre Francia y Suiza; ii) el Acuífero Guaraní, donde recientemente entró en vigor el acuerdo entre Argentina, Brasil, Paraguay y Uruguay -luego de más de diez años desde su firma-, pero los estados aún no han realizado avances en esa materia; iii) los acuíferos Ollagüe-Pastos Grandes y Ascotán, compartidos entre Chile y Bolivia, que no han sido regulados.

Utilizando la metodología de *process tracing* para analizar los casos seleccionados, se observa que dos de los factores causales son fundamentales y necesarios para lograr el resultado: el conocimiento desarrollado sobre los acuíferos transfronterizos, y el interés de los actores políticos nacionales en regular las aguas subterráneas compartidos. Si están ausentes, no habrá regulación. La presencia de los actores económicos partidarios de mantener el *statu quo* impacta en el resultado, especialmente cuando los actores políticos nacionales no muestran interés en regular estos recursos, o estos intereses son fluctuantes e inconstantes. Finalmente, la incidencia del conflicto como factor coadyuvante es evidente en el caso de los acuíferos compartidos entre Chile y Bolivia.

INTRODUCTION

We all need freshwater. It is essential for life but is a very scarce resource. Lots of it is underground and transboundary. But while a surface watercourse that crosses two or more states is regulated, transboundary underground aquifers are not. Why is that? Understanding this question is increasingly important. There is a scarcity of knowledge and governance over groundwater resources, and this is more problematic if we consider that groundwater could be at the center of disputes as a critical strategic resource (and a human right), for public water supply, irrigation, industrial use and environmental flows to wetlands. This thesis provides an answer.

My central theoretical puzzle is whether different political, economic or geographical factors condition the disposition to regulate transboundary aquifers. What kind of subnational, national and international actors and interests exert pressure for or against the establishment of such regulations?

In addressing the international politics of groundwater regulation, this work is concerned with the factors that exert influence on transboundary aquifer's regulation; the processes by which interstate agreements on shared aquifers (if any) are negotiated and the final result, that is, the kind of rules and regimes established and implemented for aquifer's management (how strict is it). The objective is not to provide detailed scientific treatment of the nature and characteristics of transnational aquifers, but rather to explore the local, regional or international political forces that facilitate or hinder the coordination of policies between states, to analyze the strengths and weaknesses of various institutional mechanisms by which states have sought to cooperate in managing and preserving groundwater resources.

Considering whether transboundary aquifers will be regulated, and how strict their regulation will be as the outcome to be explained, I will focus on the impact of scientific knowledge about the aquifer, the presence of *status quo* stakeholders, and domestic political actors in favor of regulating transboundary aquifers. Achieving

sustainable groundwater management demands that local groundwater users, enterprises (national or international), international organizations, technical specialists, and policymakers work together. Each has a role to play, whether at local, national, or international levels, in driving the tools and actions needed to manage transboundary aquifers. In order to devise an agreement that has enough support to be implemented all these actors could exchange compromises and logrolling in the political arena. Each of these layers of negotiation will mold the regulation that eventually results. They could advance formal and rigorous agreements to manage and regulate transboundary aquifers, or they could design more general cooperative regimes or instruments aimed mainly at an initial exchange of scientific data (lax regulation). This research outlines that the interaction between *status quo* stakeholders and domestic political actors is precisely the causal mechanism that will influence the outcome: regulation lax/rigorous or no regulation.

The general hypothesis of this thesis is that a rigorous regulation is the expected outcome when states sharing an international aquifer have enough knowledge about its location and hydrogeological characteristics, there are domestic political actors favorable to regulate aquifer's management, and *status quo* stakeholders with power to influence policy making (and whose interests are against regulation) are absent.

Therefore, this Ph.D. thesis introduces this topic from a theoretical framework based on international relations´ approach that draws particular attention to power relations, political and economic factors, macro and micro level actors and networks. In addition to International Relations perspectives -especially Institutional Choice Theory and Security Studies-, International Law and Geological approaches are incorporated in order to understand why (or why not) states regulate this strategic transboundary resource.

To explore my hypothesis empirically, my research strategy will be based on the study of three cases: i) the Genevese Aquifer, where transnational regulation between France and the Switzerland has been possible; ii) the Guaraní Aquifer, where transnational regulation between Argentina, Brazil, Paraguay and Uruguay has recently

entered into force, after more than ten years since the states signed it, but where states have made no progress since they signed the agreement; iii) the Ollagüe-Pastos Grandes and Ascotán Aquifers, shared between Chile and Bolivia, which have not been regulated.

I will examine these cases using process tracing methodology. This selected method lets me take an analytical and descriptive route in order to answer the research questions, determine the causal(s) mechanism(s) involved in these cases, test the hypotheses, and examine the proposed explanation. My final objective using this methodology is to contribute to the development of a theory that could be tested in other contexts or regions, or considering a higher number of cases and observations.

The main reason for using case studies for this research is their ability to explore complex causal mechanisms, which are not as easily captured with many other methods. By "helping to bring mechanisms back in" (Checkel, 2005), the insights offered by case study research can advance beyond co-variations and correlation of independently observed variables. Case study research favors a methodology and epistemology of process tracing. With case study method it would be possible to address the complexity of the processes and dynamics that characterize groundwater regulation. Additionally, because of the novelty of the topic, there is a scarcity of literature and data. There is still not accurate and complete information about the total population of transboundary aquifers, which makes a quantitative study impossible. We are only at the theory development stage.

My research has tried to be as exhaustive as possible by looking at both domestic and international drivers behind the regulation's process of transboundary aquifers. Using process tracing to research and analyze case studies, I can search for continuity, changes, similarities and differences between those cases. Principally, I explore whether the same causal mechanism operates in the three cases. Process tracing fits very well to this research because it is particularly well-equipped to identify causal paths in conditions of complex causality.

Cases were selected as a result of preliminary examinations of the research subject. Because transboundary aquifers that have an effective regulation (in terms of its actual implementation) are just six, and the remaining 586 transboundary aquifers identified by the International Groundwater Resources Assessment Centre (IGRAC, 2015) do not have any international regulation at all, the decision was taken considering a successful and positive case –the Genevese Aquifer- and two cases in the South American region where regulation has been partially successful or unsuccessful.

Why aquifers?

Water available to humans and all species that inhabit ecosystems (biodiversity) is minimal. More than 97.5 % of the Earth's total water is salty (mostly in the oceans), and only the remaining 2.5% is freshwater. Of this small percentage of freshwater, 68.7% is frozen at the poles or in glaciers, and 30.1% is groundwater: only 1.2% of freshwater is on the surface of the Earth and immediately available for human consumption. In other words, freshwater from rivers and lakes is only 0.007% of the total water of the planet. Freshwater that is not frozen and flowing over the surface is accumulated mainly by precipitation of rain, snow or thaw in drainage basins or watersheds, where water drains down a river or a network of channels (creating endorheic or exoreic basins) or infiltrates and stores underground in aquifers (Shiklomanov, 1993).

Rapid population growth and industrial and agricultural development have increased the demands on groundwater resources around the world. From North Africa to Northern Europe, to Asia, to North and South America, cities have become critically dependent on groundwater and its use for irrigation is also increasing. Often, the result has been excessive and uncontrolled pumping of aquifers with the consequent

deterioration in water quality or, even more severe, depletion of the resource[1]. Therefore, it is crucial to establish measures for constant monitoring of water tables' levels, and/or contemplate artificial groundwater´s recharge measures, if available.

Along with overexploitation, the risk of contamination is another threat to these resources. Lack of knowledge and technology and bad practices affect the quality and sustainability of surface and groundwater. While groundwater is generally better protected against contamination than surface water, it is more vulnerable because contaminants linger much longer once they enter. The most common contamination problems are usually linked to saline intrusion, the entry of polluting substances such as arsenic and fluoride. These substances are usually present in very low concentrations in groundwater, but their mobilization can also be initiated or acerbated by anthropogenic activities such as metal mining, groundwater abstraction and the use of pesticides (Margat & van der Gun, 2013).

In general, pollution of groundwater -and surface water- is principally enhanced by man-made changes in their chemical composition or other characteristics (physical or biotic). The "fracking" -or unconventional hydrocarbons' extraction by hydraulic fracturing- is another source of groundwater pollution. Some unconventional hydrocarbons as the shale gas are trapped into the rocks and its extraction requires large volumes of water, sand and chemical substances. This practice has become a new way of supplying energy sources in numerous countries but has significant environmental repercussions such as excessive use of water, emission of pollutants into the atmosphere, and contamination of groundwater by the injection of toxic products, among others.

Transboundary aquifers

[1] Overexploitation of the aquifer occurs when the groundwater's extraction levels exceed its recharge capacity. It primarily threatens to fossil or non-rechargeable aquifers. They usually contain a large volume of water but they are non-renewable, so their uncontrolled extraction would cause the resource's depletion.

Aquifers are challenging to manage, susceptible to overexploitation and contamination, and require a broad stage of exploration and research before their groundwaters are accessible. A notable difficulty in studying aquifers is the significant paucity of data on everything related to them. And this complexity seems to be greater when it comes to resources shared by two or more states. In the world there are many large aquifers shared by several countries. For example, the Northeast African aquifer extends below Libya, Egypt, Chad and Sudan; a vital South American aquifer extends below Argentina, Brazil, Paraguay and Uruguay; in the Arabian Peninsula, there are aquifers shared by Saudi Arabia, Bahrain and perhaps Qatar and the United Arab Emirates and Jordan.

Several reasons can explain the scarce knowledge of transboundary aquifer's characteristics: the lack of joint monitoring systems; limited data sharing between neighboring countries and a low degree of political interest in generating and sharing information about groundwater's characteristics; its mode of extraction and preservation, and so forth. Some countries do not even have enough information or knowledge about their groundwater resources. This includes both, those that are exclusively domestic and those shared with other states. Besides, the international community has only recently turned its attention to the question of regulation and the appropriate international institutions for the management of the resource.

This recently expanding interest in transboundary aquifers is mostly a reflection of the growing importance that groundwater resources have in a general context of climate change and water shortage. As states intensify the extraction of this shared resource, they are raising questions related to their rights and obligations over transboundary groundwaters (G. E. Eckstein, 2011).

Current Waters Regulation

To the extent that International Law has paid attention to the regulation of transboundary waters, it has been focused on surface waters. Specifically, in the mid-eighteenth century, International Water Law started to address the use of international waterways as navigational routes for transport and trade. The Final Act of the Congress of Vienna, 1815, enshrined the principle of freedom of navigation by international rivers in favor of all states, whether coastal or not. Subsequently, this regime was embodied in specific treaties between the states bordering the same international watercourse.

Later, regional treaties and conventions were embodied to regulate transnational freshwater courses during the twentieth and twenty-first centuries. The last agreement reached in this issue is the United Nations Convention on the Law of the non-navigational uses of international watercourses, signed in May 1997, after years of discussion and study by the International Law Commission, which entered into force in 2014. Therefore, there are significant agreements which regulate international surface watercourses like rivers or lakes, but only a few of them have some provisions over groundwater linked to these watercourses. It was only in the last two decades that the debate around transboundary groundwater management and legal instruments for their governance has gained force in the international arena.

Despite their relative invisibility –especially in the international legal and political framework-, transboundary aquifer systems can be found all around the world, even in arid and semi-arid zones. The International Groundwater Resources Assessment Centre (IGRAC) has identified 592 transboundary aquifers (IGRAC & UNESCO-IHP, 2015). However, only one percent of these transboundary aquifers have some kind of international regulatory framework or agreement.

According to sovereignty principle, each nation administers, manages and governs the natural resources located within its territory. But not all nations have developed an instrument to regulate groundwater and aquifers allocated in their territories. Also, there are numerous gaps in national regulations concerning groundwater that allowed their use and exploitation with little or no control. Even the definition of water lacks clarity which has made it possible to use this resource as a

market good, with the capacity to be extracted and commercialized (Chile is an example). The scenario is worse when we look at groundwater resources with transboundary consequences[2]. Only six initiatives evolved to specific international agreements, but not all of them were ratified or implemented (Sindico & Manganelli, 2016; P. C. Villar, 2016a). Those experiences are:

i. The Convention on the Protection, Utilization, Recharge and Monitoring of the Franco-Swiss Genevese Aquifer signed between France (the Community of the Annemassienne Region, the Community of the Genevois Rural Districts, and the Rural District of Viry) and Switzerland (the Republic and Canton of Geneva), in 2007.

ii. The Bamako Declaration of the Ministers in Charge of Water Resources of the Countries Sharing the Iullemeden Aquifer System (IAS), signed by Mali, Niger and Nigeria, in 2009, which has not entered into force and was replaced by a subsequent agreement in 2014 the Memorandum for the establishment of a Consultation Mechanism for the Integrated Management of the Water Resources of the Iullemeden, Taoudeni/Tanezrouft Aquifer Systems (ITAS) (Algeria, Benin, Burkina Faso, Mali, Mauritania, Niger, Nigeria). To-date, the 2014 agreement is awaiting the endorsement of a few of the seven States Parties (Eckstein, 2017).

iii. The Agreement on the Guarani Aquifer signed in 2010, which has recently entered into force (on November 26, 2020), because Brazil and Paraguay have delayed its ratification.

[2] When waters of an aquifer and its discharge and recharge areas are entirely within a state´s territory, the legal regulation of these groundwaters' exploitation corresponds, in principle, to territorial state's jurisdiction. However, the hydrological cycle of some groundwater occurs in the territory of one or more than one country (not only the place where these waters are housed –the aquifer-, but its recharge and discharge areas). The transboundary consequences of the use of these waters make them a more complex resource to regulate.

iv. Two declarations signed by Algeria, Libya and Tunisia for the Establishment of a Consultation Mechanism for the Northwestern Sahara Aquifer System (2002) and the Permanent Consultation Mechanism for the North-Western Sahara Aquifer System (2006), which started its operations in July 2008.

v. The Regional Strategic Action Program for the Nubian Aquifer System signed in 2013, by Chad, Egypt, Libya & Sudan (Stephan 2013). This Aquifer and the North-Western Sahara Aquifer are not multilateral treaties, but a set of declarations that establish consultation and monitoring mechanisms; expressions of good will and few formal commitments.

vi. By the 2015 Al-Sag/Al-Disi Aquifer agreement, Jordan and Saudi Arabia have agreed to place a five-year moratorium on all extractions of groundwater from a restricted "Protected Area", and to regulate well-drilling and the injection of pollutants in a permitted "Management Area". The Parties also agreed on the dedication of extracted groundwater from the Management Area to domestic use, to the exclusion of all other uses. A Joint Technical Committee of country representatives oversees the implementation of the agreement (Eckstein 2015). Reportedly, however, the Committee has never met to-date.

Then, there are few legal and institutional tools designed to manage groundwater resources, and those that do exist are generally at the sub-national level or the aquifer scale. As was indicated in above, some initiatives evolved to specific interstate agreements but not all of them were ratified or implemented, and there is only one transboundary formal agreement that establishes a system for allocating transboundary groundwater resources.

In addition to these agreements, there are some bilateral or regional rules or agreement about fresh watercourses that have included just a section or a mention regarding groundwaters. For example, the European Water Charter (1967); the treaties

concluded by Poland with Czechoslovakia (1958), the Soviet Union (1964) and the Democratic Republic of Germany (1965) use the concept of frontier waters, which includes surface and groundwater; the Water Framework Directive (WFD) of the European Union (2000). Nevertheless, these frameworks have not been developed congruently and do not always contain compatible principles and norms. This situation leaves much room for improvement in terms of the development of groundwater governance frameworks and the legal institutions that may underpin them.

On the other hand, the legal characterization of groundwater or aquifers as shared resources is recent and controversial. Groundwater only became the object of international law in the nineties and, even then, with limitations pointed out by many authors (G. Eckstein & Eckstein, 2003; McCaffrey, 2011; McIntyre, 2011a; Mello Sant'Anna & Villar, 2015; P. C. Villar, 2016a). Traditionally, waters that transit from one state territory to another or extend over the territories of several states are considered shared resources (Barberis, 1985, p. 23). There is no legal definition yet of this concept which is used to classify those resources of national jurisdiction whose use and protection are conditioned by certain norms of international law.

Despite attempts to incorporate the groundwater issue into different international treaties, international groundwater legislation and the regulation of natural resources remain a weak and underdeveloped body of law. Some reasons would be: the deficit or lack of knowledge about the existence of several aquifers and their characteristics; the lack of will among the states to establish research teams and monitoring of these aquifers; the absence of compulsory dispute settlement mechanisms that hamper effective monitoring and implementation of environmental standards; and the sovereignty principle over natural resources.

Regarding this last argument, although states enjoy sovereignty over the water resources located in their territory, water presents certain complexities that make the definition of sovereignty over it difficult, as it is a fluid, mutable and indivisible resource. Transboundary aquifers present challenges to states that fear losing control over the natural resources located in their territory. They fear that transboundary aquifers

will be recognized as shared natural resources and no aquifer state can claim permanent sovereignty over them.

Nevertheless, regulation and effective control and inspection of groundwater resources would be required for preventing and mitigating threats to groundwater resources. The United Nations International Law Commission (ILC) has worked on establishing Draft Articles on the Law of Transboundary Aquifers in 2008. Later, the United Nations General Assembly adopted a resolution looking on these articles and encouraging member states to consider them in making arrangements for their transboundary aquifers. However, shared groundwater resources -because they include national territories and associated concerns over sovereignty and security-, are likely to be controversial and states are reluctant to adopt these recommendations.

More recently, Resolution A/RES/70/1, 'Transforming Our World: The 2030 Agenda for Sustainable Development' made an important contribution to the use and sustainable management of national and transboundary waters. It was adopted by the United Nations General Assembly on 25 September 2015 and included a set of 17 Sustainable Development Goals (SDGs), to replace the eight Millennium Development Goals. One of the SDG is a water-and-sanitation goal (SDG 6): "ensuring availability and sustainable management of water and sanitation for all" (UNSTATS, 2020). Faced with the current global context of water scarcity -which affects more than 40 percent of people-, increased drought and desertification, SDG 6 constitutes a framework for action that determines the specific objectives in which states must be focused to achieve the objective of the human right to water and sanitation in a universal and sustainable way[3].

Even more noteworthy, target 6.5 (within SDG 6) is specifically dedicated to "implementing integrated water resources management at all levels, including through transboundary cooperation as appropriate". This target 6.5 is measured through two

[3] SDG 6 implies the fulfillment of eight targets (indicators). Some of these targets present a will clearly social, as they are related to water poverty and advocate for safe access to population to drinking water, hygiene and sanitation systems (targets 6.1 and 6.2). Others have an environmental orientation, by focusing on reducing water pollution (target 6.3), or protection of water-related ecosystems (target 6.6). Finally, certain goals have a dual economic-environmental character, and aim at achieving efficient and sustainable use of water (target 6.4), or the implementation of integrated water resources management systems (target 6.5).

indicators: Indicator 6.5.1 “the degree of implementation integrated water resources management (0–100)”, and Indicator 6.5.2 the “proportion of transboundary basin area with an operational arrangement for water cooperation”. By using agreements as a measure of transboundary cooperation, and recognizing the role that legal instruments play in the preservation and management of transboundary water resources, indicator 6.5.2 emphasizes the importance of international watercourses Law (de Chaisemartin, 2020). Finally, Target 6.6 specifically incorporates the concept of aquifer’s protection: “protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes”.

In sum, although incipient and not without question, the international community is making progress, at least, in putting the issue of groundwater resources on the table. Certainly, to achieve a comprehensive regime could be difficult but, with current regulations and agreements, is it possible to think about specific regulations for each transboundary aquifer? Which are the main rival interests about regulating these groundwater resources?

The argument of this thesis

A substantial body of research has been conducted on transboundary water, transboundary water law, and the mitigation of transboundary water conflict. From an international law perspective, Julio Barberis (1985) first, and Gabriel Eckstein[4] (2003; 2005, 2011) later, made a considerable contribution in international law for transboundary groundwater resources. Eckstein’s work has focused on aquifers classification, according to some models he has developed –rebuilt from Barberis’ models-, and he made a comprehensive study of the state of international law as it applies to transboundary groundwater resources and aquifers. He is a lawyer and has a

[4] Professor of Law in the Texas A&M University, and Director of the Energy, Environmental, and Natural Resource Systems Law Program Professor of Law in the Texas A&M University, and Director of the Energy, Environmental, and Natural Resource Systems Law Program

juridical approach about the recent developments and the emerging international law for transboundary aquifers as reflected in the practice of states and the work of the UN International Law Commission, UN Economic Commission for Europe, and International Law Association. This literature is useful to explore the advances made in legal matters at the international level regarding the regulation of transboundary watercourses in general and transboundary aquifers in particular. However, this literature does not provide the reasons why significant progress has not yet been made in the regulation of aquifers, specifically, why some states are reluctant to advance in this matter, which actors are at stake, and which interests are involved domestically and internationally.

In general, this literature tends to support arguments regarding the protection of states' sovereignty to justify its actions (or inaction) in the matter of regulating natural resources, such as groundwater. This thesis proposes to start from this general analysis about the legal advances in International Law of transboundary aquifers to examine certain specific cases and explore which are the main motivations and actors involved behind the decisions that states make regarding aquifers' regulation.

In the area of geosciences and security studies, there are many empirical studies conducted by Oregon State University, the College of Earth, Ocean, and Atmospheric Sciences and its Program in Water Conflict Management and Transformation, directed by Aaron Wolff. They analyze, principally, issues of water management from a perspective of conflict management. Their main finding is that the incidence of acute conflict over international water resources is overwhelmed by the rate of cooperation. They conclude that violence over water is neither rational, hydrographically effective, nor economically viable (Aaron Wolf, Kramer, Carius, & Dabelko, 2005, pp. 84–85). Another key finding in their research is that international water disputes have been resolved, even among historical enemies, and even as conflicts over other issues unfold (Petersen-Perlman, Veilleux, & Wolf, 2017; A. T. Wolf, 2007a; Aaron Wolf et al., 2005).

From these theoretical frameworks advanced in the area of aquifers, many case studies have been developed related to specific aquifers in certain geographical areas, generally characterized by conflicting issues such as political or borderline conflicts, areas with limited resources, etc. (Alfie Cohen, 1992; Brandt, n.d.; Cobbing, Hobbs, Meyer, & Davies, 2008; Davies et al., 2013; Gomo & Vermeulen, 2017; Mace, Sheng, & Fahy, 2001; Nava & Sandoval-Solis, 2015; Rivera, 2015; Sánchez-Munguía, 2011; Sanchez & Eckstein, 2017; Szucs, Virag, Zakanyi, Kompar, & Szanto, 2013; Waters, 2019; Zaharia, 2011). However, most of this work has focused primarily on surface water supplies from an international security approach linked to the issues of cooperation and conflict, water scarcity and climate change. My concern over the possibility of regulating transboundary aquifers goes beyond the perspective of international security.

Deficiencies in the management and maintenance of shared groundwater, therefore, affect the lives, health and dignity of individuals, do not allow for combating poverty and inequity, and limit development opportunities for communities and states, thus threatening the entire environment. The purpose of this thesis is to offer a broader approach, which allows realizing the importance of these resources for the functioning of the ecosystem as a whole.

Many geological and juridical studies analyze different aspects of groundwater issues (characteristics, composition, recharge possibilities, management, and so forth). One of the contributions of this work is to provide insights from a theoretical framework based on international relations´ discipline that draws particular attention to power relations, political and economic factors, macro and micro level actors and networks: the presence of international organizations, multinational companies, the epistemic communities, relations between policymakers, etc.

International Relations literature on international cooperation, debate over the tragedy of the commons, and institutional choice theories give us some tools to analyze the collective action problem regarding the management of common-pool goods like groundwater and transboundary aquifers, and the possibility to establish a common

regulation between actors sharing those resources. These theories propose different solutions to overcome the free-riding problem. In general, they consider that institutions (rules that coordinate social behavior) are fundamental. The establishment of common property regimes and the social institutions and rules could be internalized and increase cooperation possibilities. Incentives to participate in common pool resources' management will depend on the characteristics of the society, its size, the rules and institutions established to regulate, for example, the use, consume, production and distribution of those goods, among others. According to public choice, public participation will be more likely in small-group contexts, where participants know each other; there are ongoing social ties and a desire to maintain good relations. In these contexts, the increased possibility of monitoring and punishing free-riding behavior can encourage higher degrees of participation (Fischel, 1987; Ostrom, 1990; Rydin & Pennington, 2000; Weale, 1992). Moreover, theories focused on institutional design emphasize the relevance of design provision to guarantee states' compliance with cooperation agreements.

However, their proposals fail to explain the possible reasons for the central question of this thesis. In cases where there is not enough knowledge about aquifers, where political unities are bigger and/or present many geographical complexities, where local or regional actors do not know each other and cannot establish common rules of resource's appropriation, or there are very different and competing interests involved, it's necessary to explore other factors that can influence decisions about regulation of groundwater use and management.

Additionally, institutional choice theory does not consider endogenous forces or domestic political actors and domestic bargaining process that could exert influence on states' behavior (Allen, 2018). But when we study issues as complex as common-pool resources' regulation, it is important to take into account those actors that could be pressuring or influencing state decisions and actions. And this is the contribution that this thesis intends to make to this developing theoretical debate.

Thereby, from the analysis of different factors that influence the possibility of regulating transboundary aquifers, and focusing on specific cases, I explore the local, regional or international political forces that work to hinder the negotiation and implementation of rational policies between states, to analyze the strengths and weaknesses of various institutional mechanisms by which states have sought to cooperate in managing and to preserve groundwater resources, and to assess their relevance for the future. My argument is that there is a higher likelihood of transnational aquifers' regulation if there is sufficient knowledge of the aquifer's characteristics and location, domestic political actors favorable to regulate, and *status quo* stakeholders are absent or do not influence the decision-making process. The variance or disposition of that regulation (lax or rigorous) will depend on the presence of *status quo* stakeholders with enough economic power acting against regulation and/or the high/low interests of domestic political actors in regulating.

Organization of the thesis

This thesis is organized in five chapters, in addition to the introduction and conclusion. Chapter 1 explores the existent literature in this issue and lays out the theoretical framework and methodology applied in this work. Here are identified case studies that will be analyzed in depth in chapters 3 to 5.

Chapter 2 defines the principal concepts used in this thesis: water, hydrologic cycle, groundwaters and aquifers, basin. It exposes aquifers' characteristics and classification to understand their complexities. Subsequently, this chapter reviews the evolution of International Water Law; the legal advances regarding the regulated uses of these watercourses from navigation to new dimensions such as environmental, economic, human rights. The most relevant declarations, resolutions, conventions, and principles regarding international water uses are developed. Likewise, the recent

advances in groundwater regulation, the United Nations General Assembly Resolutions, and the Draft Articles are made explicit.

Chapter 3, 4 and 5 explores the causal factor and the hypothesis raised in this thesis in each of the proposed case studies. Chapter 3 analyzes the oldest and successfully implemented international treaty on transboundary groundwater resources: the Genevese Aquifer's case. The Genevese Aquifer spans the canton of Geneva in Switzerland and the French department of Haute-Savoie. Its main problem was its over-pumping and its deteriorating conditions. In 1978, the Canton of Geneva and the French communities decided to agree on the joint management and use of shared groundwater of the Genevese aquifer. In 2007, the agreement was extended- after 30 years of its effective implementation-, and countries signed the "Convention on the Protection, Utilization, Recharge and Monitoring of the Franco-Swiss Genevese Aquifer". Here I draw attention to a number of factors that have influenced the final outcome: a strict regulation.

Chapter 4 presents the Guarani Aquifer's case. The largest aquifer identified in South America and one of the largest reservoirs of transboundary groundwater in the world. It is shared by Brazil, Argentina, Paraguay and Uruguay, and they signed the Guarani Aquifer Agreement in 2010. This agreement represents a significant contribution to the regulation of cross-border groundwater in Latin America and the world. Nevertheless, it is a lax cooperation agreement between the four states sharing the resource. It has recently been ratified by the four countries (after ten years of its signature), and it still has some items in the agenda following its entry into force.

Chapter 5 presents and analyzed the transboundary aquifers shared between Chile and Bolivia: The Ollagüe-Pastos Grandes and the Ascotán Aquifers. They have been recently identified and have special importance for Chilean economy. But neither of the two countries involved has yet carried out an in-depth investigation about its hydrogeological characteristics, exact size, capacity, etc. This is a case that we could consider as negative, since there is no regulation for the management, use and protection

of these aquifers shared between Chile and Bolivia. I will explore the causal factors that can explain this situation.

Chapter 6, the concluding chapter, underscores the thesis' main theme that transboundary aquifer's regulation is the result of a congruence of factors: knowledge, domestic political actors prone to change the *status quo* regarding aquifer's management, and the position of *status quo* stakeholders regarding that change. A comparative analysis of the case studies allows us to understand how the combination of existing knowledge about transboundary aquifers, the presence and position of domestic political actors (decision-makers) and s*tatus quo* stakeholders (especially, economic stakeholders), are key to understand the reasons behind the transboundary aquifer's regulation -or its absence.

CHAPTER 1: THEORETICAL FRAMEWORK AND METHODOLOGY

Literature Review

Introduction

Environmental cooperation on the management of natural shared resources was not a major concern in International Relations (IR) discipline until 1970[5]. IR as a field of Political Science emerged after the First World War and has as the main preoccupation the problem of war and the achievement of security in an anarchical "self-help" system of sovereign states. Nevertheless, cooperation under anarchy has been a constant question that different perspectives in IR have tried to answer.

Most IR literature and security studies, in particular, focuses on the state as the level and unit of analysis. This is problematic when thinking about water cooperation because water transcends many levels, and the unit of analysis is not always the state. Although much of the literature on transboundary water treats political entities as homogeneous monoliths, the reality is far more complex (A. T. Wolf, 2007a). Studies on water management are an interdisciplinary endeavor that examines various levels and actors involved. This thesis aims to demonstrate precisely how the presence of other factors (such as the development of knowledge, the presence and interaction between *status quo* stakeholders -against regulation- and domestic actors prone to regulation) affects the possibility of regulating these strategic resources.

Though realism and its variants are monolithic, state-centric perspectives not concerned with natural resources, their premises allow us to understand the position of many states regarding the unfettered sovereignty they exercise over resources and their reluctance to cooperative management of transboundary resources.

It was the liberal tradition that focuses on decentralized cooperation mechanisms, such as repeated plays (Axelrod, 1984), favorable payoff structures, long time horizons, and a small number of players[6]. Mainly, neoliberal institutionalism assumes the

[5] The United Nations Conference on the Human Environment in Stockholm, 1972, and the oil crisis in 1973 were clear indicators of the relevance that the natural environment would be acquiring.

[6] As the number of players increases, transaction and information costs rise; the likelihood of autonomous defection and recognition and control problems increase, and the feasibility of sanctioning

possibility of cooperating under anarchy and realizes that economic activity and international cooperation necessarily occur within a framework of rules and agreements (Young, 1989).

In fact, neo-institutional analysts took advantage of existing assumptions of neoclassical economics in the study of public choice, collective action problems, and the conditions required for international economic cooperation (Harris, 2014). The main contribution related to public choice, public goods and the problem of the management of the commons came from the boundaries of Political Science and Economy, with articles by authors such as Duncan Black, Scott Gordon, Anthony Downs, James Buchanan and Gordon Tullock, Mancur Olson, Vincent Ostrom, Elinor Ostrom, and Gary Libecap.

The Public Choice Theory provides us with tools to analyze the collective action problem regarding the cooperation and management of common-pool resources like groundwater and shared aquifers by two or more states, and the possibility to establish a common regulation. The problem of collective action is central to the field of groundwater management, where participatory exercises potentially affect large sections of the population.

Debate over the tragedy of commons raised by Hardin (1968) is still present when we think about groundwater consumption, overexploitation, and pollution risk. He asserts that individuals, when having access to a resource, pursue the satisfaction of their interests and the maximization of their profits. Doing so, they'll bring the level of exploitation to a degree greater than the optimum level of extraction, obtaining as a result the degradation of the resources[7]. To prevent that tragedy, Hardin considers coercion as the only solution, either through the state or private ownership. But

defectors diminishes (see Oye, 1986: 19-20). Similarly, Mancur Olson (1967), when analyzes the logic of collective action as a cots-benefits calculous, asseverate that as group size increases, provision of the common good becomes less optimal. We can only have an optimal provision of the common good if the marginal costs are shared in exactly the same proportion as the additional benefits. Large groups have problems providing common goods for three reasons: 1- each group member has a lower share of the benefits; 2- it's less likely that anybody's benefits of helping provide the good exceed the costs; 3- organizational costs rise with group size.

[7] Hardin assume the presence of "free-riders", users who avoid the work and responsibilities of contributing to resource management, but take advantage of their benefits.

institutional choice theorists show us other possible solutions based on human cooperation, social institutions, or internally-enforced rules. This research makes us think about the importance of institutions (understood as rules that coordinate social relations) as mechanisms to balance behavior and facilitate cooperation.

In this line, Elinor Ostrom presents an alternative path: the existence of local or regional organization for appropriation and provision of common-pool resources as groundwaters in those cases where there is no control by the state or private actors. Property rights may fall to private agents or public bodies, or even emerge from the social community (Ostrom, 1990).

Subsequently, the tools provided by the latest theoretical developments on institutional choice allow us to think about how the design of institutions can affect their implementation, as well as the characteristics of states, their roles, the context, and the changes that could arise during or after the creation of this institution. In particular, in the case of the Guaraní aquifer, these elements could allow us to analyze why aquifer states have not yet taken actions to implement the agreement that they managed to conclude, or why the states took ten years to ratify it.

Public Choice, Institutional Choice, Collective Action Theory

Public Choice Theory tries to understand people's actions in collective decision making utilizing the analytical techniques of economics, most notably the rational choice postulate, in the modeling of non-market decision-making behavior (Rowley & Schneider, 2004). The central focus of public choice is on the incentives that individual actors (and decision-makers) face within the political process, the obstacles to effective participation, and how their behavior will aggregate into collective outcomes. "Incentives result from the structure of a situation that is affected by the type of goods involved, combined with attributes of a community and the rules used for making decisions about allocation, production, distribution, and consumption of those goods"

(Ostrom, 2007, p. 241). Within this approach, public participation is conceptualized as a collective action problem, where non-cooperative behavior -as free-riding- may impact on the effectiveness of the process.

To overcome the free-riding problem, different solutions have been proposed. First, according to public choice, public participation will be more likely in small-group contexts, where participants know each other; there are ongoing social ties and a desire to maintain good relations. In these contexts, the increased possibility of monitoring and punishing free-riding behavior can encourage higher degrees of participation (Fischel, 1987; Rydin & Pennington, 2000; Weale, 1992). Consequently, cooperation on groundwater's regulation would be more feasible at a local or sub-national level, with smaller and autonomous political and social units. We could find this example on the Genevese Aquifer, but not in the Ollagüe-Pastos Grandes aquifer, Guarani aquifer, and other similar cases in the world.

Another possibility to encourage participation may be the presence of private selective incentives –material or non-material-, understood as benefits enjoyed only by those who agree to cooperate. In general, even if relatively large numbers of persons actually engage in collective action, public choice analysts consider the logic of collective action as a troublesome problem because people's commitment and active participation in policy process are likely to be unstable and rare. Additionally, from this perspective, the collective action problem often results in the capture of participation efforts by special interest groups to the detriment of the majority of the population (Buchanan, Tollison, & Tullock, 1980).

Collective Action and Resources' characteristics

Regarding collective action in natural resources' management, one must first ascertain the characteristics of these resources. Two principal attributes have often been highlighted in discussions of natural resource management to yield a simplified taxonomy of resource categories: subtractability and excludability (Ostrom, 1990).

Economists use these two characteristics to define goods: rivalry/non-rivalry and excludability/non-excludability. The possible combination of these characteristics distinguishes among four types of goods: public goods, private goods, club goods (also called impure public goods), and common-pool goods[8] (Buchanan, 1965; Ostrom, 2003; Samuelson, 1954). According to this classification, groundwaters and aquifers can be considered as common pool resources. Their benefits are partly excludable -because non-aquifer states have no access to water resources and cannot benefit from them directly-; and they are rivals since any unit of water diverted or polluted by one riparian reduces the amount available or its quality for other users.

Additionally, there is an extensive literature on the biophysical attributes of resources and their influence on collective action (Doss & Meinzen-Dick, 2015). Physical features of the resource affect the ease of management. They include the boundaries of the resource (clear boundaries of the resource units are generally assumed to make it easier to manage); the degree of subtractability or rivalry in consumption (the extent to which one person's use or consumption affects or deprives other potential users); whether it is a divisible or joint resource, and the size or extent of the resource. The degree of subtractability makes it both more challenging -and more necessary- to manage the resource collectively and to devise rules needed to sustain it. Resources that are easily divisible (e.g., agricultural fields) can be managed by individuals, while a joint resource needs collective management to control access and use. Finally, larger resource units are harder to monitor access and use, and prone to call for collective management.

[8] Pure public goods are goods whose benefits are neither excludable nor rival. They are not excludable because it is impossible or prohibitively expensive for a potential user to exclude other persons from the use of those goods and their benefits. They are not rivals because a user's consumption of that good doesn't reduce benefits to others (for example, knowledge: once something is known, that knowledge can be used by anyone and its use by any person does not preclude its use by others). In contrast, the benefits of private good are fully excludable and rival (e.g., a piece of bread).There are also two middle-range concepts about types of goods: (1) club goods that are non-excludable, yet rival, which may be consumed by all who gain access to them but whose consumption detracts from the consumption of others (a classic example is fisheries in the oceans); and (2) common-pool goods, which are partially excludable and rival. International freshwater resources, to which only the riparian states enjoy access for purposes other than navigation, are an example of this type of good.

According to this biophysical attributes, groundwaters stored in aquifers do not fall into the category of easily manageable. Their boundaries are not always known with absolute certainty; they are rival and joint resources, and their degree of subtractability is variable and relative to each aquifer's characteristics. In general, this complexity will vary to a greater or lesser degree, depending on the characteristics of each aquifer.

But these static physical features of a resource are not enough. The flow patterns can also influence resource management. They include the mobility of the resource, its variability in space, time, and quantity, and the possibilities for storage. Mobile resources -like water or fish- are more difficult to monitor and manage compared to stationary ones –like trees; and it is easier to build collective institutional arrangements if changes in resources are predictable over space, time, and quantity. The storability of a resource could also influence resource management (e.g., greater storability may create a stronger incentive for individual exploitation). Again, and because their characteristics vary considerably regarding its mobility, variability in space, time, and quantity, groundwater resources are clearly a not easily manageable resource.

Resource technologies are another important factor because they influence the capacity to exploit, observe, or monitor resources, and exclude other potential users. The presence of efficient harvesting technologies which are available to all makes it necessary to develop strict rules to avoid resources' depletion. Finally, if there is no substitute for one resource, collective management incentives are greater than where there are alternative resources that could be used instead (Doss & Meinzen-Dick, 2015).

In the case of groundwaters, technology has facilitated their exploration and extraction, but the cost of monitoring them is high. Additionally, freshwater has no substitute -we could think of desalination mechanisms as a possible substitute, but they are expensive and difficult to access. Both characteristics make us think that the incentives for collective management should be greater, but we can see that cooperation for joint management of transboundary water resources is still scarce.

Proposals to the Tragedy of Commons

The debate over the commons has arisen around the complexity of club goods and common-pool resources, which have been considered as controversial goods. To prevent that tragedy, Hardin considers coercion as the only solution, either through the state or private ownership. But common property theorists criticize Hardin's failure in distinguishing between an open-access regime (as open sea fisheries) where his theory could fit, from a common property regime, where a group ownership exists and access is open only to the members of the group (this could be the case of groundwaters of transboundary aquifers shared by specific actors). Common property regimes increase human cooperation possibilities because social institutions or internally-enforced rules take advantage of individual rationality for collective action (Bromley & Cernea, 1989; Ciriacy-Wantrup & Bishop, 1975; Runge, 1986). Therefore, they consider that it is possible to avert the free-riding problem. Institutions -rules that coordinate social relationships- help balance behavior and, then, cooperation becomes a rational strategy (Runge, 1984).

Elinor Ostrom -one of these Hardin's tragedy detractors- asserts: "more solutions exist than Hardin proposed. Both government ownership and privatization are themselves subject to failure in some instances" (Ostrom, Burger, Field, Norgaard, & Policansky, 1999, 278). Inspired in Axelrod's ideas about evolutionary cooperation and the iterated prisoner's dilemma (Axelrod, 1984), Ostrom explains how individuals manage to create organizations for the administration of common-pool resources (CPR). She shows that, in certain communities, individuals may be able to self-organize and generate rules. Users "can make a binding contract to commit themselves to a cooperative strategy" (Ostrom, 1990, p. 15), to share returns under the limits of sustainability and the costs of enforcing their agreement. Local appropriators have better information to design the rules of appropriation and provision of CPR. Their commitment to institutions is related to their mutual monitoring of compliance with

these rules[9]. The absence of external factors -national or formal laws- doesn't influence the effectiveness of appropriators' rules.

She also mentions as a condition for an adequate management of common resources the need to have a clear definition of their limits and its possible users, allowing the exclusion of those without rights over these resources.[10]

Then, this type of cooperation is viable where the limits of the resources are known, their location, capacity, characteristics (biophysical attributes; the degree of subtractability; the flow patterns; the presence of resource technologies), and they are shared by small local communities, where it is possible to generate an emotional bond and a greater commitment among users. In this way, rules that people establish for their use, management, and protection are easier to implement and to control.

With this in mind, Ostrom's proposal would apply in the case of the Genevese Aquifer (Switzerland - France), but the Ollagüe-Pastos Grandes and Ascotán Aquifers (Bolivia- Chile), and the Guarani Aquifer present more challenges to the theory. Those cases do not meet some of the essential conditions indicated by the author: involved states have different political administration and their own legal regulation regarding groundwater (even with internal legal variants in the cases of the federal states); local actors do not necessarily know each other, and the rules of resource's appropriation cannot be clearly established between them; there is no unified knowledge about aquifers' geological characteristics between states sharing the resources; the possibility

[9] Commitment and monitoring are strategically linked: monitoring produces both private benefits for the monitor and joint benefits for others by reinforcing the continuity of the commitment and discouraging free riders.

[10] Specifically, Ostrom (1990) points out eight conditions that favor an adequate management of common resources that avoid tragedy. These rules are the following: 1) the limits of the common resource and its possible users must be clearly defined, allowing the exclusion of those without rights over the resource; 2) there must be a congruence between the rules of appropriation and provision and local conditions; 3) there must be collective choice mechanisms so that the majority of individuals affected by the operating rules of the resource can participate in the adoption and modification of those rules; 4) there must be monitoring mechanisms that allow the individuals who monitor the resource to be responsible to the users; 5) there must be a system of gradual sanctions, so that the sanctions for the violation of the rules are low there must be local mechanisms, fast and low cost to resolve conflicts between users or officials; 7) the rights of users to adopt their own rules should not be restricted by external authorities; 8) When a common resource is closely connected to a larger socio-ecological system, governance activities should be organized in multiple nested layers. Ostrom (1990) points out that the first seven design principles characterize robust institutional solutions, and indicates that the eighth principle is used in more complex cases.

of the establishment of social norms by users who make a binding contract to commit themselves to a cooperative strategy is really complex and questionable for these cases.

All these characteristics represent a challenge for the implementation of social regulation of this type of resource. Hence, there would be imperative the development of some regulation by other institutions such as the states involved or international organizations to prevent the dreaded exhaustion of the resource. However, the institutional choice remains an influential approach to study the commons. Contemporary commons researchers develop theories of CPR management to explain whether and under what circumstances it is appropriate, and how CPR's users (the state, market and civil organizations) can most efficiently and fairly supply public goods avoiding their tragedy (Klooster, 2000).

Institutional design

Research on international institutions has evolved considerably over the years. Firstly, regime analysis was adapted to the study of international environmental cooperation when the production of international environmental agreements and conventions flourished. Oran Young (1977) is one of the pioneers in this subject. He adds the concept of regime resources[11], and is focused on conditions under which institutions emerge and whether they affect state behavior (Young, 1982, 1989).

More recent studies have focused on understanding the theoretical bases for the design of international institutions to answer the question posed by Koremenos, Lipson, and Snidal: "how and why are international institutions designed as they are?" (2001, p. 769). They ground their theoretical framework in a game-theoretic and rational choice

[11] Regime resources are social institutions (recognized patterns of behavior around which expectations converge) "that serve to order the actions of those interested in the use of various natural resources" (Young, 1982, p. 16).

perspective. Institutional choice scholars hold that people have the ability to craft the institutions[12] that govern their use of a common-pool resource.

According to Koremenos et al. (2001), states act rationally and institutionalize cooperation to solve their problems. In doing that, they choose a specific institutional design –among the many options they have available (Koremenos, 2016; Koremenos et al., 2001). This approach seeks to relate specific institutional features, such as their membership and scope, to the preferences and interests of states as well as contextual factors. Barbara Koremenos (2016), within a state-centric perspective, emphasizes that particular characteristics of states cooperating and their underlying cooperation problems directly affect institutional design. NGOs or any other non-state actors don't have enough influence or authority in global governance, but that granted by states. Additionally, she asserts that compliance with a cooperation agreement will depend on design provision: "without the correct design provisions, states will often not even ratify the agreement, regardless of how heavily involved they were in the discourse leading to it" (Koremenos, 2016, pp. 13, 25–26).

This research advances in issues that help us to analyze the case studies proposed, especially the Guarani Aquifer case, where the ratification process was delayed 10 years. For example, we could inquire about states' strategic interactions when designing or choosing an institution, compliance problems when establishing these institutions, and political, social or contextual changes that could occur after the creation of that institution. In those cases where there is still no agreement, we could evaluate actors' characteristics and the fundamental elements that a future arrangement should consider to be successful.

However, institutional choice theory doesn't consider endogenous forces or domestic political actors and domestic bargaining process that could exert influence on states' behavior (Allen, 2018). In general, the authors attribute these limitations to the need to simplify certain assumptions according to methodological characteristics

[12] Institutions are, in general, understood as rules that coordinate social relationships, help balance behavior and solve the assurance problem. With adequate institutions, therefore, cooperation becomes a rational strategy (Runge, 1984).

(Koremenos, 2016, p. 29). But when studying issues as complex as common-pool resources' regulation, it's important to take into account those actors that could be pressing or influencing state decisions and actions. This thesis aims to fill those gaps. Including factors as knowledge about the aquifers, the presence and interaction between *status quo* stakeholders - against regulation - and domestic actors prone to regulation in the equation, I will consider all actors involved in the decision-making process (local, subnational, national and international) that bring about the regulation of transboundary groundwaters and aquifers shared by two or more states. And this is the contribution that this thesis intends to make to this developing theoretical debate.

Security Studies

Finally, it's important to consider the security studies perspective in issues such as environment, natural resources, and waters' use and management. These approaches tend to focus on the possibility of cooperation or conflict associated with the possession, use, and control over such resources. In extreme cases, some scholars have a mono-causal approach underlining the environment and natural resources as the reasons for war in the 21st century. Nevertheless, as Wolf et al. (2007a; 2004; 2005) have shown, environmental factors are not discarded as a conflict factor, but positioned into a broader and more complex framework where political, social, ethnic, economic factors, among others, together with the scarcity of resources leads to conflict.

It's very important to highlight this last asseveration. Much empirical research has shown that water or other natural resources are not a direct cause of conflict, and when they are involved in one, it's necessary to consider other contextual factors as social and historical relations between states, economic and political stability, etc.

However, concern about natural resources is not new. Geopolitics was the predecessor of the contemporary environmental conflict and security research agenda (Stevis, 2006). Political geographers Harold and Margaret Sprout (1957) focused on

environmental factors inherent in international politics, and became the intellectual precursor to the current literature on environmental security. Since then, resource wars (water wars, drug wars, diamond wars, oil wars) in an era of scarcity, climate change, deforestation, or pollution became widely used expressions in international relations.

In recent years, environmental issues and natural resources are deeply linked to security, but not the traditional notion focused on military security (Greaves, 2012). The concept of environmental security involves the risks posed by the environmental change to the things that people value: climate change, deforestation, soil erosion, and desertification, loss of biodiversity, air, land, water scarcity and pollution, ocean acidification, depletion of the ozone layer, among others (Barnett, 2007; Castro Pereira, 2015).

Occasionally environmental decline could lead to conflict, especially when scarce water resources must be shared. However, its impact on states is manifested as a difficulty for economic performance and, therefore, political stability (Buzan, Waever, & de Wilde, 1998; Mathews, 1997). At the same time, freshwater shared among states is seen as a potential source of dispute between states, or for regional instability, as states utilize and develop natural resources in divergent and unequal ways (Dinar, 2000; Wolf, Yoffe, 2004; Wolf, 2007; Wolf, Kramer, Carius, & Dabelko, 2005). Concepts as hydro-hegemony[13] and hydropolitics[14] were developed in this framework. Nevertheless, research on war and conflict thus far indicates that water insecurity or dispute is unlikely to result in violent conflict between states. As Aaron Wolf puts it, water may be a tool,

[13] "Hydro-hegemony is hegemony at the river basin level, achieved through water resource control strategies such as resource capture, integration and containment. The strategies are executed through an array of tactics (e.g., coercion- pressure, treaties, knowledge construction, etc.) that are enabled by the exploitation of existing power asymmetries within a weak international institutional context. Political processes outside the water sector configure basin-wide hydro-political relations in a form ranging from the benefits derived from cooperation under hegemonic leadership to the inequitable aspects of domination. The outcome of the competition in terms of control over the resource is determined through the form of hydro-hegemony established, typically in favor of the most powerful actor." (Zeitoun & Warner, 2006, p. 435)

[14] Hydropolitics is a relatively new addition to the field of international security and negotiation studies because freshwater issues are seen as affecting large-scale violence, war and peace (Dinar, 2000).

target or victim of warfare, but up until this point it has not been the cause (A. T. Wolf, 2007b, p. 4).

Many empirical studies conducted by researchers at the Oregon State University[15] demonstrate clearly that conflict over water is not inevitable and that many institutions, mechanisms and ideas exist to encourage states, local authorities and members of civil society to use water as a conduit for cooperation and peaceful interactions[16]. Another key finding in their research is that international water disputes have been resolved, even among historical enemies, and even as conflicts over other issues unfold. Some states with historical conflictive relationships (for example, Israel and its Arab neighbors) have negotiated or are in the process of doing so, and the institutions they have created often prove to be resilient, even when relations are tense (Petersen-Perlman et al., 2017; A. T. Wolf, 2007b; Aaron Wolf et al., 2005).

At the same time, it is stated that environmental variables often interact with other variables to cause violent conflict or instability (or lead to cooperation). Water conflict (about surface or groundwaters) cannot be regarded as the ultimate variable for the cause of conflict but due to rather domestic or regional causes. Some cases may show that where there is a prevalent political conflict or instability between states, water can exacerbate it (Dinar, 2000; A. T. Wolf, 2007b) but is not the determinant cause.

The conclusions reached by these investigations give us a sense that the variable conflict (or latent conflict) is not a determinant for the establishment or not of a cooperative behavior between states so that they can reach a mutually agreed regulation on a shared natural resource. Thus, the precedence of previous conflicts among countries that share an aquifer is not necessarily a constraint for regulating transnational groundwater. Conversely, there are many cases where regulation of transboundary water

[15] Specifically, the College of Earth, Ocean, and Atmospheric Sciences and its Program in Water Conflict Management and Transformation of, directed by Aaron Wolff.

[16] In a compiled dataset of every reported interaction –conflictive or cooperative- between two or more states that was driven by water, researchers of the mentioned University conclude that the incidence of acute conflict over international water resources is overwhelmed by the rate of cooperation. If we look at the total number of events related to water between nations, it is proven that the balance always leans towards the side of cooperation: 507 conflict-related events versus 1,228 cooperative, "implying that violence over water is neither strategically rational, hydrographically effective, nor economically viable" (Aaron Wolf et al., 2005, pp. 84–85).

agreements comes after a conflict generated by them, and only in few cases it has been decided to regulate and cooperate in a preventive manner (Delli Priscoli & Wolf, 2009; P. C. Villar, 2016b).

The Guarani Aquifer is circumscribed within this last type. It would be interesting to inquire about the motivations and factors that led the parties to that negotiation, especially in the case where there is no disparity of interests between parties involved. The situation is different in the case of aquifers shared by Chile and Bolivia. Those countries have a previous conflict (the War of the Pacific) whose resolution involved the unleashing of a Bolivian claim that continues to this day (the maritime demand). This Bolivians' claim is a constant in any negotiation with Chile. At first glance, the "conflict factor" seems to be the reason for the non-regulation of these aquifers. However, based on research from security studies, it should not be a determining factor. There may be other national or regional variables that, combined with the water factor, explain the result of cooperation (or regulation). This implies going beyond the perspective of security and understanding the contextual complexity in which these agreements are circumscribed, or, for which it has not been possible to delineate any type of regulation.

Theoretical Framework

There is no doubt that groundwaters are crucial resources for human and ecosystems' survival. But transboundary aquifers as common-pool resources are challenging to manage, susceptible to overexploitation and contamination, and require a broad stage of exploration and research to be regulated. Avoiding the "tragedy" of this common could be achieved through local or regional organizations (norms, rules, and institutions) as Ostrom proposed, or, when this option is not available, with formal state intervention: "the state can define and enforce new access and use arrangements and provide more formal mechanisms for arbitrating disputes" (Libecap, 2008, p. 547).

This research asks about the causal factors that influence groundwater regulation and the processes by which interstate agreements on shared groundwaters (if any) are negotiated and implemented. The objective is to explore the local, regional or international political forces that work to facilitate or hinder that regulation, analyze the conditions under which various institutional mechanisms could aid states in cooperating, managing and preserving groundwater resources, and assessing their relevance for the future.

In order to devise an agreement that has enough support to be implemented, all involved actors could exchange compromises and logrolling in the political arena. Each of these layers of negotiation will mold the regulation that eventually results. They could advance formal and rigorous agreements to manage and regulate transboundary aquifers, such as the scheme implemented on the Genevese Aquifer along the French-Swiss border, or they could design more general cooperative regimes, or instruments aimed mainly at an initial exchange of scientific data (lax regulation).

So, this work focuses on forces behind transnational groundwaters' regulations, information and knowledge about shared aquifers, actors involved, the private and political negotiations underlying them, and their influence on design of regulatory policies.

Knowledge plays an important role in identifying aquifers' characteristics, localization, capacity, use. Because it is unseen and hidden below ground, groundwater is a vulnerable resource that is not given the priority and does not receive the attention needed to ensure that the benefits it provides to human societies and to ecosystems will be sustained. Groundwater data is often imprecise, outdated, limited by legal aspects, technological capacity, or by paradigms of knowledge. There is often scientific uncertainty regarding the capacity, quality and health of the resource, the impact of human actions on it, and its future potential. Additionally, compared to surface waters, groundwaters and aquifers present many complexities because of their hydrogeological characteristics and require different management solutions.

Getting good information and developing a technical understanding of how groundwater systems work is crucial for improving its management. For example: identifying water volume (storage), what types of soils and rocks compound the aquifer; if the aquifer is naturally recharged or not; determining how much water can be sustainably taken from an aquifer; water quality and susceptibility of pollution, etc. (Smith et al., 2016). Despite its crucial role, this resource is still poorly understood, and hence poorly managed in many parts of the world. Moreover, with the advent of new technologies that allowed pump out huge quantities of water, and the increment of persistent contaminants, groundwaters need to be protected and managed.

Several authors (Hurrell & Kingsbury, 1992; A. T. Wolf, 2007b; A. T. Wolf, Yoffe, & Giordano, 2003; A. Wolf et al., 2004) emphasize that the main problem of surface and groundwater regulation is the states' lack of knowledge about water resources found in their territories (characteristics, location, etc.), to manage these resources and/or implement regulations or international agreements. Various reasons could explain this lack of knowledge: the presence of large extensions of uninhabited territory or with low population density, where there is not a high demand for water resources; the lack of economic resources to implement research or invest in equipment and technology to know in detail these resources; geographical characteristics of the land where they are located; legal difficulties that interfere in knowledge research or in the implementation of changes in resources administration; bureaucratic obstacles or problems of institutional dispersion; the state's approaches from which aquifers and groundwater resources are studied, among others. Regarding the latter, a great discussion exists around the approach from which states explore and manage their groundwater resources. In general, they implement numerical models –sometimes decontextualized from ground reality- that are not generalizable nor allow a complete understanding of the different existing resources (Interview 7).

Thus, if there is scarce or controversial data regarding aquifers (national and transboundary), this could be a limitation to resource regulation. Likewise, if there is no consensus or common information about the risk of the aquifer's overexploitation or

management, then it will be even more difficult to agree to a distribution of the rewards and costs as part of any proposed regulation.

Scientific knowledge and ideas have an effect on the emergence of new policy initiatives and institutional frameworks. They are the resources used by political actors engaged in negotiation processes, and they operate as a cognitive frameworks from which political preferences are shaped (Walter, 2013). Additionally, as Libecap (2008) asserts, some parties involved –the *status quo* stakeholders- take advantage of these information and measurement problems to opportunistically advance their own interests on that resource.

This thesis sustains that knowledge about the aquifers' real dimensions, hydrogeological characteristics, water reserves, exploitation rates, and their role in regional development is the starting point for advancing on reasonable visions and plans for transboundary groundwater regulation, identifying management actions needed.

The other challenge for transboundary aquifers' regulations is the multiple and heterogeneous group of actors implicated, with different interests and power to influence that regulation. In many developed or developing countries and regions, especially where rainfall is scarce, and human settlements have grown, aquifer's exploitation may be intensive since groundwater is often the most accessible, cheapest and reliable freshwater resource. Groundwater use has significantly increased during the last half-century in most semiarid or arid countries[17], and has been undertaken by a large number of private and public actors.

Certainly, water management has multiple objectives and is based on diverse competing interests. Within a nation, these interests include domestic users, agriculturalists, hydropower generators, environmentalists, among others, and the possibilities of finding mutually acceptable solutions fall exponentially as more and more actors are involved (A. T. Wolf, 2007b). Urban and rural domestic supply for human consumption amounts to less than 15% of global water use, but consumption for

[17] Groundwater is estimated to provide about 50% of the world's drinking water supplies (The United Nations World Water Development Report, 2003)

irrigation exceeds 70% of the world's freshwater withdrawal (The United Nations World Water Development Report, 2003). Technology's advances in hydrology and well-drilling techniques have facilitated and cheapened the access and use of groundwater, principally in developing countries where they became an essential tool to overcome hunger and the poverty threshold. Moreover, as has been shown above, governmental control and management of groundwater development have often been weak or even non-existent, and it facilitated the use and overexploitation of aquifers by hydropower, agriculture, mining companies, and other national and multinational industries and enterprises that use and/or extract groundwater for their activities.

Mapping all actors and interests involved is required to know the different levels and stakes implicated and to analyze their interests, capacities, mandates, roles, tasks, and responsibilities. First, I will explore the role of the *status quo* stakeholders, understood here as all actors that use or exploit the groundwaters of the aquifer for developing economic or financial activities: national and multinational enterprises like mining companies, hotels, and tourism (thermal recreation), bottled water enterprises, hydropower companies; etc. These actors are considered as powerful stakeholders when their activities have a significant impact on local or national economy. This economic power allows them to influence directly the decision-making process in a political unit (national or subnational government), and they would be expected to act against an aquifer's regulation, or making the regulation more flexible: no regulation or lax regulation. It's important to consider that these actors are not homogenous parties and attempt to maximize their private net gains. Some of them could be empowered and forming lobbies as a mean to protect their collective interests (Llamas & Martínez-Santos, 2005).

When we analyze the implications of all these variables in transboundary groundwater management and regulation, we can identify different domestic actors and national or international stakeholders that could influence the decision-making process and international state's behavior. For example, groundwater users form a large part of the electorate or an influential interest group in democratic regimes; politicians may fear

negative polls or a strong opposition as a consequence of trying to implement policies that constrain the perceived groundwater use rights of those users. In that case, populist and electoral motives could drive policymakers to abstain from or delay the implementation of such policies (Mukherji & Shah, 2005) or to sign an agreement which will be rejected by the congress. Additionally, patronage mechanisms result in the formulation of distorted policies that privilege some elites or sectors and corruption within governmental organizations (Cumming, Cumming, & Redman, 2006; Garduño, Nanni, & Foster, 2003; Garduño, Van Steenbergen, & Foster, 2010).

Thinking about transboundary aquifers and cooperation between states to regulate them, some assumptions of liberal perspectives lead us to consider preferences and interests molded throughout the interactions between the domestic and international levels. The "two-level-game"(Evans, Jacobson, & Putnam, 1993; Putnam, 1988) is considered as a negotiation and a learning process between national actors and institutions and their respective states and, at the same time, between the states themselves. Governments and opposition parties can use domestic approval or objection to cooperation to pursue their own political motives, as well as governments in favor of cooperation may be crippled by domestic objections.

Accordingly, domestic politics –including the role of elections-, and the number of institutional "veto players", affect the state's behavior in matters of international cooperation (Mansfield & Milner, 2012, 2010; Mansfield, Milner, & Pevehouse, 2008). Helen Milner (1997) also identifies the nature of domestic political institutions (mainly, presidential or parliamentary system, and different rules for ratification) as variables that generate a certain complexity to international cooperation. If states have divided governments (the executive and the legislature share decision-making power and both have relatively different preferences), cooperation and the ratification of the agreements reached by the executive are less likely than in a unitary state scenario. The need for ratification not only prescribes the strategy of a negotiator (Ikle, 1964) but can also lead to a failure of negotiations at the interstate level. This is what Tsebelis (1995) identifies

as "veto players": individual or collective actors whose agreement (by majority rule for collective actors) is required for a change of the status quo[18].

Then, I will consider the preference settings within each state and the role of domestic actors in favor of changing the *status quo* and regulating aquifers' management. These actors include politicians (political actors) from different national and subnational units who participate in the legislation or decision-making process. As an illustration, local authorities (mayors) who seek the protection/conservation of groundwater to ensure the community access to these resources – the State Council of the Republic and the canton of Geneva and the Prefect of Haute-Savoie. Other examples are diplomatic representatives and institutions in charge of water resources' management of four countries participant in the Guarani Aquifer System Project (GASP) that cooperate in advancing research and implementing the Pilot Projects.

These actors, based on different motivations (political interests such as the political cost of generating a large expense to change the source of water supply in a city; economic interests such as funds invested by an international organization to investigate the resource; or by national or international pressure arising from knowledge about the aquifer and its publicity), are expected to act favoring the aquifer regulation for its management and protection. In the presence of sufficient aquifer knowledge, when domestic political actors interested in changing the *status quo* of aquifer's regulation are present and *status quo* stakeholders are absent, regulation should be the final outcome and it is expected to have a rigorous disposition. When domestic actors in favor of regulation are present but their interests are narrow or unstable, and *status quo* stakeholders have enough economic power that can finally influence the decision-

[18] Tsebelis (1995) also distinguishes between institutional and partisan veto players. Institutional veto players (president, chambers) are those actors whose consent to a political decision is required by the constitution or by law; partisan veto players are all parties that belong to the governing coalition, and a government's proposal has to be approved by a majority of each of these parties. The potential for policy change decreases with the number of veto players, the lack of congruence (dissimilarity of policy positions among veto players) and the cohesion (similarity of policy positions among the constituent units of each veto player) of these players. However, in some cases, there are "other" veto players who vary from policy field to policy field and therefore depend on the particular context. As examples, Tsebelis names courts, central banks, the military, powerful interest groups, constitutionally required super majorities and referendums.

making process, lax regulation is expected. When knowledge is scarce, there is no domestic political will to regulate these resources, and powerful *status quo* stakeholders are present, the expected outcome should be no regulation. A regulation agreement reached would necessarily imply the redistribution of costs and benefits that will affect all actors involved.

Hence, the interaction between both stakeholders with the power to influence national or international policies and domestic political actors favorable to the regulation of these aquifers is the causal mechanism influencing the possibility and type of regulation of a transnational aquifer.

Understanding the type of regulation - if any- that emerges (with a rigorous or lax disposition), and its effects on the commons "depends upon identifying the key parties involved, their objectives, and their political influence" (Libecap, 2008, p. 549). Transnational aquifers present a greater complexity because these waters cross political boundaries and involve citizens, organizations, regulations, and institutions of multiple jurisdictions. In these cases, political bargaining within and across jurisdictions must be examined as well.

So, in this thesis, I argue that there is a higher likelihood of transnational aquifers' regulation if there is sufficient knowledge of the characteristics and location of the aquifer, domestic political actors favorable to regulate, and *status quo* stakeholders are absent or do not influence the decision-making process. The variance or disposition of that regulation (lax or rigorous) will depend on the presence of status quo stakeholders with enough economic power acting against regulation and/or domestic political actors with low or unstable interests in regulating. More to the point, difficulties involved in addressing transnational aquifers are the existing or generated knowledge about those resources and the actors involved, here the *status quo* stakeholders with enough power to affect both the possibility of regulating and the kind and characteristics that regulation will adopt, and the absence of domestic political actors favorable to regulation.

All these actors will be implicated in the political arena to reach an agreement easily implemented, and regulation will be the result of this web of commitments and negotiations. They could arrive at a complex and rigorous instrument covering, for example, controlled groundwater extractions, controlled artificial aquifer recharge operations, pollution control, the apportionment of all relevant costs, and a permanent bilateral institution for the administration and implementation of the agreement. The Geneva Aquifer is the only example existent of this kind.

By contrast, a lax regulation establishes framework-type agreements, whose centerpiece is an interstate institution to administer aquifer monitoring, and data collection and exchange. These kinds of instruments are fundamentally based on customary international law, which binds all states with a transboundary aquifer in common, and its rules govern cross-border impacts of groundwater exploitation and management. The principal aim of customary international law is preventing harm between states or remedying the consequences of harm. Two fundamental rules guide transboundary groundwater management:

- no state has the right to inflict significant harm across an international border through its own actions or those of its citizens. States are required to take measures to prevent such harm, and to take action to eliminate or mitigate harm when it occurs;
- all states that share an aquifer are entitled to a reasonable and equitable use of groundwater from the transboundary aquifers that they have in common (Smith, Cross, Paden, & Laban, 2016)

In sum, for this thesis, the regulation of transboundary aquifers and its disposition as rigorous or lax is the expected outcome. The causal factors that I'll test are information of the aquifer's characteristics, the presence of *status quo* stakeholders with economic power, and domestic actors in favor of regulating transboundary aquifers. Achieving sustainable groundwater management demands that local groundwater users, enterprises (national or international), international organizations, technical specialists, and policymakers work together. Each has a role to play, whether at local, national, or

international levels, in driving the tools and actions needed to manage transboundary aquifers. This research outlines that this interaction between *status quo* stakeholders and domestic political actors is precisely the causal mechanism that will drive our outcome: regulation lax/rigorous or no regulation.

The general hypothesis of this thesis is that a rigorous regulation is the expected outcome when states sharing an international aquifer have enough knowledge about its location and hydrogeological characteristics, there are multiple political domestic actors in favor of regulating aquifer's management, and powerful *status quo* stakeholders capable of influencing policy-making (and whose interests are against regulation) are absent.

Some alternative causal factors will be tested. The first one is that posited by Elinor Ostrom about common's management by their own users who are able to make a binding contract to commit themselves to a cooperative and efficient strategy of use and control. According to Ostrom, the local appropriators have better information to design the rules of appropriation and provision of CPR, and what guarantees their commitment to these institutions is related to their mutual monitoring of compliance with these rules. Hence, the problem of resources' regulation is solved with their users' commitment to creating management rules and institutions, and their mutual monitoring regarding that commitment.

Another alternative explanation is found in security studies, particularly in the area of hydropolitics; this is the conflict variable. Aaron Wolf and other scholars from Oregon State University argue that the variable conflict is not a determinant for the establishment or not of cooperative behavior between states to reach a mutually agreed regulation on a shared natural resource. Likewise, the precedence of previous conflicts among countries that share an aquifer is not necessarily a constraint for regulating transnational groundwater. Even though there is some literature and evidence showing that conflict does not constitute a driving factor in states behavior and it is not an impediment for transboundary regulation, I will test it, especially in the case of the

aquifers shared by Chile and Bolivia where there is a latent conflict affecting their bilateral relations since 19th Century.

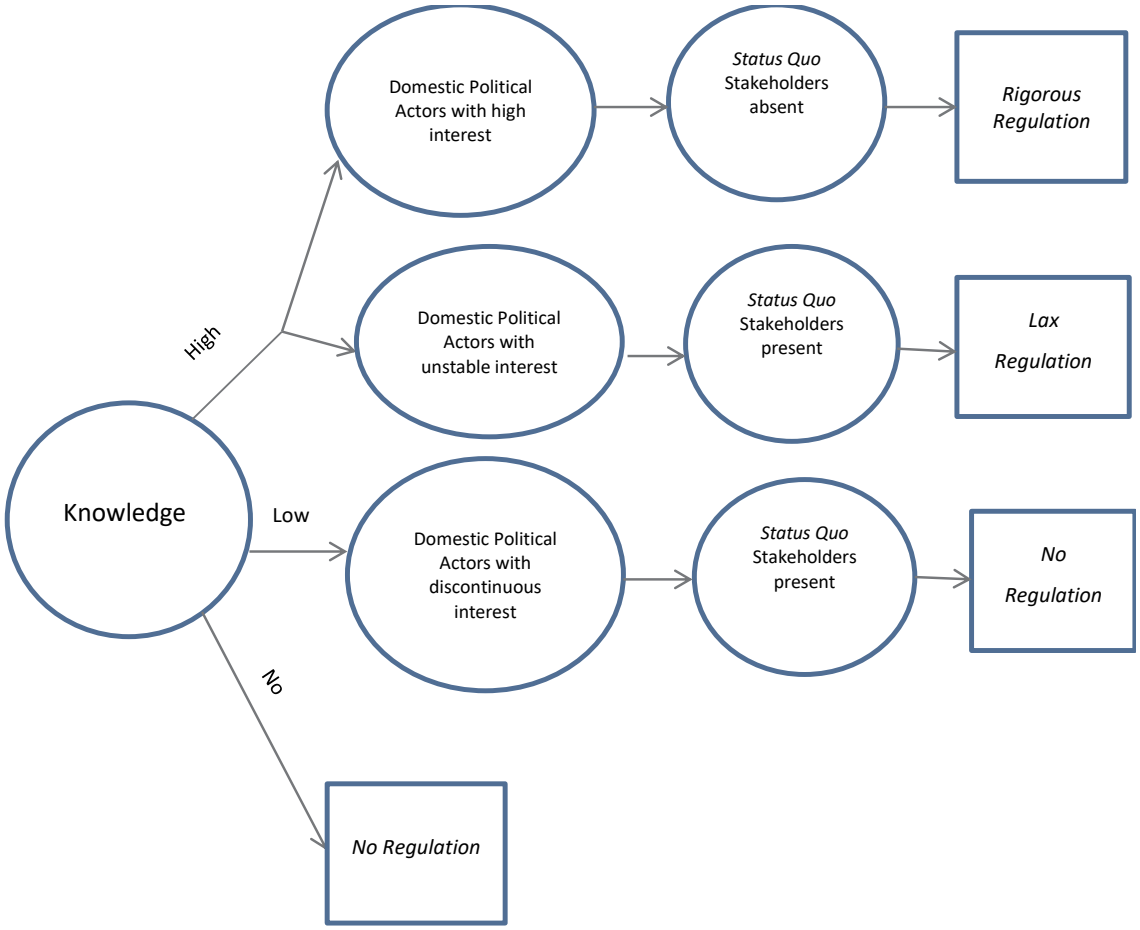

Figure 1.1: Causal Factors and Outcomes.
Own Elaboration

Methodology and Research Design

For the purposes of this project, my research strategy is a qualitative methodology based on three case studies following the process tracing method, which allows me to take an analytical and descriptive route to answer the research questions,

determine the causal mechanism involved in these cases, test the hypotheses, and examine the proposed explanation. My final objective is using process tracing as a theory-building methodology, that is, to contribute to the development of theories that can be generalizable to other regions or cases (transboundary aquifers in the world) or considering a greater number of cases and /or observations.

Process tracing is a case-based method that relies on observations within -rather than across- case studies. The methodology of this approach attempts to identify the intervening causal process, the causal chain, and causal mechanism that link the causal factors to the outcome (George & Bennett, 2005). When used to test theory, process tracing can provide insights into the existence of causal factors, mechanisms, or auxiliary traces posited by a theory. The inductive side of process tracing can contribute to theory development by studying the mechanisms and underlying processes observed in a case study.

In process tracing methodology, mechanisms are linked to the process of causation. They are more than empirical events or intervening variables that can be applied to the units of analysis (Falleti & Lynch, 2009; Mahoney, 2001). While variables measure attributes of specific cases, causal mechanisms reveal the underlying social processes that connect inputs and outcomes. Certainly, mechanisms are theories about how and why one event leads to another; they explain how a hypothesized causal factor leads to a particular outcome in a given context. They are considered relational concepts because they describe the relationships or the actions among the units of analysis or in the cases of study.

Additionally, it's important to consider the relationship between causal mechanisms and contexts, which determines the outcome. Mechanisms alone cannot cause outcomes. Rather, causation resides in the interaction between the mechanism and the context within which it operates. Falleti and Lynch define context "as the relevant aspects of a setting (analytical, temporal, spatial, or institutional) in which a set of initial conditions leads (probabilistically) to an outcome of a defined scope and meaning via a specified causal mechanism or set of causal mechanisms" (2009, p. 1152).

Process tracing is employed in case studies as fits the aim of this thesis to identify and explore the principal causal factors that exert influence on the possibility of regulating transboundary aquifer's; the processes by which interstate agreements on shared aquifers (if any) are negotiated, and the rules and regimes established for aquifer management. Process tracing is a useful instrument to identify causal paths in conditions of complex causality (Checkel, 2005; Tannenwald, 2015). This appears necessary since cases selected for this thesis present different background conditions and different characteristics of the causal factors that make it difficult to identify the causal order. By reconstructing the developments in a well-arranged way these patterns get clearer for an analysis.

It is important to note that "process- tracing is an "ordinary" social science method, like many others, with comparative strengths and weaknesses. It is not a panacea, but when applied in appropriate research situations, it can enable us to make strong within- case causal inferences about causal mechanisms based on in- depth single- case studies that are arguably not possible with other social science methods" (Beach & Pedersen, 2013, p. 2).

The main reason for using case studies for this research is their ability to explore complex causal mechanisms, which are not as easily captured with many other methods. By "helping to bring mechanisms back in" (Checkel, 2005), the insights offered by case study research can advance beyond co-variations and correlation of independently observed variables. Case study research favors a methodology and epistemology of process tracing. With case study method, it would be possible to address the complexity of the processes and dynamics that characterize groundwater regulation.

According to the subject of this thesis, the expected outcome is transboundary aquifers' regulation with a more rigorous or lax disposition, measured by agreements signed, ratified -if necessary- and implemented, and the causal factors are knowledge about aquifer's characteristics, the presence of powerful *status quo* stakeholders capable to influencing the decision-making process, and domestic political actors favorable to regulate shared aquifers.

To validate or not the causal mechanism, the dimensions of need and sufficiency of the empirical evidence obtained will be analyzed. The "hoop tests" will be employed to probe the presence or absence of causal factors. Each causal factor is necessary by itself but not sufficient to probe the causal mechanism and the outcome. The "straw in the wind tests" is used to look for evidence that is neither necessary nor sufficient. It does not confirm the presence of the causal mechanism but strengthens confidence in my hypothesis. These tests will be used to evaluate the effect of alternative explicative factors: the local action in contexts where the actors know each other and can engage in a cooperative agreement; the presence of prior or latent conflict between states.

Cases were selected as a result of preliminary examinations of the research subject. Because transboundary aquifers that have some kind of international regulatory framework or agreement are just six, and the remaining 586 transboundary aquifers identified by IGRAC don't have any international regulation at all (then, no regulation is considered as the general trend), the decision was taken considering the only world case where the aquifer has a current management regulation, and two cases in the South American region, regarding the most similar system design (Przeworski & Teune, 1970).

The first case is the Genevese aquifer, which has an agreement signed since 1978 and revised in 2007 (The Convention on the Protection, Utilization, Recharge and Monitoring of the Franco-Swiss Genevese Aquifer), and is the only one with a joint water management institutional structure. Here, I will test the presence of causal factors and causal mechanism and analyze its functioning.

The second case is the Guarani Aquifer, where states that share the aquifer have bargained an agreement but they had to wait almost ten years till all members ratified the treaty. The treaty has recently entered into force but states have not implemented any change since its signature. Additionally, the Guarani Aquifer is the most important aquifer in the region because of its dimension and the quantity of water stored in it, shared by Brazil, Argentina, Uruguay, and Paraguay. Epistemic communities have developed large amounts of information about this aquifer, there is enough knowledge about its characteristics, and there are different *status quo* stakeholders involved (e.g.,

thermal water parks, multinational water bottling companies, etc.). In this case study, states established a lax regulation.

The first and second cases are comparable using the most similar system design. Both cases are similar in terms of aquifer's knowledge and the presence of political domestic actors interested in regulating transboundary groundwater resources. But they differ in the role that *status quo* stakeholders play in each case and in the outcome (strict and lax regulation).

Lastly, the Ollagüe-Pastos Grandes and Ascotán Aquifers shared by Chile and Bolivia. This is the South American case which has its own particularities. There is information delivered by IGRAC's researches and other studies (principally conducted by private actors as mining companies) about its general characteristics and location, but apparently neither of the two countries involved has yet carried out an in-depth investigation into its hydrogeological characteristics, exact size, capacity, etc. Further, these aquifers have another particularity. They probably have hydrogeological connection being part of a unitary water system, together with the Silala's waters (Rossi, 2017). And all those resources are shared by two states that have a current conflict in their shared border relative to surface freshwater (the Silala river), they have an historical confrontation because of Bolivian maritime demand, and they also had several negotiation instances to try to reach a mutual agreement on the use of these water resources. Then, this aquifers are located in one of the most remote and inhospitable places on earth, but forms what the United Nations Environmental Program (UNEP) named, in 2007, as the only "high risk" basin in South America and one of the most hydropolitically vulnerable basins in the world. This situation has revealed the presence of the other causal factors: *status quo* stakeholders and domestic interests involved.

Both South American cases are also compared with the most similar system design. They have powerful *status quo* stakeholders and certain knowledge about shared transboundary aquifers. But the outcome is different and also the role of political domestic actors. Then, I will analyze the role of stakeholders involved (international organizations, national and multinational companies, epistemic communities, etc.), the

will of political domestic actors in regulating transboundary aquifers, knowledge development, and specifically in the third case, the role of previous conflict.

Process tracing methodology requires a lot of empirical material. To answer the research questions, I rely on qualitative data collected through official documents, academic research, journals and analyses of scholars and commentators of domestic and international politics. Also, I have conducted ten semi-structured and in-depth interviews, both with officials, experts of groundwater issues, and entrepreneurs, IO's members with participation in each case. I also participated in different meetings, seminars and workshops where policymakers and experts shared their insights on the status of national and transnational regulation of aquifers in Chile and South America.

The final aim of this methodological strategy is culminating in a general preposition that could be applied to other cases in the population. I hope that my findings could be helpful to analyze the other identified transboundary aquifers where states have advanced in cooperation for joint management or, at least, for protection and sustainable use of the shared aquifer. My results could also help those who are thinking of moving towards cooperation and joint management agreement (in those aquifers where there are still no transnational regulations) to consider the importance of the causal factors identified here to achieve a successful agreement.

CHAPTER 2: CONCEPTS AND EVOLUTION OF TRANSBOUNDARY WATERCOURSES REGULATION (FRESHWATER AND GROUNDWATER)

Water and borders: shared hydric resources

Water, like other natural resources, does not respect political borders and many bodies of water are shared by two or more states. Actually, in the world, there are 263 transboundary lake and river basins covering nearly half of the Earth's land surface. A total of 145 nations include territory within international basins, and 21 countries lie entirely within international basins. Most basins are shared between two countries, but there are 13 basins shared between five and eight riparian nations. Five basins, the Congo, Niger, Nile, Rhine, and the Zambezi, are shared between 9 and 11 countries. The river that flows through the most nations is the Danube, which travels within the territory of 18 nations (United Nations, 2015)

Although states enjoy sovereignty over the water resources located in their territory, water presents certain complexities that make the definition of sovereignty over it difficult, as it is a fluid, mutable and indivisible resource. “Waters which cross political boundaries have additional complexities brought on by strains in riparian relations and institutional limitations” (A. T. Wolf, Natharius, Danielson, Ward, & Pender, 1999, 387).

For this work, we assume that shared, transboundary, international and cross-border are synonymous, and refer to a watercourse or part of it that crosses one or more state borders, thus extending through the territory of two or more states. The preceding does not pretend to ignore the significances or legal or political connotations that each concept may have.

Defining concepts: basin, aquifers, groundwater

Understanding concepts such as basin, aquifers, and groundwater, as well as knowing and identifying the aquifer’s characteristics is very important when establishing

definitions in regulations for different kind of aquifers. Generally, existent treaties and conventions do not incorporate this characterization. They provide a vague and diffuse definition that allows multiple interpretations, and doesn't facilitate the correct regulation and management of groundwater courses. Differences in aquifers' characteristics (for example, if it's an aquifer or an aquitard, if they are confined or unconfined), imply the need to establish specific rules for control and manage them. For example, the UN Watercourse Convention, entered into force in 2014, has this kind of deficiency: it doesn't contemplate cases where a transnational aquifer is confined, unrelated to any surface body of water and not rechargeable, or cases where a non-confined aquifer that flows across an international border and is hydraulically linked to a river situated within the territory of one state. For this reason, "it is uncertain how international law deals with aquifers that do not flow to a common terminus or are hydraulically connected to more than one river basin" (Villar, 2016: 4).

Additionally, these differences in aquifer´s characteristics may impact on the possibility of generalizing an agreement of regulation reached between certain states that share the resource towards other states that possess an aquifer of identical features. Because of all these reasons, it´s necessary to take into account the following characteristics and conceptual, geological and geomorphological differences of aquifers.

Hydrologic cycle, Groundwater, Aquifers and Basins:

The water follows a cycle in nature commonly called the hydrologic cycle. This hydrologic cycle is the continuous circular process by which water evaporates from the oceans, condenses and falls to the Earth as rain or snow, becomes run-off and groundwater recharge and eventually returns to the oceans through river flow and groundwater discharge (Figure 1) (Hartmann, 2016). The water entering the soil, after exceeding its retention capacity, slowly infiltrates until reaching the phreatic level. The groundwater moves from the sites of greater to ones of smaller hydraulic potential and, since these correspond with morphologically low zones, the discharge is produced over

them. This circulation of groundwater is due to gravity: the water infiltrates and then flows laterally to lower ground. But there is also another movement of water: from the water table to the surface due to capillarity. The water rises and can be absorbed by plants through their roots.

Nevertheless, not all aquifers are interconnected with surface water or land. Some aquifers are completely detached from the hydrologic cycle, and they're known as fossil or not rechargeable aquifers. As this type of aquifers don't have a source of recharge and don't discharge naturally, water contained on them is non-renewable, stagnant and has little if any flow (G. Eckstein & Eckstein, 2003). The Nubian Aquifer in northeaster Africa is an example of a fossil aquifer and it constitutes an important source of water for nations that share it. These non-renewable aquifers are more vulnerable to depletion. Therefore, the regulations for these types of resources must guarantee their protection, their reasonable use, and artificial recharge options could be considered if necessary.

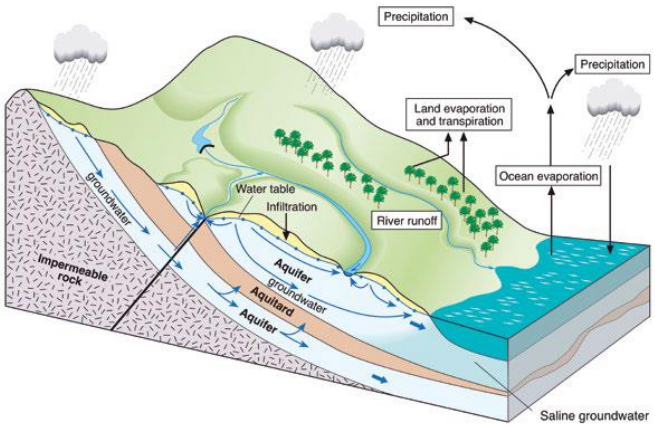

Figure 2.1: Hydrologic cycle (Vaessen & Brentführer, 2015)

Groundwater differs from surface water as a result of the different physical and chemical environment in which it is found. Some groundwater occurs in most geological formations with sediments and rocks in effect forming a subsurface reservoir or aquifer

in which groundwater can be accumulated and transmitted. The hydrogeological properties, porosity and permeability, of geological layers and their spatial distribution vary for many reasons: the type of rocks or sediments, cracks and fissures within the rocks and the depth of burial. The availability of groundwater depends on hydrogeological setting, which may be very variable (Kresic, 2009). Groundwater flow within the aquifer systems is difficult to ascertain and can fluctuate over time due to pumping, natural discharge and recharge, climate change, etc.

An aquifer is defined as "a geological formation (or sometimes part of a formation or a group of formations) that contains saturated material of sufficient permeability to yield 'useful' quantities of water to wells and/or springs (Vaessen & Brentführer, 2015). It's the type of substrate that can contain water in appreciable quantity and which allows it to flow through it with ease (for example, sand, gravel, granite or fractured compact rocks).Then, the aquifer is a kind of container of groundwater. The concept of aquifer corresponds to the general denomination of the materials of the soil and the substrate from the point of view of its capacities to allow the entrance and circulation of the water within its mass. The characteristics that they present are in function of the porosity (quantity and diameter of the pores), their connectivity and the existence of cracks and fissures.

In addition to aquifers, there are other geological formations according their hydrological comportment (entrance and water mobility). The Aquiclude is a type of substrate that may contain water in appreciable amounts and which does not allow water to flow through it. Although it's a porous hydrologic unit capable of storing water, it is not capable of transmitting it at rates sufficient to furnish an appreciable supply for a well or spring. For example, clays which contain a large amount of water but it is trapped and cannot escape by gravity and/or circulate in the subsoil nor in natural conditions nor to a well that is pumping. The aquitard is an intermediate concept between the two previous ones. It is a type of substrate that may contain water in appreciable amount but water circulates through it with difficulty. Aquitards retards but does not prevent the flow of water to or from an adjacent aquifer. It is a leaky confining

bed. It does not readily yield water to wells or springs, but may serve as a storage unit for groundwater (Subramanya, 2006; Vaessen & Brentführer, 2015).

An aquifer could be considered as overexploited when extraction is greater or close to recharge, considering long-term mean values. However, recharge and even abstraction (or extraction) are uncertain terms, which may present a large variability range. Also, mean recharge is not constant since it may be modified by human activities and aquifer development. Nevertheless, in practice overexploitation is a concept linked to the observation or perception of some persistent negative results of aquifer development such as continuous water level drawdown and quality deterioration.

Where groundwater is in direct contact with the atmosphere through the open pore spaces of the overlying soil or rock, then the aquifer is said to be unconfined. The upper groundwater surface in an unconfined aquifer is called the water table. The depth to the water table varies according to factors such as the topography, geology, season and tidal effects, and the quantities of water being pumped from the aquifer. Unconfined aquifers can receive direct recharge from rainfall infiltrating and percolating through the unsaturated zone down to the water table. That is, unconfined aquifers are those into which water seeps from the ground surface directly above the aquifer. These aquifers are also known as phreatic aquifers. The water in them is at atmospheric pressure and when these aquifers are pumped, the water table is lowered aquifer (Stewart & Howell, 2003; Margat & van der Gun, 2013; Vaessen & Brentführer, 2015).

In turn, aquifers may be buried beneath impermeable materials. This typically occurs in sedimentary basins where permeable and porous sedimentary strata dip beneath impermeable strata to become cut off from the land surface. These aquifers are known as confined aquifers because they are separated from the surface by an impermeable layer and don’t receive direct recharge from rainfall. They may receive recharge from a distant point where the aquifer strata outcrop at the surface, and at this point the aquifer is locally unconfined. They also may be entirely confined under impermeable strata and receive no recharge at all. This is also called artesian aquifer (Margat & van der Gun, 2013; Trimble, 2008; Vaessen & Brentführer, 2015) (Figure 2).

There is another way to classify aquifers according to the composition and structure of the subsoil (Margat & van der Gun, 2013):

- Sand and gravel aquifers are the most extended, accessible and exploited aquifer systems in the world. Because these aquifers mainly coincide with areas of intensive human occupation (e.g. urbanization, intensive agriculture), they are also affected by pollution. These sediments have their origin in the erosion of rocks which are deposited after being transported by streams (alluvial or fluvial deposits), ice (glacial and fluvio-glacial deposits), wind (wind deposits) or sea (marine deposits). They are characterized by their high porosity and permeability; in general, they are usually unconfined, with shallow water tables and are primarily recharged by the infiltration of excess rainwater.
- Sandstone aquifers: they are the consolidated version of a sand and gravel deposits being, therefore, older than those. Individual grains are glued together by a cement of calcite, silica, clay or other minerals, while the weight of the younger layers that cover them may have produced compaction. Porosity and hydraulic conductivity of sandstone aquifers are lower than those of unconsolidated sand and gravel aquifers. Compaction reduces pore space but external pressures often produces fissures in the solid rock that facilitates groundwater storage and flow. Because sandstones extend over large areas and are often thick, they form an important category of aquifers in a global context. Several of the mega aquifer systems consist largely of sandstone (e.g. the Guaraní Aquifer System, the Nubian Sandston Aquifer System, the Great Artesian Basin in Australia).
- Karst Aquifers are a special type of carbonate fractured rock aquifers (limestone, dolomite or magnesite) that cover almost a quarter of the world's land surface. Into these rocks, the water in the fractures has dissolved the relatively soft rock, thereby significantly increasing the size of the fractures, forming voids, caverns and even caves. Karst terrains are, by nature, lacking in surface waters, and all water circulation occurs underground. However, these resources are very

difficult to utilize and to protect. Due to their characteristics, they are particularly vulnerable to pollutants and excessive exploitation. An excessive and uncontrolled utilization of the reserves of deep phreatic zones can be a hazard for these kinds of aquifers: deep waters move very slowly and need years or decades to be substituted, so an excessive exploitation could endanger the utilization of the entire aquifer forever. In addition to its climatic and anthropogenic vulnerability, more research is still needed to develop more knowledge about these aquifers

- Volcanic aquifers: they are complex and of small size and their origin coincides with that of the formation of volcanoes on the planet. Most of the volcanic rock formations are not very permeable. However, there are some productive but heterogeneous and discontinuous aquifers in Quaternary volcanic rocks, or even in older ones which consist of an alternation of fissured lavas and porous pyroclasts, generally very permeable. These aquifers are scattered over the many volcanic massifs of our planet. Volcanic rocks favor the infiltration of rainfall and snowmelt, and thus recharge volcanic aquifers. Aquifers located in the Chile-Bolivia border are an example.
- Basement aquifers: basement or crystalline base is composed of igneous and metamorphic rocks, and underlies the sedimentary and volcanic rock sequences on all continents. Its reliefs are variable and receive on average more precipitation than the areas covered by sedimentary rocks. They also store more groundwater than has been previously believed, particularly in regions with a humid climate (in sub-arctic, temperate and tropical zones). The basement outcrops contain very special aquifers, with conductive and storage functions. These aquifers provide modest but rather widely distributed groundwater resources, used for rural domestic or animal water supply and even for small-scale irrigation.

Regarding the process of charge and discharge of aquifers, it can occur entirely within the territory of one state, or in more than one state. In the latter case, we can find several types. Considering aquifers' hydrogeological characteristics, Eckstein and Eckstein (2005) present six models as illustrative of the main scenarios in which groundwater resources have transboundary implications. In the simplest of these, an aquifer can be traversed by an international boundary that leaves one part of it in one state and another in a neighboring state. It may also happen that an aquifer is entirely in the territory of a state but it's hydraulically dependent on an international river or an aquifer situated in another state. A different case is when an aquifer that is in the territory of a state has its area of recharge or discharge in another. In all these instances it may be that the activity taking place in the territory of a state with respect to groundwater has consequences beyond its borders and changes the natural state of those waters. For example, over-exploitation of an aquifer located across an international boundary will have effects on the part of the aquifer belonging to another state.

- **Model A** depicts an unconfined aquifer that is linked hydraulically with a river (either losing or gaining), both of which flow along an international border. The contamination of the river or the overpumping of the aquifer may impact in both sides of the borderline.
- **Model B** represents an unconfined aquifer intersected by an international border and linked hydraulically with a river that is also intersected by the same international border (the political boundary bisects both the river and the aquifer). Generally, gradients may explain the transnational consequences: water in the river and the related aquifer flows down-slope from State A to State B implying that most transboundary situations will result from pollution in State A transported into State B (through either the river or the aquifer) or from overpumping in State A, which reduces the flow into State B. The Silala River (Bolivia-Chile) and its aquifer, and the Genevese Aquifer are examples of this type.

- **Model C** is for unconfined aquifers that flow across an international border and are hydraulically linked to a river that flows completely within the territory of one state. Any modification on the river or the aquifer will have transboundary consequences.
- **Model D** represents unconfined aquifers that are completely within the territory of one state but is linked hydraulically to a river flowing across an international border (the river is international, while the aquifer is geographically domestic). The transboundary implications for this model are solely dependent on river volume and quality flowing from State A to State B. In this model, State A has the singular opportunity and responsibility for ensuring the quantity and condition of water in the river.
- **Model E** describes a confined aquifer, unconnected hydraulically with any surface body of water (except perhaps within the recharge zone in an unconfined portion of the aquifer) that traverses an international boundary or that is located completely in another state. This type of aquifer has transboundary consequences which are a function of the rate of pumping. Any excessive pumping in one or both states could have serious implications for the part of the aquifer along the border between the two countries. The Guarani Aquifer is an example of this model and the aquifers located in the border between Chile and Bolivia (Ascotán and Ollagüe- Pastos Grandes Aquifers).
- **Model F** represents all transboundary aquifers unrelated to any surface body of water and disconnected from the hydrologic cycle, therefore devoid of any significant recharge. Such aquifers contain ancient water and may be confined or unconfined, as well as fossil or connate, so they are non-rechargeable and cannot be sustainably exploited. The Nubian Aquifer is an example (Eckstein and Eckstein 2005).

In all these cases, we are faced with the issue of legally regulating activities that have or may have consequences beyond the limits of the territory of the state in which

they are carried out. Sometimes, states ignore the "transboundary" consequences of their groundwaters, because they consider that are nationally resources, and their activities can impact their neighbors. This is why advance in research about groundwater characteristics is so important. It is the starting point to cooperate in a preventive way and avoid possible irreparable damages and future conflicts. When analyzing the "knowledge" causal factor, we are talking about the necessity of having enough information about all these characteristics: model of aquifer, hydraulic connections, porosity and properties of soil and subsoil, recharge and discharge areas, storage capability, tolerable rate of pumping, among others.

If we consider the kind of transboundary consequences that an aquifer may have (guided by the models presented above), then it is possible to determine, for example, exploration methodologies, the kind of extractions and activities consider as more viable or more dangerous for the sustainability of the resource, all data and information that states should share with others aquifer states, etc. Any aquifer's management agreement has to consider all these characteristics which have transboundary impact and can affect to all states involved.

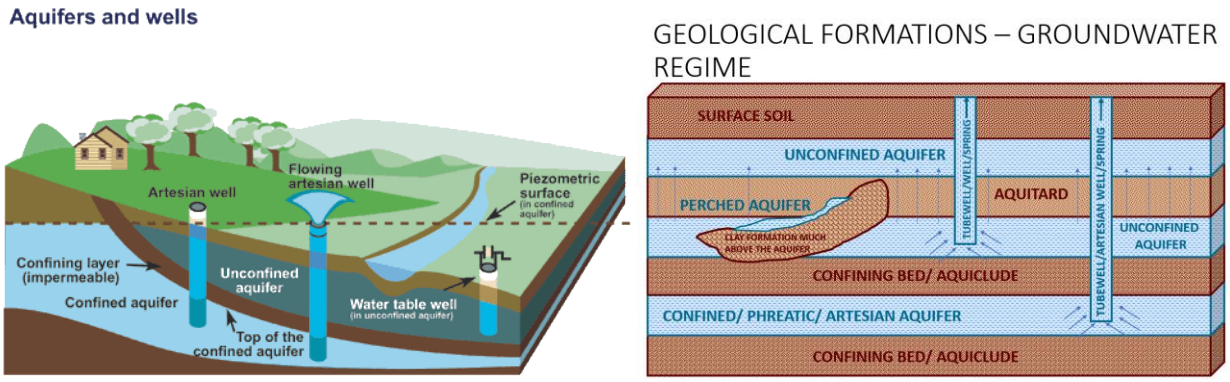

Figure 2. 0.2: Confined and Unconfined Aquifer, Aquitard and Aquiclude
Source: USGS

A drainage basin or river basin is the land surface within which the precipitated water is drained by a river or river channel networks. The basins whose drained waters

flow into the sea are called exorheic basins. Otherwise, if they converge to a closed valley, they are called endorheic basins. So, the river basin is "the area which contributes hydrologically (including both surface and groundwater) to a first-order stream, which, in turn, is defined by its outlet to the ocean or to a terminal (closed) lake or inland sea" (A. T. Wolf et al., 1999, 389). If any perennial tributary crosses the political boundaries of two or more nations, then it is an international basin.

Recently, freshwater reservoirs or aquifers under the oceans, similar to those found below the earth, have been discovered and their salinity is low enough to be converted into drinking water. On the coasts of Australia, China, South Africa, and North America, for example, freshwater aquifers have already been identified, and their volumes of water could sustain some regions for decades. In the case of Chile, UNAB geology academics have discovered the existence of freshwater aquifers contained in continental plate marine sediments throughout Central Chile, offshore of Valparaiso and Itata. In all these cases, these are fossil aquifers -non-rechargeable- formed more than 20,000 years ago, at the end of the glacial era. Sea level was more than 100 meters deep compared to the current level, and water from rains and glacial melt infiltrated the ground filling areas at the water table. With the thaw, the sea level increased, and those areas were covered by the ocean. Layers of clay and sediments under the sea protect the aquifers there formed.

These waters pose new challenges to international law. Indeed, access to these waters and their exploitation face technical, economic, and ecological difficulties (due to damage to the ecosystem and the risk of saline intrusion). Additionally, the rights of exploration, exploitation, and conservation of these resources will depend on their exact location in the maritime legal space in which the oceans and seas are divided according to the United Nations Convention on the Law of the Sea, and on whether those locations are shared by two or more states (Movilla Pateiro, 2014).

International Water Law

International watercourses law has evolved in recent years. Its object of regulation has changed from the restricted concept of International River to a wider one such as the International Basin. The regulated uses of these watercourses were diversified. Formerly, only their uses associated with navigation were regulated, and later, new dimensions of water resources in the environmental, economic, human rights field, among others, were recognized. As Movilla Pateiro (2014) indicates, what currently exists is a normative pluralism that allows us to talk about the existence of an International Water Law.

The international watercourses law considers the set of rules related to watercourses as waterways -and currently focuses on the different uses of that activity-, with the aim of avoiding conflicts between states that share the resource, in the management and distribution of its waters.

In general, watercourses have been regulated through bilateral or multilateral treaties between states that share the resources. Though, less than half of the international basins identified have a treaty that regulates them, and not every state sharing the basin is part of the treaty (Movilla Pateiro, 2014). This particular regulation on each basin has made difficult to recognize general norms to create a universal regulation. However, it's possible to identify an evolution on watercourses regulation with universality aspiration, specially attending to their uses for navigation or other purposes. In this sense, the 1997 United Nations Convention on the Law of the Non-Navigational Uses of International Watercourses is the only treaty governing shared freshwater resources with universal applicability.

Evolution in the regulation of the watercourses uses and object

About regulated uses

International water law has started to address the problem of transboundary watercourses fundamentally in the early nineteenth century, after the Napoleonic wars,

when the expansion of commercial navigation on international rivers moved to riparian states to some kind of systematic collaboration. By that time, non-navigational activities such as irrigation or industrial consumption were emerging and escaped the attention of international law until relatively recently (Baranyai, 2020). The Final Act of the Congress of Vienna in 1815 and its consecration of the principle of freedom of navigation on international rivers was the first milestone in the evolution of international water law. This principle was reinforced and expanded repeatedly by various international treaties -as the Berlin Conference in 1885, and the Versailles Treaty at the end of the First World War-, and was recognized by the Permanent Court of International Justice in 1929 in the River Oder Case as customary international law.

Nevertheless, during the Cold War, there was a setback in the internationalization principle given the context of competition between the two superpowers, and a greater regionalization of rivers with the consequent limitation of river navigation. At present, this principle was not adhered to by later agreements. In the post-colonial world, the freedom of navigation for all flags resulting from the treaties concluded by the colonial powers was replaced, upon independence, by agreements or legislation limiting that freedom to the vessels of the riparian states. This also seems to be the position under contemporary international law and was framed through a specific legal regime carried out by treaties and national legislation. Actually, there are different concepts of freedom of navigation's principle that varied depending on the region or watercourse they applied to (Boisson de Chazournes, 2013). In general, states have tended to regulate international watercourses through specific treaties that establish a particular regimen for navigational or non-navigational uses.

After the World War II, non-navigational uses of transboundary basins have grown in importance for the International Law due to the proliferation of new and competing demands for water by agriculture, industrial, urban users, etc. It's important to note that the non-navigational uses of international watercourses such as energy production or irrigation -and unlike navigation-, have a privative character because if a state detracts water flows in its territory, it is depriving other riparian states of these

flows. The need to preserve and protect these waters revealed the limitations of non-existent standards at the international level (Movilla Pateiro, 2014). Some international institutions help in the development of the relevant international customary norms, principally, the jurisprudence of the International Court of Justice, the Institute of International Law (IIL), and the International Law Association (ILA). The IIL is an international organization that made important contributions to non-navigational uses of international water since the early twentieth century (1911). One of these contributions was the Madrid Declaration that established the "no harm" principle, a fundamental base of the current international water law.

The other private scholarly body which enjoys a high reputation in this particular field is the ILA. In 1966, the ILA adopted the Helsinki Rules, a codification of the Uses of the Waters of International Rivers whose foundational concept was the principle of equitable utilization. After their issuance, the Helsinki Rules became the most authoritative set of rules on the use and protection of international watercourses and were gradually accepted by the international community as reflecting customary international law (Boisson de Chazournes, 2013; Caflisch, 1998). Helsinki Rules' main input is the rules on the non-navigational uses of the international drainage basin and the idea that the uses and resources of such waterways are shared among the riparian states per equitable and reasonable principles.

Despite their importance and impact, the Helsinki Rules, as such, had no official standing, and the world's water resources continue without a general regulation. For this reason, the General Assembly of the United Nations decided, in 1970, to request the International Law Commission to study non-navigational uses of international watercourses and evaluate its eventual coding. The negotiation process was not without difficulties and controversies between the states, so the writing of the final version of the articles took several years. Some issues that were controversial among the members of the commissions in charge –and reflect the different interests of the states- were its provisions about the relation between the principle of equitable and reasonable utilization and the rule that no harm may be caused by one watercourse state to another,

the effect of the new convention on existing watercourse agreements, the establishment of a peaceful settlement of watercourse disputes, and its configuration or not as a binding agreement.

Finally, in 1997, the General Assembly adopted the Convention of New York or "Convention on the Law of the Non-navigational Uses of International Watercourses", which collects these norms considered as customary law with 103 votes in favor, 3 against and 27 abstentions (Caflisch, 1998; Movilla Pateiro, 2014). However, it was not until 2014 when it entered into force after obtaining the thirty-five instruments of ratification required.

The Convention is the result of political compromises among states with different interests and perspectives. It is a Framework Convention because it constitutes a set of articles that can be applied or modified in response to the unique nature of international watercourses and the complexity of the international system. For these reasons, and to obtain the necessary ratifications, some provisions are somewhat general or ambiguous. For example, states may set new agreements and apply or adjust the provisions of the Convention according to the characteristics and uses of the watercourse concerned; and existing agreements would survive without change and may be amended with the consent of all states parties to them (Caflisch, 1998; Movilla Pateiro, 2014).

Thereby, the Convention has collected pre-existing or in formation norms and codified them as customary law. Its principal input is to establish a list of applicable general principles as that of equitable and reasonable utilization, the no-harm rule, the protection of the environment, procedures for dispute settlement or avoidance, the involvement of non-State actors, and the general obligation to cooperate which is specified in certain obligations such as the exchange of data and information.

The principle of equitable and reasonable utilization and participation is set out in Article 5 of the UN Watercourses Convention:

"1. Watercourse States shall in their respective territories utilize an international watercourse in an equitable and reasonable manner. In particular, an international watercourse shall be used and developed by watercourse States with a view to attaining optimal and sustainable utilization thereof and benefits therefrom, taking into account

the interests of the watercourse States concerned, consistent with adequate protection of the watercourse.

2. Watercourse States shall participate in the use, development and protection of an international watercourse in an equitable and reasonable manner. Such participation includes both the right to utilize the watercourse and the duty to cooperate in the protection and development thereof, as provided in the present Convention*"* (United Nations, 1997).

The Article 6 describes some factors and circumstances to apply this principle, including geographical, social, economic, cultural, historical and ecological considerations. It also mentions "The effects of the use or uses of the watercourses in one watercourse State on other watercourse States", which connect the principle of equitable and reasonable utilization with no-harm rule.

Article 7 establishes the 'no-harm' rule as follows:

*"*1. Watercourse States shall, in utilizing an international watercourse in their territories, take all appropriate measures to prevent the causing of significant harm to other watercourse States.

2. Where significant harm nevertheless is caused to another watercourse State, the States whose use causes such harm shall, in the absence of agreement to such use, take all appropriate measures, having due regard for the provisions of articles 5 and 6, in consultation with the affected State, to eliminate or mitigate such harm and, where appropriate, to discuss the question of compensation*"*(United Nations, 1997).

It is important to note that these principles have arisen in contrast to the sovereignty-driven interests because they suppose a limited conception of sovereignty and reflect the concept of the community of interests. Gradually, these principles have been incorporated in both state practices, evidenced by their incorporation in many conventional instruments, and judicial proceedings (Boisson de Chazournes, 2013).

Regarding the UN Convention's real impact, it has not been as expected, especially when it is taken into account that several of its components are not part of a large number of existing agreements on water. In practice, quality and quantity problems are not always considered together; equity in the distribution of water resources remains a quest in many parts of the world; cooperation and information exchange must still be strengthened; and dispute prevention and avoidance mechanisms remain, in general, underdeveloped.

At the regional level, two important treaties regulate transboundary watercourses for uses other than navigation, attending regional specificities. It's important to mention that these instruments have been influenced by the ILC's negotiating process. The first one is the Helsinki Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Helsinki Convention), in 1992. This is a framework agreement that applies in the European region. However, parties of the Helsinki Convention, in 2003, adopted an amendment that aims to extend the Convention's geographic scope to non-member States of the Economic Commission for Europe.

Helsinki Convention has similarities with the New York Convention, but its scope is more extensive. Its notion of transboundary waters considers any surface or groundwaters –confined and unconfined aquifers- which mark cross or are located on boundaries between two or more States. Additionally, the Helsinki Convention has been more successful in its scope. A large number of bilateral and multilateral agreements on specific watercourses have been concluded under its provisions.

The other regional treaty is the Protocol on shared watercourse systems in the Southern African Development Community (SADC) reveals a similar set of interactions between the universal and regional levels. The 1995 Protocol on shared Watercourse Systems in the SADC and its 2000 revised version has been prompted by the UN Watercourses Convention. Eventually, it suggests certain influence between the universal and regional levels. Its principal aim is to foster closer cooperation in the management, use sustainable and coordinated of shared water resources, and promote the integration and harmonization of member states' water policies. A remarkable thing about this treaty is that it takes general provisions from the UN Convention and incorporates others considering their own socioeconomic, political, climate, and geological characteristics.

The object of watercourses' regulation: the international basin concept

Since the late eighteenth century, the object of international watercourses law was common rivers shared by two or more states. Article 108 of the Final Act of the Congress of Vienna of 1815 enshrined the expression of international rivers or lakes referring to navigable waterways of concern to two or more states or lakes crossed by a frontier or surrounded by several riparian states.

Another expression used in 1921, in the Barcelona Convention, was waterway of international concern, which extended the principle of freedom of navigation to all flowing waters, national or international, and was just linked to navigational uses. Later on, the international rules were extended to tributaries, canals, and secondary courses in addition to main streams, though only concerning surface water. Underground waters were not covered yet.

As multiple uses other than the navigation of water resources become prominent, the limitation of the concept of "International River" begins to manifest. The development of hydraulic engineering techniques and the emergence of economic theories of integrated river basin compelled to review the traditional criterion of 'navigability' of a river to designate it as international. "It has been realized that what is of international concern is not only the main course of a river, but all the waters belonging to the same river basin or system, and that any human interference with the waters located in one part of a basin or system may affect waters located in another part of it, directly or indirectly" (Caponera, 2007, p. 187).

In the 1950's, the International Law Association (ILA), proposed the concept of international drainage basin. The Helsinki Rules of 1966 advanced with a definition considering it as a "geographical area extending over two or more States determined by the watershed limits of the system of waters, including surface and underground waters, flowing into a common terminus"(International Law Association (ILA), 1967). Despite its limitations, this concept of "international basin" was polemic and broader than "international river". At the international level this concept finds the stumbling block in state sovereignty because states have the erroneous idea that it could affect their absolute

control over their territory. It could be like co-sovereignty over strategic resources. Because of states' distrust, the International Law Commission of the United Nations (ILC) -and the Convention of New York- has adopted the concept of international watercourses when referring to rivers, lakes, glaciers, and underground water.

Other concepts as been employed in different sources of law, for example, international water resources system, transnational water, shared hydric resources. Although there is no general consensus over the correct concept, what has become evident is the change occurred in the object of the international watercourses law, which is broader and considers all surface and groundwater connected as a unitary whole (Caponera, 2007; Movilla Pateiro, 2014).

The evolution of International Water Law

As a result of the increased use of water resources and the concerns of international society regarding the use and management of them, the traditional Law of International Watercourses has been considered insufficient. Other sectors of International Law began to study and regulate the new dimensions of shared water resources. The International Law of Human Rights, the Humanitarian International Law, the Law of Armed Conflicts, and the International Environmental Law are some examples. This normative set referring to water from different international legal systems was called International Water Law.

International Economic Law and Fresh Water

Recently, we have witnessed a growing economization of water as a natural resource. Freshwater has economic, social, and political characteristics, both at the national and international levels. But is has been seen as a source of profit and the subject of International Economic Law. This feature is observed in the context of

international trade law and investment law, and may also be perceived in domestic and interstate negotiations concerning proposed international bulk water transfers.

There are different aspects into which freshwater occupies an increasingly important place in international economic law: as a good, as a service, as an object of bilateral investment treaties.

In the area of international trade, arguments have emerged both for and against the privatization of water services and the consideration of freshwater as a commercial good subject to the rules of the General Agreement on Tariffs and Trade (GATT). For example, bottled water is clearly a product and its expanding international market is subject to International Economic Law. But when water is exported or transferred to other countries (if it is diverted or transported in large quantities by tankers or pipelines), it is diffuse the boundary between the International Economic Law and the International Watercourses Law (Movilla Pateiro, 2014).

In general, freshwater as an exportable product is subsumed to GATT and OMC rules and general exceptions. Some of these general exceptions are about restrictions on international trade that states can impose to protect people's health and life and for the conservation of exhaustible natural resources. On the first point, there is an area of concurrence between international commercial law and international human rights law.

Although water has been considered and is included in the GATT tariff tables as a product, its main role is as a service industry. The General Agreement on Trade in Services (GATS) regulates trade in services and aims to liberalize it among WTO members. An essential service as water supply falls within this liberalization objective. But, trade liberalization of water services faces strong opposition because it would limit the state's capacity to implement policies for the common good and to guarantee this right. Undoubtedly, water supply is a human right that states have to guarantee to their population.

Therefore, water is treated both as an economic good and as a public good. The population’s clean water supply and maintenance of infrastructure and distribution networks require a major capital investment. Proponents of market-based solutions argue

that the way to efficiently exploit water resources to avoid the tragedy of the commons is to commercialize water by delivering this service to the private sector. Detractors of water supply service's privatization emphasize the past experience of several market failures to provide water services to the poor at an affordable price. They argue that this right could be threatened when states do not have enough regulatory capacity and fail to control private companies and to guarantee such service (Gavouneli, 2011).

The International Investment Law is another controversial area of the role of freshwater as it relates to goods and services. Furthermore, the privatization of drinking water and sewage sectors keeps questioning the relationship between states and private operators in the care and distribution of this crucial resource. The principal instruments used to regulate this matter are the so-called Agreements for the Promotion and Reciprocal Protection of Investments, bilateral and regional investment treaties, and multilateral frameworks for investment dispute settlement. These mechanisms have become the basis for establishing rights and obligations throughout an investment. Investment treaties have promoted certain principles, such as the principle of fair and equitable treatment (Boisson de Chazournes, 2013). But in the area of freshwater supply services, these instruments have shown some questionable results when the arbitrations resolve in favor of the investor and to the detriment of the recognition of the right to water.

International Environmental Law and Fresh Water

Since the mid-twentieth century, International Environmental Law has been contributing in a variety of ways to the protection and effective management of freshwater. There has been a growing concern about water, its use, and its degradation in environmental debates. The existence of numerous linkages between freshwater and the environment has allowed talking about the "ecologization" of freshwater regulation in national and international contexts (Movilla Pateiro, 2014).

Principles and norms of International Environmental Law have been incorporated in many treaties dealing with transboundary water resources. For example, many principles in the Stockholm Declaration on the Human Environment of 1972 and the 1992 Rio Declaration on Environment and Development are included in international agreements and arrangements dealing with the protection and management of freshwater. “Environmental protection of transboundary freshwater systems has emerged as one of the key principles of international water law” (Boisson de Chazournes, 2013, p. 118).

The ecosystems’ protection and water quality have seen a remarkable increase linked to sustainable development; particularly since the 1987 Brundtland Report named “Our Common Future”, by the World Commission on Environment and Development. This report defines sustainable development as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs”(United Nations Commission on Sustainable Development, 2007). Later, this concept has been used in the Earth Summits held since then: the United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro 1992; the Johannesburg Summit 2002 -the World Summit on Sustainable Development-; and the United Nations Conference on Sustainable Development 2012. In general, in these instances, the states committed themselves to integrate water resources into sustainable development, giving special importance to water and sanitation in order to achieve these dimensions of development.

Additionally, sustainable development has been included in different regional and multilateral agreements, such as the founding agreement of the World Trade Organization, the European Union Law, the General Assembly and the Security Council of UN, or the international jurisprudence.

The environmental dimension has also been incorporated in the management of water resources in the 1997 UN Watercourses Convention. The Convention codifies specific cooperation obligations that help prevent or mitigate the risk of environmental damage. It consolidates the obligation of states to protect and preserve the international

watercourses' ecosystems. Protecting water quality is another concern of the 1997 UN Watercourses Convention. Pollution is a constant threat to freshwater conservation. For example, the Convention establishes that riparian states cooperate to establish lists of substances that should be subjected to special regulation.

Many multilateral environmental agreements (MEA's) consider the protection of these resources and establish institutional mechanisms for the implementation of these agreements. International environmental law instruments and those instruments dealing with freshwater complement each other in enhancing the protection and management of freshwater. Some multilateral environmental conventions regarding aspects of the protection of international freshwater sources apply at the universal level; others regulate environmental management at the regional level. These conventions are added to the set of norms that regulate the use and protection of water resources and have different aims: to protect freshwater resources, in particular, to protect biodiversity (for example, the Convention on Biological Diversity (CBD) and the Convention concerning the Protection of the World Cultural and Natural Heritage); to protect this resources against the negative impacts of human activity (e.g., The United Nations Framework Convention on Climate Change, the Convention to Combat Desertification in Countries Experiencing Serious Drought and/or Desertification, particularly in Africa).

Climate change is another area that has important links between the environment and freshwater. It affects the environment and ecosystems, in particular through the medium of water. It entails, for example, significant variability in weather patterns, changes to precipitation levels, desertification, and the rise in sea levels. As this topic has gained international relevance, some joint commissions on transboundary water resources have started to implement programs dealing with climate change adaptation, for example, the Climate Change and Adaptation Initiative (CCAI) developed by the Mekong River Commission in 2007 (Boisson de Chazournes, 2013), and some pilot projects in the United Nations Economic Commission for Europe (UNECE) region.

Water in the International Human Rights Law and the International Humanitarian Law

Water is essential for the satisfaction of basic human needs and the development of human life. These human needs have been incorporated into the law applicable to freshwater through a variety of avenues that have been engaging both state and non-state actors. The law of transboundary water resources increasingly sees the management and allocation of water resources through human beings' lens and human development. This concern has become increasingly relevant within certain civil society sectors and within the United Nations human rights protection system.

The perspective regarding the protection of basic human needs is increasingly present in the law of transboundary water resources[19]. Both the Convention on the Law of the Non-navigational Uses of International Watercourses 1997 and the 2008 International Law Commission's Draft Articles on the Law of Transboundary Aquifers consider human needs into their provisions, and apply both the principle of equitable and reasonable utilization and the principle of the prohibition on causing significant harm when they refer to basic rights of populations that depend on watercourses or aquifers. Nevertheless, the International Law of Transboundary Watercourses has its limitations and has made it necessary to advance the water's protection as a human right. As Bourquain (2008) notices, the Law of Transboundary Watercourses does not apply in national waters, a state's domain, and so, cannot assure its access to the national population. Additionally, general principles recognized in this Law –equitable and reasonable utilization and no-harm rule- are not enough to protect and guarantee water access to all persons.

At the international level, the recognition of water as a human right was recently produced, in 2010, from a series of resolutions issued by the General Assembly of the United Nations and the Human Rights Council. Before that, the United Nations

[19] The Law on Transboundary Watercourses refers principally to the rights and obligations of states -unlike International Human Rights Law that protects the rights of individuals-, and for that reason, they talk about human needs rather than the human right to water (Movilla Pateiro, 2014).

Committee on Economic, Social and Cultural Rights, during its 29th session (2003), has issued the General Comment N°15 where it states that: *"The human right to water is the right of everyone to have sufficient, safe, acceptable, accessible and affordable water for personal and domestic use".* In turn, he stressed that the right to water is inextricably associated with the right to adequate health, housing and food.

On the other hand, in the Resolution 64/292 (2010), the United Nations General Assembly officially recognizes the human right to water and sanitation. It assumes that safe and clean drinking water and sanitation are essential for the full enjoyment of life and the realization of all human rights. As such, it links this right to the right to life and views it as a prerequisite for the realization of all human rights.

The human right to water and sanitation requires that services be available, safe, acceptable, accessible, and affordable. After that, the Human Rights Council through the resolution 15/9 (2010) has reinforced the concept of human right to water and sanitation as part of current international law and confirmed that this right is legally binding for States.

The recognition of water as a human right has been quite controversial. It implies a significant advance as it provides legal tools that allow states to prioritize its treatment. But there is still an insufficient consensus on its concrete scope and content, and it generates suspicion on the part of the States due to the economic demands that this right may entail.

Finally, the International Humanitarian Law applicable to armed conflicts – *ius in bello*- protects water and sanitation as a basic human necessity. The poisoning of water as a means of combat is prohibited, as is the destruction of dams and reservoirs that provide access to water for civilian populations. Moreover, prisoners of war are also afforded protection (they should be provided with enough potable water to maintain good health as well as enough water for daily personal hygiene).

The Geneva Conventions (1949) and their Additional Protocols (1977) highlight the importance of access to drinking water and sanitation for health and survival in international and non-international armed conflicts. In general, water regulation has

occurred within a context of growing concern for the protection of the environment in armed conflicts. This area of international law has also established specific provisions on the protection of water resources during the conduct of hostilities. In this regard, there are two groups of norms, those relating to the prohibition of the use of certain weapons or methods of conducting hostilities, and those associated with water as an indispensable good for protected people.

The emerging International Law for Transboundary Groundwater Resources

Transboundary aquifers can be found all around the world, even in arid and semi-arid zones. Until recently, their number was unknown. In 2015 the International Groundwater Resources Assessment Centre (IGRAC) had identified 592 transboundary aquifers (IGRAC, 2015). Given this number, one would expect an abundance of treaties and legal rules to govern these resources. However, few states regulate the use of their groundwater, and regulation is even scarcer in cases of these transboundary resources. There are only six transboundary aquifers agreements, and no global o regional treaty exists. Principal guidelines come from non-binding legal instruments and isolated provisions in surface water treaties. Therefore, we are simply in a nascent stage or *statu nascendi*. "Aquifers are strange new beasts for international-law purposes" (Gavouneli, 2011, p. 319).

The beginning: International Groundwater Law from the 1960s until 1999

The first codification of modern water law is the above mentioned Helsinki Rules on the Uses of Waters of International Rivers (1966). Although groundwater is included in its scope, not a single article addresses the specific challenges of managing a shared aquifer. In addition, according to the definition of international basins that this convention provides, it only considers groundwater that is hydraulically related to

surface water and flows to a common mouth and leaves out non-connected aquifers like the 1997 New York Convention will do later.

In 1977, the United Nations Water Conference -the first international reunion about water- in Mar del Plata, Argentina, issued the Mar del Plata Plan of Action. This plan of action establishes recommendations for groundwater management with a focus on the utilization of aquifers and increasing aquifer-related knowledge (Mechlem, 2011).

But it was only a decade later that groundwater became an issue of international law again. In 1986 during its reunion, the ILA adopted the Seoul Rules on International Groundwaters as a complement of the Helsinki Rules. The Seoul Rules contained four articles and extended the scope of applicability to the excluded types of aquifers, namely to aquifers that are or are not hydraulically connected to surface waters (confined aquifers). The most important type of confined aquifers is non-renewable aquifers or fossil aquifers that receive no significant contemporary recharge, which are particularly important in arid and semi-arid areas, often affected by drought and desertification. Besides, the Seoul Rules contained specific provisions about pollution and the obligation of basin states to protect groundwater. They establish that states have to consult and exchange relevant data and information with the purpose of protecting groundwaters, the geological structure of aquifers and the recharge areas, paying special attention to the interdependence of both groundwater and surface water, and groundwater with each other, and any aquifers' filtration caused in their respective jurisdictions (International Law Association, 1986).

The Seoul Rules were the first step in considering that all types of aquifers should be subject to the rules of international water law (McCaffrey, 2011; Mechlem, 2011; Movilla Pateiro, 2014). Nevertheless, the next step towards international water regulation, the 1997 Convention on the Law of Non-navigational uses of International Watercourses (UNWC), will take a step back in this regard by incorporating the formula contained in the Helsinki Rules. The inclusion of groundwater related to surface water in the Convention (first official codification of the Law of International Watercourses) was a significant advance when introducing aquifers, traditionally ignored by international

law, and gives them great visibility as a strategic resource. But it just adopted the international watercourses concept, and its articles on watercourses only cover groundwater that is hydrologically connected to surface water and flowing to a common terminus. In this way, a large number of aquifers with transboundary implications are left out of its scope. It doesn't consider transboundary unconnected aquifers –its waters are not connected to surface waters or don't have any recharge, such as fossil or confined aquifers-, but also all other aquifers that receive their recharge exclusively from the infiltration of rainwater or aquifers not sharing the same terminus with the surface water body -the ones that discharge into the sea or another aquifer, or which constitute themselves the endpoint due to evaporation (Mechlem, 2011; Stephan, 2019).[20]

As with most of the treaties that contain references to groundwater, the 1997 New York Convention includes them nominally within its scope of application by integrating them into the definition of international watercourses, but does not define them independently or contain specific provisions for groundwaters and aquifers. Nevertheless, it's important to note that, when the United Nation International Law Commission (ILC) adopted the final version of its draft articles on the law of the non-navigational uses of international watercourses in 1994, it also presented to the UN General Assembly a resolution on confined transboundary groundwater. The ILC recognized that groundwater that was unrelated to surface water –i.e., confined transboundary aquifers- also constitutes a vital natural resource for human beings and the ecosystem integrity. Considering that it's necessary to continue efforts to elaborate rules related to this kind of groundwater, the Commission requests states to be guided by the principles established in the 1997 New York Convention to regulate confined and unconfined transboundary groundwaters. Still, the General Assembly did not approve any measure mentioned in this text (McCaffrey, 2009, 2011; Movilla Pateiro, 2014).

In 1989, the United Nations Economic Commission for Europe (UNECE) adopted a Charter on Groundwater Management, which listed policy measures for

[20] Some examples of these kind of aquifers are the Umm er Radhuma/Rus aquifer shared by Saudi Arabia and Qatar that finish in Persian Gulf marine springs, or the Israeli Palestinian Mountain Aquifer, which has the recharge zone in the Judea Mountains top.

groundwater protection. And the same year, a multidisciplinary group of scholars developed a model treaty for the use and management of a transboundary aquifer called the Bellagio "Draft Agreement Concerning the Use of Transboundary Groundwaters". This draft agreement was intended to serve as a guide for states sharing groundwater in developing flexible and effective treaties in this area. Its previsions and definitions are similar to the ones established by ILA in the Seoul Rules. But Bellagio has a central suggestion: the establishment of a commission in charge of joint management, including the elaboration and maintenance of databases, the protection of the aquifer, and a dispute settlement mechanism (Mechlem, 2011; Movilla Pateiro, 2014).

Despite the significant contributions made by both the Seoul Rules and the Bellagio Draft Agreement, none has managed to have an impact on states practices. From there, the development of international groundwater law stayed stagnant, in contrast to the codification of surface water law that continued at all levels since the Helsinki Rules, as was described above (Mechlem, 2011).

Growing concern: Groundwater Law during the last two decades

The Berlin Rules on Water Resources

After this slow development, efforts to use legal means to manage and protect transboundary aquifers intensified during the 21st century. Further non-binding instruments were developed. In 2004 the ILA presents the most innovative and controversial instrument: the Berlin Rules on Water Resources. Its principal characteristic is that it incorporates all waters superficial and groundwaters, extending its scope from internationally shared waters to domestic resources. Thereby, its provisions are aimed at all kind of aquifers -whether they are in the territories of a single state, or are shared by two or more states-, and apply the same general principles to all freshwater resources.

The Berlin Rules contain a chapter dedicated exclusively to groundwater adapting rules applied to all waters: the precautionary management of aquifers, the duty

to acquire the information necessary to manage groundwater and aquifers, sustainability and protection. Special emphasis is placed on preventing contamination and degradation of these resources, even aquifers that are wholly within one state's boundary. Finally, principles of equitable and reasonable utilization, the no-harm rule, the general obligation to cooperate and exchange information are included. "The Berlin Rules are an example of an approach that addresses all freshwater resources in a holistic and comprehensive manner with a strong focus on their sustainable management and protection" (Mechlem, 2011, p. 218).

The Draft articles 2008

In 2008 the United Nations International Law Commission (ILC) completed its work on a set of nineteen draft articles on the law of transboundary aquifers and transmitted the draft to the General Assembly. It's the first official instrument that codifies rules specifically aimed at the regulation of transboundary aquifers, and it's probably the most profound effort to develop a governance system for transboundary aquifers. As we have seen, until now only existed the 1997 Convention of New York, that only considered unconfined aquifers in its provisions, and the ILC Resolution, which, among other things, recognized the need for elaborate specific norms for confined transboundary groundwaters.

The process of preparing the draft articles began in 2000 when the ILC included shared natural resources in its work schedule, and decided to focus on groundwater. The draft articles effectively added something new because it involved the development of specific knowledge about aquifers, which are much less understood by the states and their political subdivisions than surface waters. The introduction of scientific elements in its writing is due to the understanding that the lack of knowledge about this resource had been one of the causes of its scarce historical regulation (Movilla Pateiro, 2014).

The special rapporteur, Chusei Yamada, incorporated a series of reports for the Commission made by groundwater experts from UNESCO, the Food and Agriculture Organization (FAO), the Economic Commission for Europe, and the International Association of Hydrogeologists. This work involved a relevant contribution to knowledge about aquifers, groundwater, and hydrogeology, giving the draft articles a scientifically sound basis and the potential to inform future agreements and arrangements between states concerning shared groundwater (McCaffrey, 2009).

Regarding the final form of the draft articles, states manifested divergent positions. Some governments favored a framework convention, taking precautions to prevent it from replacing previous agreements or from limiting states to conclude them. Others were supportive of the adoption of a non-binding instrument, in the form of a General Assembly resolution containing general guiding principles for the conclusion of agreements or in the form of guidelines or a set of model principles. Several of them considered that the adoption of a convention, particularly if it was not ratified or not wholly supported, could reduce the usefulness of the draft articles. Others found it more reasonable to postpone the decision on the final form of the text, and some even considered that the approval of a non-binding instrument could be the first step in establishing an adequate regime for the use of all shared natural resources (International Law Commission, 2008). What is evident from this debate is the lack of consensus in international community about this issue.

Finally, the Special Rapporteur, aware of the global crisis over water resources, considered, for practical reasons, that it would be better to take urgent measures and that the affected states conclude bilateral or regional agreements based on the provisions of Draft Articles. He suggested that the Commission should propose what is referred to as a "two-step approach" recommending that "the General Assembly should:

(a) Takes note of the draft articles on the law of transboundary aquifers in a resolution and annex the draft articles to the resolution;

(b) Recommend that States make appropriate arrangements bilaterally or regionally with the States concerned for proper management of their transboundary aquifers on the basis of the principles enunciated in the draft articles;

(c) Also consider, at a later stage and in view of the importance of the topic, the possibility of convening a negotiating conference to examine the draft articles with a view to concluding a convention" (International Law Commission, 2008, p. 5)

The UN General Assembly (UNGA) received the Draft Articles favorably in 2008 and, according to ILC recommendations, during its sixty-third session, adopted Resolution 63/124 entitled "The Law of Transboundary Aquifers" by consensus on 11 December 2008. The resolution annexed the Draft Articles and encouraged the states concerned to make appropriate bilateral or regional arrangements for the proper management of their transboundary aquifers, taking into account the provisions of this Draft Articles (United Nations General Assembly, 2008). Additionally, the UNGA decided to include in the provisional agenda of its 66th session in 2011 an item to examine the form that might be given to the Draft Articles, whether they should be transformed into a convention or comparable document (Yamada, 2011). Since then, the decision on that final form has been postponed in subsequent sessions and resolutions. In 2011, 2013, 2016, and 2019 the Draft Articles were again raised at the UNGA, and their status and final form considered. While the member States gave the topic considerable attention, they again failed to reach a consensus on whether and how to move the issue forward.

According to reports submitted by the Secretary-General containing the comments and observations of some governments on the draft articles, it is possible to observe diverse and changing opinions about their final form. Among the states that gave their opinion on the final form that the Draft Articles could take, some favored the elaboration of a convention such as Portugal, Chile, Philippines and El Salvador, while for others, it would still be too premature -Austria, Colombia, Czech Republic, France and Mexico, and greater conventional practice by states was needed. Others advocated that the draft articles take the form of a non-binding resolution or declaration -China.

Others favored promoting the elaboration of bilateral and regional agreements because they predicted little success to a hypothetical convention - Panama, Brazil and the United States. In this respect, Brazil argued that the Commission should not be overly ambitious on this issue, at the risk of losing all or part of the support of the Member States. The final product should be in the form of a non-binding declaration by the General Assembly, in which generic principles are proposed that guide the States to structure regional agreements, which constitute the most appropriate instrument for the legal regulation of transboundary aquifers. Uruguay also considered that draft articles should serve as guidelines, recommendations or models to be drawn on by states with shared aquifers in the conclusion of multilateral agreements or arrangements for their management, use and preservation. Similarly, Argentina argued that the final form could be a declaration or a framework convention offering guidance for the conclusion of detailed agreements and other arrangements in regard to the operation and management of transboundary aquifers by the States concerned (Sixth Committee, 2007a). Finally, others adopted flexible positions as Slovenia.

In 2013 the Secretary- General of the United Nations produced another report. States that this time commented on the final form of the project did it again in a disparate way: some were in favor of drawing up a convention like Finland, Portugal, and Kuwait; others adopted flexible positions that did not reject its elaboration, while also advocating bilateral cooperation -the case of El Salvador and Japan-, and the United States again expressed its preference for specific agreements for each context. The United States continued to believe that context-specific arrangements, as opposed to a global framework treaty, provided the best way to address pressures on transboundary groundwaters. Numerous factors might appropriately be taken into account in any specific negotiation that a global framework would not consider, such as the hydrological characteristics of the aquifer at issue; current uses and expectations regarding future uses; climate conditions and expectations; and economic, social and cultural considerations (Sixth Committee, 2007a, 2007b, 2007c, 2007d, 2008; United Nations General Assembly, 2011, 2013b).

Thus, states argue, broadly, that in view of emerging state practice on the subject of transboundary aquifers' management, the final form should be considered at a later stage, as this would allow time to assess whether the articles as currently drafted would stand the test of time. States should first be given time to evaluate the draft articles based on their own practice and to make bilateral or regional arrangements, if needed. Regional and bilateral practice might then provide input for the possible development of an international instrument.

Additionally, not all states agree with the letter of the Draft Articles, some submitted several observations on the writing of the articles. They consider that there was still much to learn about transboundary aquifers in general, and specific aquifer conditions and state practice varied widely. Due to the complexity of aquifers, many aspects were not being considered in the Draft Articles. Therefore, if there is still no generalized consensus about the main concepts and definitions that are proposed in the Draft Articles, it would hardly be possible to advance along the lines of an international convention with a binding character for the states.

Despite the discord about its final form, in 2013, the UNGA resolution 68/118 made a significant change. This resolution commends: "to the attention of Governments the draft articles on the law of transboundary aquifers annexed to the present resolution as guidance for bilateral or regional agreements and arrangements for the proper management of transboundary aquifers" (United Nations General Assembly, 2013a). Previous resolutions only encouraged states to "take into account" the Draft Articles when discussing bilateral or regional agreements. Now, resolution 68/118 raises the level of the Draft Articles to the status of "guidance" in the negotiation of future transboundary aquifer agreements. This is not simply a change in the word or expression used. Conversely, the use of the term "guidance" suggests a stronger recognition of the Draft Articles by the international community and a stronger warning to states to comply with their norms and principles (G. Eckstein & Sindico, 2014).

Finally, and following the trend of previous years, the last resolution 74/193 of the UNGA in 2019 decided to include in the provisional agenda of its seventy-seventh

session (2022) the topic entitled "The law of transboundary aquifers" (United Nations General Assembly, 2019). The idea of developing a convention has not been totally discarded and remains in the debate of the UNGA although it does not seem to be something that can be achieved in the short term. It would appear to be expecting to gain acceptance by states of the draft articles as a non-binding guidance document, and if its use is successful, they could negotiate a binding convention.

General definitions and principles contained in Draft Articles

The ILC's draft on the law of transboundary aquifers consists of nineteen articles arranged in four parts: I) Introduction; II) General Principles; III) Protection, Preservation, and Management; IV) Miscellaneous Provisions.

The first part of the Draft Articles is about its scope and key definitions. The ILC's decision to establish transboundary aquifers, rather than groundwater, as the principal subject had effects on its physical scope. The draft defines aquifer as "a permeable water-bearing geological formation underlain by a less permeable layer and the water contained in the saturated zone of the formation" (United Nations, 2008a). It is remarkable to consider the aquifers as the management unit because both components, the rock and the water of an aquifer, have to be managed and monitored jointly to properly protect the resource. But the draft articles focused mainly on the rock, not the water, moving away from the approach of the 1986 Seoul Rules on International Groundwaters, which regulate the waters of international aquifers (McCaffrey, 2009; Movilla Pateiro, 2014).

This emphasis on geologic formation evidence intentions and has consequences on aquifer management. Firstly, it gives rise to the first and questionable general principle announced in the draft, the sovereignty of aquifer states, which seems to have become its leitmotif. Secondly, the conceptual differences with the 1997 United Nations

Convention –aquifer vs. groundwaters- could have compatibility problems between both texts.

Additionally, about its physical scope, the draft articles purport to cover the water contained in all transboundary aquifers or aquifer systems, this is both confined aquifers -not covered by the 1997 UN Convention-, and those that are recharged from surface waters and discharge into those waters -unconfined ones (aquifers in the continental shelf are excluded from the scope of the present articles)[21]. But the given definition of transboundary aquifer still has certain drawbacks. Subparagraph (c) of Article 2 provides that "transboundary aquifer" or "transboundary aquifer system" means, respectively, an aquifer or aquifer system, parts of which are situated in different States" (United Nations, 2008a).

Firstly, determining whether or not the aquifer at issue traverses an international political boundary, from a practical perspective, currently presents a difficult task. Since aquifers are hidden from sight, states require more sophisticated technics as well drilling, core sampling, isotope tracing, and other science-based tactics (G. Eckstein, 2007; Movilla Pateiro, 2014).

Secondly, using "transboundary" rather than "international" term is a departure from the approach used in the Watercourse Convention. "While the use of the different terms may appear to be semantics, these words are significant in that they determine which aquifers fall under the rubric of the Watercourse Convention, which fall under the present Draft Articles, and which might fall under the scope of both" (G. Eckstein, 2007, p. 554). Not all transboundary aquifers are international. Some aquifers have transboundary implications but won't be subject to the Draft Articles. For example, if an aquifer is completely in the territory of a state but its recharge or discharge zones –which are not included in the aquifer definition-, are transboundary (a river traversing the international political border) or situated in the territory of another state, it will be

[21] Paragraph 2 of commentary about article 2 assets: "Submarine geological formations under the continental shelf do not hold freshwater and accordingly such formations and water therein fall outside the scope of the present draft articles (United Nations, 2008b)". Nevertheless, with the latest discoveries of water masses' existence under the continental shelves, this statement has become obsolete and the inclusion of these aquifers in the project should be revealed.

excluded from Draft Articles provisions. Thus, Draft Articles wouldn't apply to above-explained aquifers' models D and E, described by Eckstein and Eckstein (2003)[22]. Undoubtedly, this is a problem presented by the Draft Articles that do not apply to all cases of aquifers with international implications, and this detracts from its usefulness.

Finally, into the general definitions of Article 2, the Draft Articles formulates specific definitions and principles for the Recharge and Discharge Zones –not as part of the aquifer concept- considering their characteristics and their importance to the overall hydrologic process and the normal functioning, management, and protection of aquifers.

Second Part of the Draft Articles describes all General Principles applied to aquifers, which are the same considered in the 1997 UN Watercourses Convention but adapted to aquifers' specific characteristics, and adds a new one "the sovereignty of aquifers' states" (article 3). This principle proclaims the sovereignty of each aquifer state over the part of a transboundary aquifer or aquifer system located in its territory. This remarkable provision will be discussed further later.

Article 4 describes the right to equitable and reasonable utilization. It implies obligations to an equitable and reasonable accrual of benefits, to maximizing long-term benefits, to establishing individual or joint comprehensive utilization plans -considering present and future needs and alternative water sources-, and not to utilize an aquifer at a level that would prevent the continuance of its effective functioning. Article 5 contains a non-exhaustive list of factors to be taken into account in ensuring that the utilization of a transboundary aquifer is equitable and reasonable. Specifically, about aquifers' use, this article adds the contribution to the formation and recharge of the aquifer or aquifer system and the role of the aquifer or aquifer system in the related ecosystem. Article 5.2 pays special attention to "vital human needs", an important recognition of something that will later be called the human right to water. The obligation of not to cause significant harm is described in Article 6: In utilizing or in undertaking activities other

[22] Model D represents unconfined aquifers that are completely within the territory of one state but are linked hydraulically to a river flowing across an international border (the river is international, while the aquifer is geographically domestic). Model E describes a confined aquifer, unconnected hydraulically with any surface body of water (except perhaps within the recharge zone in an unconfined portion of the aquifer) that traverses an international boundary or is located completely in another state.

than utilization of a transboundary aquifer or aquifer system in their territories, states shall take all appropriate measures to prevent the causing of significant harm to other aquifer states. This article also reflects a hydrologic reality in incorporating the prevention of causing this significant harm to states in whose territory a discharge zone is located.

A general obligation to cooperate as well as the more specific cooperation obligation to regularly exchange data and information is mentioned in Article 7. States are encouraged to establish joint mechanisms and to enter into bilateral or regional agreements. According to Article 8, where knowledge about the nature and extent of a transboundary aquifer is inadequate, aquifer states shall employ their best efforts to collect and generate more complete data and information. Here, the draft articles make an important contribution emphasizing the obligation of generating and exchanging data and information about shared aquifers in a context where knowledge of most aquifers' characteristics continues to be incomplete (McCaffrey, 2009; Mechlem, 2011). It's important to consider that these principles don't apply to recharge and discharge zones, not incorporated on aquifer o aquifer system definitions. The last article of this second part (Article 9) is about bilateral and regional agreements and arrangements between states sharing aquifers. To manage a particular transboundary aquifer or aquifer system, the aquifer states are encouraged to enter into agreements or arrangements (United Nations, 2008a).

As was previously mentioned, the principle of sovereignty was placed blatantly as the first principle in this part. On the words of Article 3, "Each aquifer State has sovereignty over the portion of a transboundary aquifer or aquifer system located within its territory. It shall exercise its sovereignty in accordance with international law and the present articles" (United Nations, 2008a). This emphasis on sovereignty is atypical for a legal instrument on transboundary freshwater resources and is, without doubt, the single most controversial departure from established international water resources law.

The single definition of "aquifer" contained in the Draft Articles – which includes both the underground geological formation, a static territorial element, and the

water contained therein, often a moving natural resource which might transit from the territory of one state to that of another- gives rise to the assertion of state sovereignty over transboundary aquifers extends to shared groundwater resources. The main issue is that it combines instead of dividing the geological element, in respect of which it is appropriate to think in terms of sovereignty and ownership, from the water contained in it, which is a migratory natural resource and would be more appropriate to think in terms of sovereign rights to use. A state may have exclusive sovereignty over the rock, but not over the water shared with other state or states overlying the aquifer (McCaffrey, 2009; McIntyre, 2011a). The Commission could have avoided this inconvenience by providing separate definitions and legal regimes, one for "aquifer", focusing on the geological formation and its sovereign control and protection, and another for "groundwater" contained therein ant its utilization and shared management.

It is important to highlight that this article was not included by the special rapporteur of the Commission, but was later incorporated at the request of numerous states, most of them with aquifers in their territory. The ILC's Commentary to the 2008 Draft Articles explains that the need for an explicit reference to the sovereignty of states over natural resources was promoted, especially, by those aquifer states considering that "groundwaters must be regarded as belonging to the States where they are located, along the lines of oil and natural gas" (United Nations, 2008b, p. 39). This suggestion was made in a context where the issue of aquifers and groundwater was originally proposed for examination by the ILC within the topic of shared natural resources, which was initially supposed to include confined transboundary groundwaters, oil, and gas[23].

Among the countries that expressed their opinion regarding the inclusion of the principle of sovereignty, there are the representatives of Argentina, Brazil and Chile. Brazil has been one of those that maintained a strong position in favor of this principle. Surely, this is related to its position as one of the states that has the highest percentage of

[23] States favorable to sovereignty principle were concerned with promoting the notion that groundwater resources were subject to humankind's common heritage. Others doubted of the principle of sovereignty's role since transboundary aquifers were recognized as shared natural resources, and no aquifer state could claim permanent sovereignty over them. See Eckstein, 2007.

groundwater shared with other countries in its territory. Then, Brazil stated that fully adheres to the principle of sovereignty of States over transboundary resources located in their territories, in accordance with draft article 3. Furthermore, it suggests replacing the expression “shared natural resources” in the title of the topic being discussed for "transboundary natural resources", so as not to put that sovereignty into question. The representative from Argentina argued that while a transboundary aquifer may be subject to shared management by the States in which the aquifer was situated, the concept of a “shared” natural resource must not imply that the aquifer constituted a shared heritage of mankind or was subject to collective ownership (Sixth Committee, 2008). Then, Argentina supported the inclusion of the affirmation of a State’s sovereignty over the portion of a transboundary aquifer or aquifer system located within its territory, as set out in draft article 3 (Sixth Committee, 2007a). It’s important to note that, in 2010, Argentina, Brazil, Paraguay and Uruguay took into account the provisions of the draft articles in the Guarani Aquifer Agreement, especially, this notion of sovereignty. Chile also expresses its commitment to the principles that inspire the draft articles on the law of transboundary aquifers, that is, the exercise of sovereignty in accordance with international law, the principle of equitable and reasonable use, the obligation not to cause significant damage, and the obligation to cooperate (Gorostegui, 2016).

The ILC’s report also indicates that Article 3 adopts a positive type of formulation in state practice concerning sovereignty over an aquifer or portions of an aquifer, and represents an appropriately balanced text reflected in both sentences of this Article. This perspective considers that states have limiting conditions to the exercise of this sovereign right[24]. “The reference to “international law” has been added to indicate that, although the present draft articles have been elaborated against the background of the continued application of customary international law, there are other rules of general international law which remain applicable” (United Nations, 2008b, p. 40). Hence, this

[24] An example is “States have, in accordance with the Charter of the United Nations and the principles of international law, a sovereign right to exploit their own resources pursuant to their environmental and developmental policies, and the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of their national jurisdiction” (United Nations, 2008b).

principle is just a reference to sovereignty over an aquifer located within a state's territory and differs from the "exercise of sovereign rights" exerted, for example, over the continental shelf or in the exclusive economic zone adjacent to the territorial sea.

Certainly, the inclusion of article 3 in ILA's Draft Articles has given rise to a wide doctrinal debate on its implications, being the object of numerous criticisms. Stephen McCaffrey, one of the special relators of the 1997 New York Convention, has suggested its suppression of the Draft Articles. He asserts that this principle is not a part of customary international watercourse law and "tends to be used as a fig leaf to cover up ill-advised, improper or unlawful conduct" (McCaffrey, 2011, p. 570). Furthermore, it has been strongly questioned that the Commission has established the sovereignty as the primary guiding principle from which the interpretation and application of all others will be informed by relegating the principle of equitable and reasonable utilization, the no-harm rule and cooperation principle to the following articles. Other analysts consider that this article is confusing and unnecessary, because it seems to uphold and deny sovereignty at the same time, and it would have been appropriate to put more emphasis on the other principles over that of sovereignty (Dellapenna, 2011; Mechlem, 2011). The general concern is about the implementation of this provision in international agreements between states sharing the resource and its consequences. An example of the influence of the sovereignty principle over shared water resources upon subsequent state practice is the 2010 Guarani Aquifer Agreement. This agreement defines the Guarani Aquifer System as "a transboundary water resource", focusing on the water resource element rather than the geological formation. Still, Article 2 states that "[e]ach Part exercises sovereign territorial control over their respective portions of the Guarani Aquifer System", after identifying in Article 1 the four aquifer states as "the sole owners of this resource". Clearly, the ILC Draft Articles mentioned in the Preamble of this agreement played a crucial role in informing its normative content (McIntyre, 2011b).

Despite the arguments put forward, and according to the comments made on each article, it seems clear that the true intention of the ILC behind this controversial article is to establish limited sovereignty over the transboundary aquifers. Limits to this

sovereignty are imposed by the principles mentioned in the following articles, as well as by International Law and International Custom (Customary Law).

Draft Articles related to principles on protection, preservation and management

Part III of the Draft Articles contains six articles with substantive principles for the management of transboundary aquifers and has been influenced by developments in environmental law. The principles outlined here may not yet form part of Customary International Law due to their novelty, the scarcity of state practice, and the fact that they are significantly adapted to transboundary aquifers' circumstances. Thus, these principles are framed within what is considered a progressive development of international law, and the ILC can carry out such work. At the same time, and according to Eckstein (2007), principles mentioned in this part (the protection, preservation, and management of a transboundary aquifer) are necessary prerequisites for the application and compliance of substantive principles such as equitable and reasonable utilization of that aquifer and the no-harm rule.

Article 10 addresses the states' obligation to protect and preserve ecosystems within, or dependent upon, the transboundary aquifers or aquifer systems. This obligation includes taking necessary measures to ensure the quality and quantity of water, both within the aquifer and at its discharge zones. Article 11 is concerned with recharge and discharge zones, which is something new in watercourses international law. These zones are areas of the land surface through which an aquifer is recharged, or where water from an aquifer emerges from the ground into a watercourse of some kind (such as a stream or a lake) or into the sea. The protection of these zones is essential to avoid aquifers' pollution. This article provides for the identification of such zones and the cooperation of states others than the aquifer's states but in whose territory these zones may be located. Despite this statement, it is not clear whether non-aquifer states could be parties to any instrument based on the Draft Articles (McCaffrey, 2009).

Article 12 provides that states shall prevent, reduce and control pollution that may cause significant harm to other aquifer state. But it seems to be insufficient insofar as the consequences of the impact that contamination could have, as well as its recognition by the affected state, are more difficult to detect and diagnose. Aquifers have their own difficulties and vulnerabilities related to their physical underground location, their slower flow and their more limited or prolonged recovery capacities compared to surface water. This situation makes monitoring and ensuring their integrity a more complicated task. Additionally, any pollution occurring in one aquifer state may take years or decades to manifest in another aquifer state (G. Eckstein, 2007). According to these particularities that aquifers present, a detailed and robust provision on this subject would be expected.

Article 13 compels aquifer states to monitor transboundary aquifers and to use agreed or harmonized standards and methodology for monitoring them. Here, monitoring entails the continuous examination of various characteristics and conditions related to the aquifer. Article 14 requires aquifer states to establish and implement plans for the proper management of their transboundary aquifers. Finally, Article 15 specifies and details conditions for planned activities. If a state is going to perform an action that could cause significant harm to other state, it should consider and assess all possible effects, should notify possible affected states, and if they disagree on these effects, they should negotiate and arrive at an equitable resolution. The extension of this article could be explained given the sensitivity of aquifers.

Part 4 contains the final four articles of the draft and contains which are miscellaneous provisions. Article 16 requires all states -not merely aquifer states- to promote cooperation with developing countries about the technical and legal aspects of the management and protection of transboundary aquifers. Article 17 is about emergencies and requires a state where an emergency arises to notify potentially affected states and competent international organizations, and to take all practicable measures to prevent, mitigate, and eliminate any harmful effects that it may cause. Article 18 refers to aquifers' protection in times of armed conflict. And the last one

(Article 19) establishes that states shall cooperate providing as much information as possible to other aquifer states but are not obligated to provide data and information crucial to their national defense or security.

General observations about ILA's Draft Articles

Law on transboundary aquifers is still in a nascent stage, and the ILC Draft Articles constitute the most significant compilation of legal thinking about this issue. Their provisions, together with the few treaties on specific aquifers, reveal a noteworthy development in international groundwater law. They constitute a significant progress in the understanding of groundwater and aquifers' nature and risks. Effectively, Draft Articles recognize that aquifers should be managed as units in their own right and that institutional mechanisms should be established for that end.

Although the text is not perfect, the vast majority of states have been in favor of it. Disagreements seem to arise around its final form, so that decision is still postponed. Closely related to this, states decided not to include a clause on dispute settlement, and they dissipate the idea of establishing a binding convention. At the end of 2008, the UN General Assembly took note of the draft articles and encouraged States to make appropriate bilateral and regional aquifer agreements taking into account the draft articles. Later, in raising the status of Draft Articles, the UNGA requested states to use them as guidance for their arrangements.

On this point, it should be noted that, if states adopt a convention, they will face some challenges such as its relationship with the 1997 New York Convention and pre-existing agreements on specific transboundary aquifers, or the need to establish a dispute settlement mechanism. States' reluctance to ratify the 1997 New York Convention is an antecedent to continue maintaining the status quo of this text as draft articles to be used as a guide by states. Additionally, Draft Articles' success would lie in their practical acceptance by states. Since they mainly constitute progressive development of

international law in this matter, their realization will be expressed in their ability to consolidate or generate international customs.

By the way, today it's not possible to speak of a customary nature of the Draft Articles provisions due to the recent development and the scarcity of state practice concerning to aquifers. Although they include norms on which there is a broad consensus on their customary nature in international law -as the principle of equitable and reasonable utilization-, there are other norms that don't have yet sufficient consistency and consensus in state practice to ponder them as customary law. They could only be considered as emerging rules. Examples of these norms are the ones referred to ecosystem pollution, joint management of recharge and discharge zones base on the precautionary principle, etc. Their evolution and/or consolidation will depend on state practice and effective implementation.

Since the resolution 63/124 adopted by the General Assembly on 11 December 2008, the Draft Articles have already had some impact on other legal instruments. A few states have concluded bilateral or regional agreements about their transboundary aquifers according to their provisions. Namely, these agreements have quoted the UNGA resolution 63/124 in their preambles. These are the 2010 Guarani Aquifer agreement, and the Memorandum of Understanding for the establishment of a consultative mechanism for the integrated management of the water resources of the Iullemeden Aquifer System, Taoudeni/ Tanezrouft of 2014. Although these agreements are heterogeneous in terms of their legal form, length, and content, they have in common the obligation to exchange data and information and the establishment of an institutional mechanism whose functions are at least that exchange.

CHAPTER 3: The Genevese Aquifer

Introduction

Since 1978, the Genevese Aquifer Agreement constitutes the oldest and most successful international treaty on transboundary groundwater resources (Hardberger, 2004). This agreement and its effective implementation are considered as an example in the area of transboundary aquifers management and regulation. But, how do we explain the success of the agreement? How did they overcome the free-riding problem and advance in cooperation?

Multiple factors can explain the success and continuity of the aquifer's management agreement: i) specific knowledge generated about aquifer's hydraulic characteristics, and the epistemic community that works to develop and exchange knowledge and information; ii) local political actors promoting the administration of the resource to avoid its depletion, guided by economic and political motivations (they pursued the less economic and political cost); iii) users favoring this local management according to technical and legal facilities; iv) the institutionalization of this agreement: a bi-national commission was established and charged to supervise the management of aquifer recharge, as well as attend to problems related to the use, maintenance and monitoring of the whole system; v) the pragmatism of domestic political actors and stakeholders involved to solve the problem and elaborate basic norms for aquifer's management.

In the 1970´s there were no legal instruments regulating international groundwater to serve as guidelines. Norms today considered as customary international law were recently evolving for international superficial watercourses (equitable and reasonable use, no-harm rule, exchanging data and information). It was clearly an application of logical resolution in front of a problem of scarce resources that are prone to depletion. Then, in the Genevese aquifer's case the development and implementation of the agreement was possible because of the knowledge's development of hydrogeologic conditions, local interest in effective management of the transboundary

aquifer, and domestic political actors favorable to changing the *status quo* and working to manage and regulate the use of those resources. Additionally, the companies involved in water extraction and distribution aligned themselves with this strategy.

This chapter is organized in four sections. The first one explains aquifers' general hydrological characteristics, location, uses. The second section explores research and aquifer's knowledge development, the bilateral relations between the Canton of Geneva and the French region, and the Genevese Aquifer agreement. This section also explains legal and institutional capacity within each country to cooperate. Third section examines the presence of other actors involved in bilateral cooperation. Finally, fourth section presents the concluding reflections and arguments.

Aquifer's Characteristics

The Genevese Aquifer's Characteristics

The Franco-Swiss transboundary Genevese Aquifer spans the canton of Geneva in Switzerland and the French department of Haute-Savoie. It has over 19 km in extension and an area of 30 km2. It is located partly at the south of the Lake of Geneva and its effluent, the Rhône River which crosses the Canton of Geneva westwards. The aquifer is crossed over from East to West by the Arve River, a tributary of the Rhône originating in France, and thus benefits from natural recharges (Figure 1).

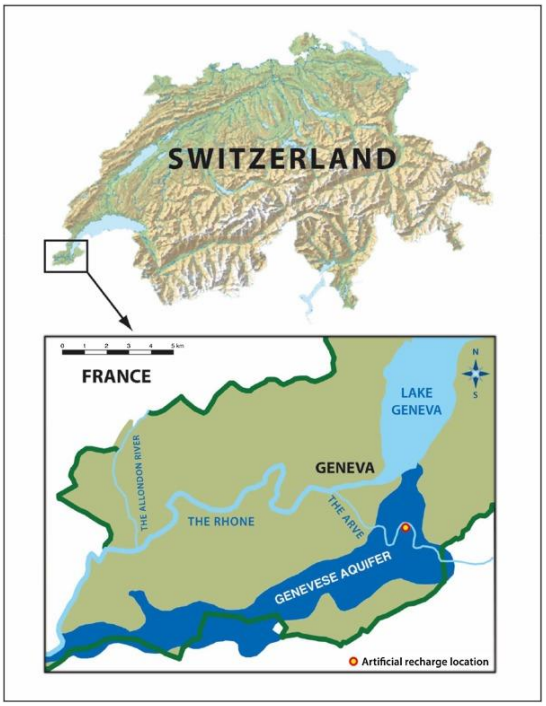

Figure 3. 1: Genevese Aquifer Location
Source: de los Cobos, 2018

Its width varies between 1 and 3.5 km, and the average water level may range between 15m and 80m deep. The aquifer is made up of silty-sandy gravel of glacial and fluvioglacial origin, lying directly on the molasse formation, which is considered to be the impermeable substratum (de los Cobos, 2018).

The Genevese aquifer is exploited for supplying drinking water from 10 wells on the Swiss side and five wells on the French side. French and Swiss extract an average of 15-17 million cubic meters of water annually from the subterranean aquifer (Yamada, 2004). Of a total extracted volume of water, French withdrawals amount to only 2 million cubic meters per year. In the Canton of Geneva, the water extracted from the aquifer represents 20% of the total drinking water supply; the remaining 80% comes from 3 pumping stations on Lake Geneva. In the rest of Switzerland, the situation is exactly opposite in the use of national water resources, since 80% of drinking water

comes from springs and groundwater, and 20% from lakes and rivers (de los Cobos, 2010; Wohlwend, 2002).

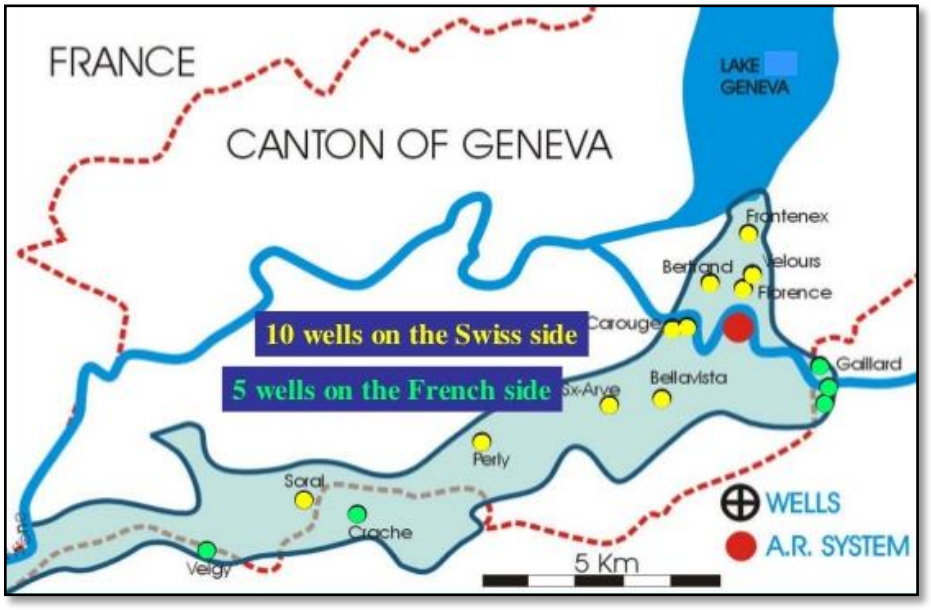

Figure 3. 2: Swiss and French Wells and Artificial Recharge System.
Source: de los Cobos, 2012

Knowledge and Bilateral Relations

Progressive control and intervention of hydrographic resources in the Franco-Genevese region began in the 19th century and continued through the 20th century. In those times, the region was in constant demographic and economic growth. However, growth was accompanied by increased water demand, and the supply of the communities located far from the city of Geneva's main water supply systems –and far from surface water resources- became increasingly expensive and complicated. For this reason, waters from the regional aquifers became increasingly important.

In 1866, the State of Geneva authorized to a newly founded company, the *Société des Eaux de l'Arve* (SEA), to start supplying water to the eastern communes. The waters delivered by the new company were abstracted from wells located on the Arve River's margin. In 1902, the company began abstracting water from new deeper wells (54 meters) in the same location. Other areas in the west and southwest of the Canton of Geneva had problems with water supply. In 1930, the *Services Industriels de Genève* (SIG) –public service responsible for the supply of water, gas, and electricity in the Canton- started exploiting the aquifer, and installed new groundwater pumping stations. On the other hand, the French communes of Gaillard and Annemasse, St. Julien-en-Génévois, and Viry, along the Franco-Swiss border, began exploiting the aquifer in the late 1950s (Walter, 2013).

Between 1940 and 1960, water withdrawals from the aquifer were close to the average natural recharge. As new communes emerged as suburban extensions of the city of Geneva, water demand increased. Alternative sources of water were too limited or too polluted to respond to that demand, and groundwater turned into the principal source of supply. During the 1960s and 1970s, the uncontrolled over-pumping and the lack of coordination among distributing and beneficiary entities caused the groundwaters' levels to fall drastically, reducing the total groundwater storage by about one third. As a consequence, certain wells dried up and had to be closed.

This situation affected Geneva and the entire adjoining French region. The problem was not the general availability of water, as waters could be drawn from Lake Leman and other regional sources of surface water (Grandjean, 1990). Instead, they were associated with the political and economic costs of changing water supply systems from groundwater to surface resources, and to security of water supply. Changing the source of freshwater involved the construction of new infrastructure and the loss of investments associated with groundwater exploitation. Additionally, this change would generate an exclusive dependence on surface water and the vulnerability of water supply.

Facing this situation, scientific investigations were developed to specify the aquifer's features, identify the zones of groundwater recharge, hydraulic linkages and

the specific hydrogeologic features of the terrain, and understand the causes and effects of water level's drop. The Geneva's Service of Geology was in charge of the original studies on the aquifer. The first Director of the Service was Gad-François Amberger, assisted by Daniel Baroni. Generated knowledge allowed delimiting the problem to two viable solutions: 1) to use another water resource –from surface waters- which required the construction of new water filtration and treatment plant in the lake (Baroni, 1970); and 2) to reinforce the natural capacity of groundwater through artificial recharge (de los Cobos, 2010, 2018). The choice between the two possibilities was difficult and was conditioned to two principal criteria: economics and water supply security.

First option was costly[25] but required a well-known and controlled technology; on the other hand, artificial aquifer recharge was still a technical and political challenge. Moreover, this reliance on surface waters also meant that Geneva's diversity of supply sources was going to be limited. Water security requires diversifying the water resources to maintain water distribution in case of a mechanical breakdown or serious contamination of the resource.

The other alternative, the injection of surface waters into the aquifer, could restore water levels and compensate for over-draft practices. The main idea was to fill the aquifer faster than it was naturally produced, using water from the Arve River -which was its main natural source of recharge-, so that reserves could be made available during the summer periods when the demand for water increased the most. It also would protect existing investments, keep current infrastructure operational, and conserve alternative sources of freshwater in the Canton. Nevertheless, it was not absent of technical, economic and political challenges. The artificial recharge was an already utilized method to restore aquifers. Still, whether the artificial recharge of the Genevese Aquifer was feasible would depend on its particular hydrogeological features.

[25] The cost of a new water treatment plant in the lake, with the necessary modifications to the water supply system, was approximately 150 million Swiss francs (as at 1975). The cost of a groundwater aquifer recharge (MAR) system, including an automatic laboratory system for pollution detection in the Arve River, was around 20 million Swiss francs (de los Cobos, 2018).

Between 1967 and 1974, Geneva's Service of Geology, together with SIG's Water Service, started research to assess the feasibility and consequences of aquifer's artificial recharge, and they tested several infiltration methods. They implemented several tests in order to determine the most suitable technique for the chosen site. Aquifer recharge tests by surface irrigation with water from the Arve River made it possible to determine the infiltration rates of the water in the ground and the flows in the aquifer (tracers). With the excellent results of this first phase of tests, they put into operation a pilot station (de los Cobos, 2009). Finally, they concluded that aquifer´s recharge was feasible, and it was more appealing than switching to a supply exclusively based on surface waters.

The next step was to obtain the necessary political support to implement this solution. The important economic investment to construct the artificial recharge plant required the willingness of the users to finance its construction and to undertake the necessary regulations to control the exploitation of the aquifer.

Bilateral meetings and agreement

Once knowledge about the Genevese aquifer properties and from the assessment of alternative courses of action by its users was developed, interests about its protection emerged. The Canton of Geneva contacted the neighboring French communes to inquire about their interests in the aquifer's possible joint management.

Since 1972 to 1977, several meetings and discussions were held between both parts in parallel to more research on the aquifer. The drastic reduction in groundwater resources was already evident. This problem was not going to stop and the situation was affecting not only Geneva, but also the entire contiguous French region. Although approximately 90% of the aquifer's groundwater is in the Canton of Geneva, the remaining 10% is in the France border. In the 1970s, it was mainly two water companies that were in charge of water distribution in Geneva: *Société des Eaux de l'Arve*, and

Services Industriels de Genève – SIG. In the French side, various communities or syndicates exploited the wells located there.

Until 1975, these negotiations focused on specifying the aquifer's hydrogeological issues, such as recharge and discharge zones, actual and future pumping for each well, rates to be assigned to each region, among other factors. In turn, an inventory was prepared on the existing drinking water resources in the region, and its scope, availability, and costs related to its extraction were evaluated (de los Cobos, 2010, 2018). They also discussed cost- sharing mechanisms for the construction of the facility. The meetings' main goals were, in first place, to impose restrictions on use of diminishing groundwaters till the artificial recharge system was functioning. Secondly to establish an equitable cost sharing once the recharge plant was operational and benefiting to users on both sides of the border.

During the negotiations, parties involved analyzed water resources available to each of them and their dependence on groundwater. For users who depend almost exclusively on groundwater - as in the case of Haute Savoie and SEA users in Geneva - the possibility of switching to other water sources was either too expensive or inaccessible. The disability resulted both from the lack of alternative sources of freshwater and from the costs associated with supplying alternative sources of water.

In France, "there were multiple turnarounds. People would agree, and then show disinterest. In fact, the French had expectations on their aquifers, they found water, but the volumes found were not as large as they expected them to be. They then expressed interest (in the restoration of the aquifer) but not in directly financing (a joint management initiative)" (de los Cobos, in Walter, 2013). Effectively, the French were confident on their water resources and were reluctant to partially bankroll the construction of the artificial recharge system. In 1975, they declared that they would no longer use Genevese groundwater but wished to retain the possibility of later participating in and benefiting from artificial recharge.

Once the French regions obtained sufficient information on the availability and relative costs of exploiting alternative sources of water, they finally agreed to participate

in a mutual agreement. “They did so because they were aware of the costs of transitioning to a water supply based on alternative sources of freshwater and especially because free-riding the Swiss intervention would not possible for all French communes” (Walter, 2013, p. 307). Thus, despite having alternative sources of supply, the French wanted to have the future option of using, if necessary, the waters of the aquifer and, therefore, benefiting from the Genevese artificial recharge works. Accordingly, the French was not going to contribute financially to the construction of the station, but was willing to pay a cost to use the water generated by this recharge station.

Thus, the Genevese took the decision to bear the entire financial cost and technical responsibility of building the plant and of the artificial recharge operations. Actually, the financial burden was assumed by *Société des Eaux de l'Arve*, which pumped exclusively from Genevese groundwater. But the final cost of artificial recharge (depreciation, interest, usage, maintenances and renovations costs) would be spread among all groundwater users, French and Genevese (de los Cobos, 2010). France, so, would participate through a concession tax which compensates the cost of water. French parts agreed to pay the Swiss a cost for water used to the extent that it does not exceed operating costs for pumping at their alternative own aquifer, the Arthaz (which had been recently discovered in the region of Nangy). After that, the negotiations had centered on the right of the French to use water pumped from the Genevese Aquifer. Both parts finally agreed on a free share of two million metric cubes per year, which corresponded to the volumes that French extracted before the introduction of artificial recharge. Surplus amounts extracted would be calculated with a formula based on total pumping and recharge costs[26].

[26] Once the quota of two million metric cubes per year was surpassed, the price per m3 would be calculated on the basis of an equation comprising the following factors:
- the costs of operating the plant (SIG expense): E
- depreciation: A
- total pumping (Swiss + French): VE
- share in natural recharge (7.5 Mm3/yr): AN
- volume pumped by the French authorities minus the quota: Vefp
French participation: Pf = (A + E) * Vefp / VE-AN (de los Cobos, 2018, p. 121)

In sum, in this case it's possible to observe how the deteriorating conditions of the aquifer and the knowledge generated about its characteristics and bi-national nature aligned the interests of regional stakeholders (principally, companies linked to water services) and policy-makers to consider alternative strategies for its protection and sustained exploitation. Knowledge development about the aquifer (specially, respect to its capability, water quality and artificial recharge option), and research about alternative sources of water was key to encouraging all actors involved to negotiate.

The 1978 arrangement

Signing an agreement for the aquifer's joint management was not an easy goal to achieve. Once the involved parties overcame certain differences in interests and capabilities, they had to face administrative and legal obstacles.

In the Geneva area, and according to the Swiss Federal constitution, cantons are sovereign and are allowed to deal with transboundary matters directly (under the supervision of the Confederation). In general, most Swiss public policies are determined by the local and regional authorities. Cantons are in charge of their own administration relative to water supply, sanitation and infrastructure, and they could sign international agreements of this type with foreign bodies (de los Cobos, 2010, 2018; Walter, 2013). But in France, the situation was different. Local authorities could not deal autonomously with transboundary issues. A formal agreement required French national political authorities participation, who showed little interest in solving the situation of a small aquifer (Walter, 2012, 2013). For that reason, the Prefecture of Haute Savoie had to represent the sovereignty of the French State and sign the agreement. However, at the time, Prefectures and local representatives did not possess the formal authority to engage in international negotiations relative to environmental management. In the 1970s, there were also no legal instruments specifically regulating international groundwater to serve as guidelines.

Finally, and dodging all difficulties, in 1977, the State Council of the Republic and Canton of Geneva and the Prefect of Haute-Savoie (Upper Savoy) signed the renewable 30-year "Arrangement on the Protection, Utilization, and Recharge of the Franco-Swiss Genevese Aquifer", which entered into force in January 1978. It was an exception at the time (Mechlem, 2011). Its first paragraph states what would be the main reason why the parties joined their wills to reach this agreement: "Recognizing the need of establishing an agreed management for the Genevese aquifer in order to protect this natural resource and to preserve the quality of its waters" (1977).

The arrangement's provisions covered the principal aspects of aquifer's joint management to guarantee its continued exploitation – at limited extra cost for the users-, and dissipate future threats on its depletion through the creation and management of an artificial recharge plant. Institutionally, both parts agreed to create a bi-national commission charged to supervise the management of aquifer recharge, as well as attend to problems related to the use, maintenance and monitoring of the whole system. Article 1 to Article 6 defined its composition, mission and functioning. The commission was to be comprised of three Swiss and three French members designated respectively by the Council of State of the Canton of Geneva and by the Prefect of Haute-Savoie (Article 1). At least two members in each delegation were to be technicians specialized in water matters (Article 2). They would meet at least twice a year to assess the aquifer's condition and supervise groundwater use.

The commission was responsible for elaborating a yearly management program of the Genevese aquifer taking into account groundwater levels and forecasts of water user needs, the performance of the recharge facility, and potential threats to the quality of the groundwater to ensure its preservation. It is responsible of the budget, the operating costs[27], the status of the resource in terms of pumping and artificial recharge, the regulation of quantities reserved for each part for the coming year, the quality of the water, and the alert system in case of accidental pollution.

[27] Both parties had to participate in the calculation of these factors (operating costs, depreciation, volume pumped) because they composed the equation to calculate the price per m3 (it's the cost that French communes had to pay when the quota per year was surpassed).

Thus, the commission is a central institution for joint management of the aquifer, but its function remained consultative. The authorizations, permits and concessions to extract groundwater remained with the respective national authorities.

About the groundwater recharge installation, the arrangement provides for the canton of Geneva to construct and operate the required groundwater recharge installation, for which it remains the sole owner. The State of Geneva may delegate the operation of the plant to a third party (Article 8). In 1988, the water company Société des Eaux de l'Arve was bought out by SIG, as of which point, Geneva had one single water supplier.

Regarding water rights, both parts agreed to limit water pumping to a certain volume to obtain an adequate average groundwater level. The French authorities and communities undertook to ensure that total abstraction by users on their territory would not exceed five million cubic meters per year, which includes the free share of two million metric cubes per year. This free quota corresponded to the volumes of groundwater extracted by French users at the time the agreement was signed. In exceptional cases, the commission may agree to exceed this limit after consulting the operator (Article 9). The water allocated to the Swiss was restricted only by the aquifer´s recharge capacity.

In order to assure the proper management of the recharge plant, at the beginning of the year each user has to announce to the commission their estimated volume of extractions from the aquifer for the next twelve months. Such forecasts are designated as “reserved water volume”. Subsequently, the water extracted by each part is analyzed using standardized qualitative analysis criteria established by the commission (Article 10).

All waterworks shall be equipped with a device for the recording of the volume of water extracted from the aquifer, and the variations in the water-level of the aquifer (Articles 6 and 7).

Furthermore, as stated above, the agreement established a calculation on the costs of water extraction, which includes the cost of building the plant (fees and honorariums,

civil engineering costs, equipment, buildings and external construction, labor), the cost of operating electromechanical equipment, maintenance, reparations and transport, among other things. The French authorities obtained an annual allowance of two million cubic meters. Once French users surpasses the assigned quota, the price per cubic meter would be calculated on the basis of an equation comprising the following factors: the costs of operating the artificial recharge facility, depreciation, the total pumping (volume of water extracted from the aquifer), the volume of natural recharge, and the total volume of groundwater abstracted by the French (Articles 11 to 14).

Final provisions are about quality control, pollution abatement and part's liabilities (Articles 16, 17 and 18). Both water extracted from the aquifer and water intended to be injected shall be analyzed by both sides at regular intervals and on the basis of standard qualitative analysis criteria established by the Commission. French and Swiss involved societies and third parties remain liable for pollution of the aquifer occurring within their national territories. The canton of Geneva would be liable for damage to the water quality resulting from failure to maintain the recharge installation or from defects in its operation, in particular of its treatment plant (except if it can be proved that such pollution would have occurred even in the absence of a recharge installation).

The arrangement was agreed for a period of 30 years and would be tacitly renewed for periods of 5 years unless terminated by either party with a year's advance notice. Disputes relating to its implementation have to be submitted for conciliation to the Franco-Genevese Regional Committee. If this mechanism fails, the matter shall be referred to the Franco-Swiss Consultative Commission for Problems of Neighborliness (Article 20).

Through its provisions, the agreement guaranteed access to water mainly to users who depended on the aquifer for their supply in French and Geneva neighboring communes. At the time, it ensured the continuity of the aquifer by creating an artificial recharge plant, and establishing mechanisms for the regular exchange of information on its usage. In turn, the definition of costs and the establishment of prices per cubic meter

extracted acted as a powerful economic deterrent to prevent the increase in withdrawals from the aquifer (dissuading free-riders).

The 2007 Convention on the Protection, Utilization, Recharge and Monitoring of the Franco-Swiss Genevese Aquifer

In 2007, the commission had to face a new challenge, the extension of the agreement, after 30 years of its implementation. To that end, the commission formed a Franco-Swiss sub-working group, composed of technical experts and political representatives. New arrangement was made in a new international context. Since 1978, new international and European legal instruments had come into force and they constituted new legal bases. i) the European Outline Convention on Transfrontier Co-operation between Territorial Communities or Authorities (the Madrid convention) of 21 May 1980 (in force since December 1981); ii) the Convention on the Protection and Use of Transboundary Watercourses and International Lakes of 17 March 1992 (the Helsinki convention); iii) The Karlsruhe agreement on transboundary cooperation between local communities and local state entities of 23 January 1996 (de los Cobos, 2010).

The 1996 Karlsruhe agreement was the legal basis on which the new Franco-Swiss arrangement was built. The Karlsruhe allows for transboundary cooperation and the creation of operational systems between local communities and local state entities. So the new agreement was now subscripted by the State Council of the Republic and the canton of Geneva and the three French communities involved (the greater Annemasse region, the Community of Genevese communes and the commune of Viry).

Finally, on December 18, 2007 the Convention on the Protection, Utilization, Recharge and Monitoring of the Franco-Swiss Genevese Aquifer was signed between the Community of the 'Annemassienne' region, the Community of the 'Genevois' Rural Districts, and the Rural District of Viry, on one part, and the Republic and Canton of Geneva, on the other. This new agreement succeeded the 1978 arrangement and entered

into force on January 1, 2008 for 30 years. "Because of the successful management of the Genevese aquifer during the first 30 years of the 1978 arrangement, the renewal of the agreement focused on the legal and technical aspects derived from international law rather than potential fallout of a political or operational type (de los Cobos, 2018, p. 124)".

In fact, few changes were made to the 1978 agreement. Its basic provisions that specified the mechanisms for the management of the aquifer were preserved. The Convention includes a Preamble which lists the international agreements and French and Swiss (federal and cantonal) legislative provisions that validate its legitimacy. Article 20 added some aspects about the applicable law and dispute settlement provisions, indicating that "Any matter relating to the interpretation of this Convention shall be resolved in accordance with Swiss Law" (International Water Law Project, 2007). According to article 16, each state conducts its own water quality assessments, as the French and Swiss standards have been aligned to European directives.

In sum, the 2007 Convention represents not only the update but, mainly, the legal validation of a pragmatic agreement that looked for timely and fast solutions for all the parties involved.

Actors involved in water's use and management

Having considered the evolution of the negotiations and the administration of the Genevese Aquifer, it is also reasonable to consider the factors that contributed to the success of this process. A confluence of actors and factors explains the effective aquifer's management it this case.

First, as the demand for water increased and groundwater levels decreased, the knowledge development process deepened to have more complete information on the aquifer, its characteristics, capacity, impact or scope (total dependent population), and accessibility to alternative sources. In this stage, the epistemic community (Geneva's

Service of Geology, the SIG, Genevese and French geologists and hydrogeologists, engineers, among others), together with economic stakeholders (such as water's services companies as *Société des Eaux de l'Arve*, which finally financed the aquifer's recharge plant), work to develop and exchange knowledge and information.

Second, there was a confluence of interests between local political actors and economic stakeholders guided by economic and political motivations. They pursued the less economic and political cost. The solution required public and political support. Despite being high, the economic cost of establishing an artificial groundwater recharge system was much lower than that of a new water treatment plant in the lake and the modifications to the water supply system. Diversifying water sources was also a considerable advantage. The next step was to obtain the necessary political support and the willingness of the users – in the French and Geneva regions- to finance and implement this solution and to undertake the necessary regulations to control the exploitation of the aquifer.

Third the pragmatism of domestic political actors and stakeholders involved to solve the problem and elaborate basic norms for aquifer's management. They have negotiated an arrangement, and they have implemented it through the establishment of a bi-national commission, overcoming the difficulties that their respective national laws presented for regulating shared natural resources, and to sign international agreements.

Finally, managing the administrative and regulatory aspects of the aquifer at the local level was essential. In this case study, the local level acts as an important factor, and the social and cultural characteristics could also explain the commitment to the agreement reached (despite its questionable legality). The strategic mobilization of knowledge about the resources, the aquifer's hydrologic conditions, and alternative management approaches reshaped the incentives of the users of the Genevese Aquifer to cooperate. But the mutual monitor system and the compliance with the agreement were reached because of the technology implemented that allowed controlling water extractions on both sides of the border. Moreover, although the users (water distribution

companies and syndicates) advanced in alternatives to avoid depletion, it was the states that intervened and carried out the negotiation.

Discussion and conclusion

In 1978, the Canton of Geneva and the French communities decided to agree on the joint management and use of shared groundwater of the Genevese aquifer. The construction of a recharge plant was identified as the best option for both parts. In 1980, the Genevese aquifer recharge system was operational and led to the restoration of groundwater levels.

The main problem of the Genevese aquifer was its over-pumping and its deteriorating conditions. Regional urban freshwater supply was at risk. Once French and Swiss populations had enough knowledge about shared aquifer's hydrologic conditions, it became evident that cooperation to joint management was strategically preferable to its depletion. But, how did they overcome the free-riding problem and advance in cooperation? Multiple factors can explain the success and continuity of the aquifer's management agreement.

Firstly, as stated in this thesis, knowledge about transboundary aquifers (their real dimensions, geological characteristics, hydraulic links, water reserves, exploitation rates, their role in regional development) is the first factor to consider and the starting point to advance in reasonable plans for the regulation of transboundary groundwater, and to identify the necessary management actions. In this case, knowledge about the aquifer's properties and the economic and strategic viability of the recharge solution supported decision-making. The agreement allowed the parties to focus on solving the specific technical problems of groundwater management at the local level, following the option that had the least economic impact for users (final water consumers) and, therefore, the least political effect.

Secondly, the results of the studies carried out indicated that the impact of the aquifer's deterioration were asymmetrical (not all communes have the same dependence on groundwater; some users depend almost exclusively on this aquifer, as Haute Savoie and SEA users in Geneva), and there were no economically competitive alternative sources of water to replace the Genevese aquifer (the possibility of switching to other water sources was either too expensive or inaccessible). This situation aligned French and Geneva stakeholders (specially, water services' companies) and policy-makers' interests and supported the artificial recharge alternative and the co-management approach. So, according to the hypothesis proposed here, the presence of domestic political actors prone to change the *status quo* in aquifer's management, and the confluence of interests with the stakeholders -together with the knowledge generated-, explains the outcome: a rigorous regulation.

The way in which the national political actors involved handled the administrative and regulatory aspects of aquifer's management was fundamental. But also the local level was a contributing factor in explaining the commitment to the agreement reached. This type of cooperation was viable because the limits of the resources were known, as their location, capacity and characteristics (biophysical attributes; the degree of subtractability; the flow patterns; the presence of resource technologies). Moreover, the technology implemented allowed to control the fulfillment of the agreement by both parties.

The local authorities of French and Geneva communities managed to overcome the difficulties that their respective national laws presented for, on the one hand, regulating shared natural resources, and on the other, to sign international agreements. The principal problem was that the French communities did not have the administrative authority to sign international agreements and autonomously resolve this local but international problem, as had the Canton of Geneva (this is why the agreement was signed by the Prefect of Haute-Savoie). Furthermore, in the 1970s, there were no legal instruments specifically regulating international groundwater to serve as guidelines. It was with the multiple reforms undertaken by the European countries that the

administrative structures were decentralized and the arrangement to manage the Genevese aquifer was validated with reforms and several instruments ratified by both Switzerland and France (the 1980 Madrid Convention, the 1992 Helsinki Convention).

Having considered those difficulties, although the legality of the agreement was never effectively questioned, its actual legal validity remained in doubt until the agreement was renewed in 2008. Nevertheless, it was never breached by the parties. This is a point to consider in the success of local cooperation, of sub-national entities. "Compliance was independent of the agreement's formal validity because the signatories had de facto authority and interest necessary to autonomously enforce it. (…) The effectiveness of the agreement was rooted in the interest of the parties to abide by it" (Walter, 2013, p. 311), and not in its legality or in their formal authority to sign it.

In a pragmatic way (Yamada, 2004), both parts decided to focus on the financial and technical aspects of aquifer management for the benefits of all users, leaving aside legal obstacles or discussions on sovereignty and equitable administration. So, the problem relating to international water resources was solved at the local level, rather than at the level of sovereign states. All technical aspects (hydrogeological studies, management of pumping stations, local hydraulic evaluations) have always been handled by local actors. This information was subsequently passed on to local decision makers, who are very familiar with specific regional and cross-border issues (de los Cobos, 2010, 2018). Then, the regional nature of the agreement has been crucial. The regional level, which is directly involved, can operate efficiently and quickly without being hampered by bureaucratic structures at national level. Nonetheless, each state maintains its sovereign prerogatives, but they manage it as a joint resource for the benefit of all users (Scheumann & Herrfahrdt-Pähle, 2008).

In short, the development and effective implementation of the agreement was made possible by the convergence of a number of factors: the knowledge's development of hydrogeologic conditions, and the local interest in effective management of the transboundary aquifer: the domestic political actors were in favor of changing the *status*

quo and worked to manage and regulate the use of those resources, and the companies involved (stakeholders) aligned themselves with this strategy.

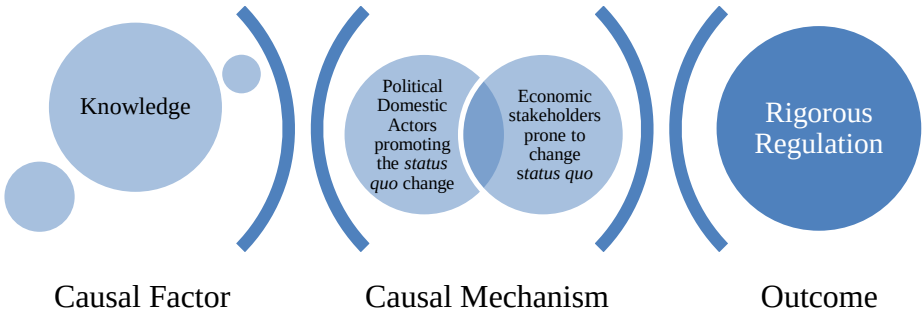

Figure 3. 3: Hypothesis. Own elaboration

The artificial recharge of the aquifer had been successfully implemented; it guaranteed the continuity on wells' exploitation. Aquifer's waters were protected and the parties involved have fulfilled their assumed commitment to systematically exchange information about its usage. The knowledge obtained from the investigations carried out by Canton of Geneva and French communities about best economic and strategic solution promoted the rapprochement between the parties and facilitated decision-making process.

CHAPTER 4: The Guarani Aquifer

Introduction

The Guarani Aquifer System (GAS) is one of the largest reservoirs of transboundary groundwater in the world, and the most important in South America. It is also the only one in the region which has a management's agreement signed by countries sharing the resource. The Guaraní Aquifer Agreement (GAA) -signed in 2010- was based on the fundamental principles of the 2008 Draft Articles and includes obligations to do not cause harm, and provide additional information, which includes studies, activities and works that contemplate the sustainable use of the water resources of the Guaraní System.

According to Pilar Villar (2015), the GAA was the result of a long process of which 3 fundamental stages can be distinguished:

i) The first one was the stage of the knowledge development, the moment of the regional epistemic community (national universities and institutes), and the information's diffusion. Then, scientists mobilized to connect with international organizations and funds for research, and this led to the second stage in cooperation;

ii) the Guarani Aquifer System Project's moment (since the year 2000), lead by states and the IO's involved (UNESCO, the OAS and the World Bank's Global Environment Facility (GEF)), during this stage the scientific knowledge of the physical-environmental characteristics of the basin increased;

iii) The sign of the Guarani Aquifer Agreement (2010) marks the third stage. After that, cooperation process suffers a paralysis in the agreement's implementation and the consequent absence of cooperation in aquifer's regulation and management.

The GAA represents a significant contribution to the regulation of cross-border groundwater in Latin America and the world. Its promulgation occurs in the absence of conflicts about transboundary groundwater resources in the region. It also contributed to the consolidation of the international customary law in the case of groundwater. Nevertheless, the Guarani Aquifer Agreement is a lax cooperation agreement between the four states sharing the resource, which obliges them to manage its waters following the rules of international freshwater law. It has recently been ratified by the four countries (after ten years of its signature), and it still has two items on the agenda following its entry into force: the creation of the Commission under the La Plata River Basin Treaty, and the negotiation of a Protocol setting the dispute resolution procedure. Both tasks require the goodwill of all parties and a budget.

Why states delayed its ratification and entry into force? Which factors explain the outcome (a lax regulation not yet implemented)? This chapter explores the development of knowledge about aquifer's hydrologic characteristics, and the role and interaction between all actors involved (international epistemic community, states, subnational entities, International Organizations, economic *status quo* stakeholders).

This chapter is organized into five sections. The first one explains aquifers' general hydrological characteristics, location, uses. The second section explores aquifer's knowledge development, the role of transnational epistemic community and international organizations in advancing research. Also, the antecedents of the Guaraní Aquifer Agreement, and the Agreement itself, are analyzed. The third section examines the characteristics of the legal and institutional framework within each country to understand the tools and institutional capacity they have to cooperate in cases of shared water resources. The fourth section explores the presence of other actors involved in this bilateral relationship. They are the *status quo* stakeholders whose activities impact the local or national economy, and this power allows them to form lobbies to influence political decision-making. Finally, the fifth section presents the concluding reflections and arguments.

Aquifer's Characteristics

The Guarani Aquifer System (GAS) is one of the largest reservoirs of transboundary groundwater in the world, and the most important in South America, with current water storage of approximately 37.000 km3 and a natural recharge of 166 km3 per year. The GAS is defined as a set of sedimentary Mesozoic continental clastic rocks, present in the Paraná and Chaco-Paraná Basins. Its origin dates from the Triassic period (250 million years) and the age of the water varies. In the areas of confinement, from the central and deeper part of the aquifer, older waters tend to be more than 30,000 years (OAS, 2009). Water is found in the pores and fissures of sandstones, formed during the Mesozoic age, which are typically covered by thick strata of basalt.

The geological continuity of this sandstone was recognized in the 1990s, after the drilling of some oil exploration wells and subsequent stratigraphic interpretation by academic researcher (Foster, Kemper, Garduño, Hirata, & Nanni, 2006). The current name was chosen in homage to the Guaraní indigenous peoples, the first inhabitants of the region where it is located (OAS, 2009, p. 109). The denomination of Guaraní aquifer comprises various geological formations with the following names in their respective countries: Pirambóia /Botucatu in Brazil; Misiones in Paraguay; Tacuarembó in Argentina; and Buena Vista/Tacuarembó in Uruguay.

It is estimated that this aquifer covers an area of 1.087.879 km² (OAS, 2009), and is located in the eastern and mid-southern of South America. It is principally located in Brazil (735.918 Km², the 68% of the aquifer), Argentina (228.255 Km², 21%), Paraguay (87.536 Km², 8%) and Uruguay (36.170 km², 3%) (Hirata, Kirchheim, & Manganelli, 2020; Walschot, 2020). More than 92 million people are located in the territory overlying the GAS. The GAS constitutes an important resource for the potable water-supply of many towns with populations of 50,000-250,000 as Tacuarembo and Rivera in Uruguay, Caaguazu and Ciudad del Este in Paraguay, and many cities in Brazil (Santana do Livramento and Caxias do Sul in Rio Grande do Sul, Londrina in Paraná, Uberaba

and Uberlândia in Minas Gerais, and Campo Grande in Mato Grosso do Sul) (Foster, Hirata, Vidal, Schmidt, & Garduño, 2009).

According to recent studies, there are approximately 2,000 operating deep extraction wells. Some of them are capable of producing more than $500m^3$/hr, but considering actual average abstraction, less than 20% of the total is producing more than $100m^3$/hr (Foster et al., 2009).

Groundwater extracted from the GAS is used for many activities, mainly, for public water supply: 66% of the GAS's water resources are used for human water supply, 5% for irrigation, 16% for industrial uses, and 13% for thermal tourism (Hussein, 2018; OAS, 2009) The increasing drilling of the GAS is explained because of the good quality of its waters (Filippon, 2012), they are generally potable, with low levels of mineralization[28], but there is a hydrogeochemical evolution when recharging waters from outcrop areas flow slowly into the deeper confined aquifer[29]. For example, in the extreme southwest of the SAG in Argentina, there are marked increases in groundwater salinity. This changes possible uses of the aquifer system (Foster et al., 2009).

[28] Because of its good quality, some cities like Riberão Preto in the Brazilian State of São Paulo, rely entirely on groundwater from the GAS (Sindico, 2011).

[29] "Certain areas display higher concentrations of sulfates and of fluorine, at levels higher than is recommended for household use. Areas where less regional flows circulate tend to be associated with greater salinity (especially in central parts of the basin, in the Brazilian States of Paraná, Santa Catarina and Rio Grande do Sul). When salinity exceeds acceptable limits, there are restrictions on the use of the water, as occurs in the extreme south of the GAS region and on its western limits in Argentina (…). In certain wells located in thermal areas in the southern portion of the GAS there is evidence that, aside from salinity, the water has high concentrations of other inorganic elements, such as arsenic, and must be carefully analyzed prior to being declared suitable for use" (OAS, 2009, p. 69).

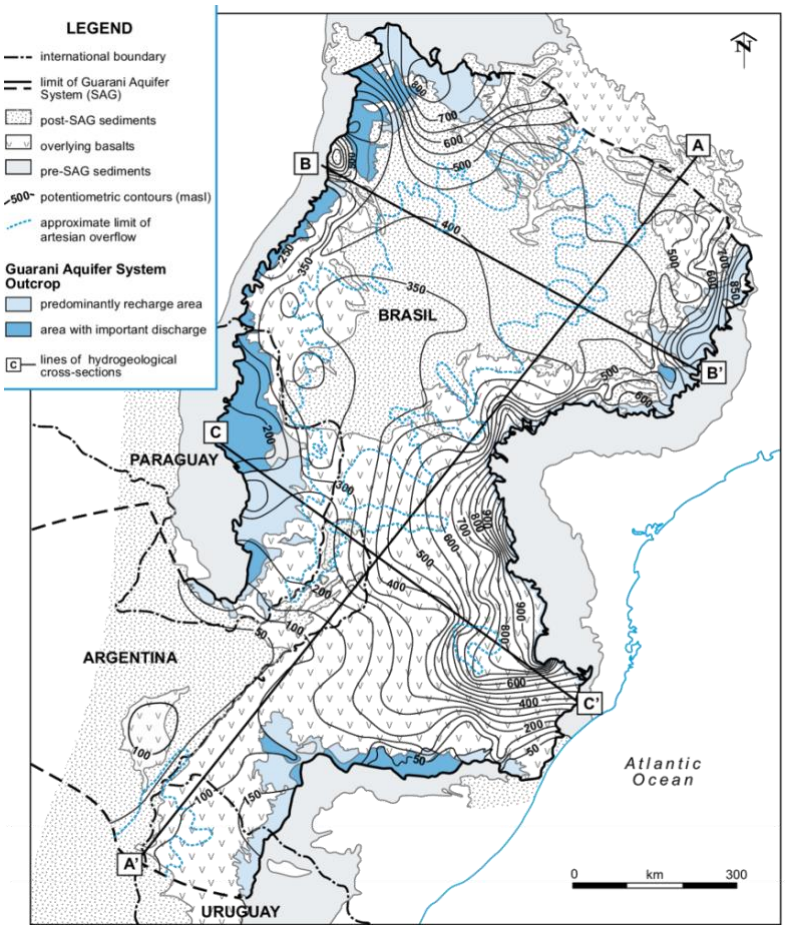

Figure 4. 1: Guarani Aquifer (Foster et al., 2009)

Because of its different characteristics, there are regions in which the aquifer emerges on the surface, and other regions where waters are more than 1.500 meters deep. Therefore, the ages and the quality of water vary considerably. In confined areas, water is older, replenishment rates are extremely slow and water quality problems are more frequent due to the natural interaction of water with rock minerals. In the recharge zones, waters are fresh, usually suitable for human consumption, but also vulnerable to contamination (C. P. Villar & Machado Gransiera, 2019). Recharge and discharge aquifer zones are relevant to consider and to control because in cases of transboundary

aquifers they have transnational impact. They are fundamental to the overall hydrologic process and the normal functioning, management, and protection of aquifers.

According to Borghetti Boscardin, Borghetti, & Da Rosa Filho (2011), there are direct and indirect recharge zones:

- Direct recharge areas or outcrops occur in regions where erosion exposes part of the sandstones. In the GAS, about 80,000 km² represent recharge areas. The main aquifer recharge zones in Brazilian territory are located on the border between the states of Goiás, Mato Grosso do Sul, São Paulo and Santa Catarina. The largest aquifer recharge area in Paraguay is in the departments of Caaguazú and Alto Paraná. Recharge in this area occurs through direct infiltration of rainwater through the ground (Borghetti Boscardin, Borghetti, & Da Rosa Filho, 2011).
- The replacement of Guaraní by indirect recharge zones occurs by surface drainage (vertical filtration) of the water through the cracks in the rocks and by indirect underground flow, along the discontinuities from the rocks. In this zone, the sandstone is covered by a not very thick layer of basalt (less than 100 m) that is highly fractured. Here the aquifer is semi-confined, and the recharge is lower. Therefore, it is necessary to make a groundwater's use compatible with recharge rates and to establish adequate land use policies.
- In confined areas, the aquifer is covered by a thick layer of basalt (which protects waters from anthropic contamination). There is no significant recharge and the extraction of the waters is not renewable. Here, it's necessary a conscious use and long-term exploitation (Foster et al., 2006; OAS, 2009; C. P. Villar & Machado Gransiera, 2019).
- The discharge zones occur mainly in regions whose topographic levels are less than 300 m. The main discharge areas of the GAS are close to the regions near the base level of the Paraná River or within the area of influence downstream of its hydrographic basin, as well as in the Argentine Chaco. These main areas would be the flat and swampy regions between the

Uruguay and Paraná rivers, in Argentina; and along the Paraná and Tietê Rivers in Brazil (Borghetti Boscardin et al., 2011, pp. 180–181).

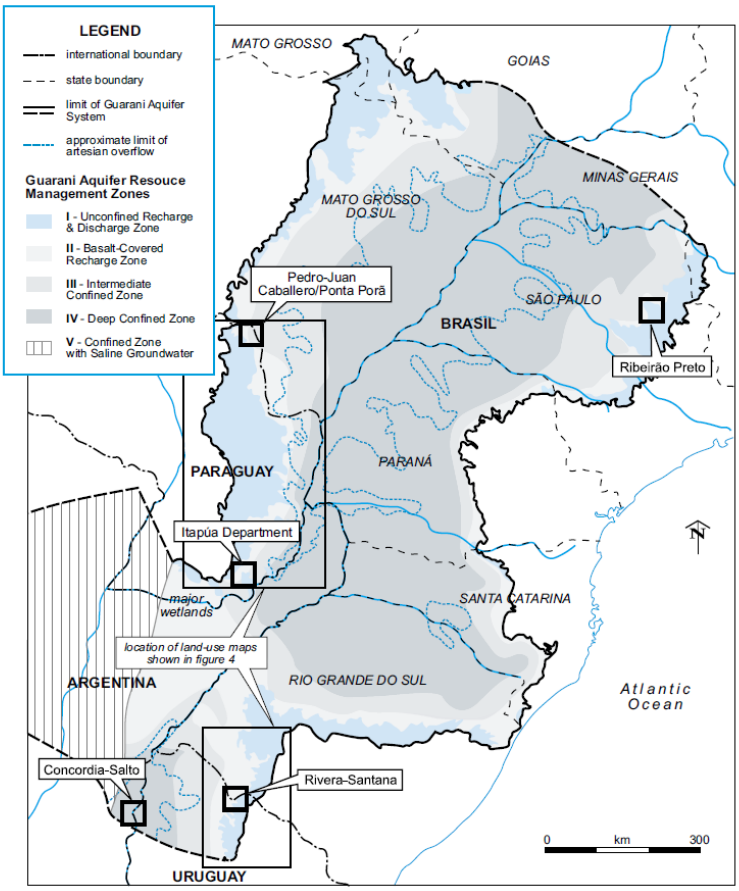

Figure 4. 2: Guarani resource management zones and location of Pilot Projects
Source: Foster et al., 2009

According to the distribution of annual volumes of groundwater abstracted from the GAS in each country, it's noted that 93.6 % of current abstractions occur in Brazil, the State of São Paulo has the largest number of wells and volumes of water extracted (Foster et al., 2009; OAS, 2009). See Table 1.

Country	Annual volume (m3)	Percentage
Argentina	13.421.524,5	1,3
Brazil	973.032.362,9	93,6
Paraguay	22.937.184,0	2,3
Uruguay	29.735.995,2	2,8
Total	1.039.127.066,6	100

Table 4.1: Volumes abstracted by country (m3/year)
Source: OAS, 2009, 78. Own Elaboration

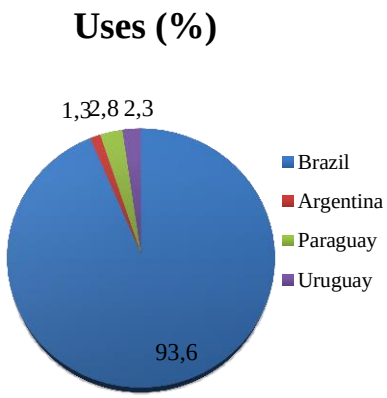

Figure 4. 3: Volumes abstracted by country (%)
Own Elaboration

Although there are abundant surface water resources in the area covered by the SAG, they often experienced pollution and/or occasional droughts. This is why the dependence in groundwater resources is increasing for domestic, industrial or agricultural uses. Because of growing demand, groundwater can also be threatened by pollution or overexploitation. At present, the GAS does not seem to be under big threat, but this situation may change in the future. Actually, the GAS "is not a homogenous system where anthropogenic interference in one part of the aquifer will be felt immediately in other parts, often very remote. However, possible future groundwater

pollution, overexploitation or negative effects arising from climate change, may have a transboundary effect" (Sindico, 2011, p. 257).

Knowledge and Multilateral Relations

Knowledge's evolution: the role of academic community in GAS' awareness

Although groundwaters allocated in the SAG have been used since the first decades of the 20th century, their research are rather recent, and have been deepening and acquiring greater relevance since the 1980s. Both, political changes in the region and the "discovery" of a transboundary aquifer system, can explain this.

First, at the end of the 1980s, the political changes that affected the South American region had an effect on relations between neighboring states, promoting an approach from cooperation, as well as the perspective of natural resources, their use and joint management.

Domestic and international changes accompanied democratic transitions. On the one hand, new democratic governments promoted reginal cooperation for economic development and democratic consolidation. In 1986, Argentina and Brazil began an integration process through the Economic Exchange and Cooperation Program (PICE). It was the basal stone for the major integration process, the MERCOSUR that included Uruguay and Paraguay.

On the other hand, democratization fostered a structural reorganization of institutions and authorities in charge of natural resources management. Additionally, new international paradigms of water management helped to introduce these perspectives of water governance in the region. Changes also had an impact on academic institutions, which acquired autonomy in their management, organization and research centers. Regional Universities acquired autonomy to establish new disciplines and careers that were forbidden under the autocratic regimes. Specifically, in the case of Hydrogeology, it was recognized as an independent discipline, allowing obtaining more

funding for research, and also a growth in the number of experts and knowledge in the field. This process occurred alongside the increasing of regional hydrogeologists cooperation engaged in joint research projects.

Second, the discovery of this transboundary aquifer system and its name[30] was particularly the result of the articulation of various actors and intense international cooperation processes at different levels. Regional theories emerged suggesting the existence of hydrological linkages among the regional aquifers despite geological discontinuities. There was a general consensus about the need to change the approach to regional aquifers as a single entity, challenging the propositions of orthodox geologists. Before the 1990s, there was no idea of its transboundary dimension. Epistemic community and international organizations (UNESCO, the OAS and the World Bank's Global Environment Facility (GEF)) played an important role in including the notion of transboundary aquifer on the regional agenda, as happen with the other transboundary aquifers.

This transboundary concept was first embodied in 1993 during the "*X Simpósio Brasileiro de Recursos Hídricos y I Simposio de Recursos Hídricos do CONE SUL*", in Gramado, Brazil. The symposium was organized by *the Associaçao Brasileira de Recursos Hídricos* (ABRH) and the *Instituto de Pesquisas Hidráulicas* / UFRGS, with the sponsorship of UNESCO, among other cooperation agencies. During the event, an international working group was established whose objective is the detailed study of the "Botucatu International Aquifer" (currently known as the Guaraní Aquifer) to carry out a rational use of the underground water resource, and to elaborate a hydrogeological map of the Guaraní Aquifer, with the existing data. In 1994, the "*Jornada Técnico-Científica sobre Gestao Sustentável do Aqüífero Internacional Botucatu*" was held in Curitiba (Brazil), organized by the Universidade Federal do Paraná, Universidad de la República,

[30] The Guaraní Aquifer denomination was proposed by the Uruguayan geologist Danilo Anton in 1994, during some meetings held in Montevideo, in homage to the Guaraní indigenous nation, since it covers most of the geographical domain inhabited by that civilization before the discovery of America. In 1996, the four countries involved approved this designation at a meeting in Curitiba, Brazil. It was also called the Gigantic Mercosur Aquifer for a while due to its occurrence in the four countries taking part in the mentioned commercial treat (Borghetti Boscardin et al., 2011; Jara Botton Faria & Goncalves De Poli, 2006; P. C. Villar, 2015).

Uruguay, and Associaçao Brasileira de Águas Subterrâneas (ABAS), under the auspices of the International Development Research Center (IDRC), Canada. In 1996, at the First Seminar and Workshop on the Giant Aquifer of the Mercosur, scientists agreed on the new unified denomination of the aquifer system. Then, in 1997, during a second seminar held in Paysandú, Uruguay, the regional hydrogeologists drafted a public declaration – Paysandú's Declaration- where they claim the creation of an institutional mechanism for joint research, preservation and planned exploitation of the GAS. They brought to the table the need to create a regulatory framework for the governance of transboundary groundwater resources (Campos, 2000; Walter, 2012).

The unified approach of Guarani Aquifer led to regional hydrogeologists to unify their claims for recognition in academic institutions and domestic governments, and helped obtaining more sources of funding for research[31]. As a result of the Paysandú's meeting, the specialists presented to UNESCO, the OAS and the World Bank's Global Environment Facility (GEF) an international research project in order to improve the hydrogeological map of the region. Because GEF's just could finance governmental management initiatives, they recommended proposing to their respective governments a joint management and research project (Walter, 2012). In fact, epistemic community with international organizations or funds from United Nations have been the main actors responsible for promoting knowledge and awareness about the need of groundwater protection and cooperation, as well encouraging international joint projects (Souza, Silva and Barbosa 2014).

Pilar Villar (2015) identifies this moment of scientific studies, discovery and knowledge diffusion as the first stage in the GAS cooperation process. Here, transnational epistemic community (national universities and institutes) took a leading role. Then, scientists mobilized to connect with international organizations and funds for

[31] In the global context, academics work in the elaboration and implement of the Internationally Shared Aquifers Resources Management Programme (ISARM), jointly with the International Association of Hydrogeologists (IAH), the Food and Agriculture Organization of the United Nations (FAO) and the United Nations Economic Commission for Europe (UNECE) in 2000. The ISARM aims to set up a network of specialists and experts to compile a world inventory of transboundary aquifers and develop wise practices and guidance tools concerning shared groundwater resources management (ISARM, 2020)

research, and this led to the second stage in cooperation, since the year 2000, in which international organizations and states would lead it. The result of this moment was the Guarani Aquifer System Program. Finally, third stage of cooperation starts in 2009, with states as key actors signing the Guarani Aquifer's agreement. After that, cooperation process suffers a paralysis in the agreement's implementation and the consequent absence of cooperation in aquifer's regulation and management.

The Project for the Protection and Sustainable Development of the Guaraní Aquifer System (GASP): the moment of International Organizations and States

The second stage in the cooperation process started with the participation of GEF, the World Bank, and the OAS, joint with the regional states as key actors. The academic community opened the door to their participation after the above mentioned Paysandú meeting. In this phase, it is important to note that "the need to prepare the GASP project arose from a group of researchers from local universities and the interest of government institutions responsible for the management of water resources in the four countries" (Hirata et al., 2020, p. 389). So, domestic political actors –here, diplomatic representatives and institutions in charge of water resources' management- had an active role in cooperation process. But, it was possible to launch the GASP because international organizations were the ones that created the financial and structural conditions for its implementation.

In 2002, GEF approved the allocation of the funds for the Project for the Protection and Sustainable Development of the Guaraní Aquifer System's implementation (also known as the Guarani Aquifer System Project -GASP). In 2003 the project was officially launched. Its initial duration was four years, but it was extended until January 2009. The World Bank was designated as the implementing agency for GEF resources, and the Organization of American States (OAS) was the executing

agency (a financial and human resources manager)[32]. The total cost for project's execution was initially estimated at USD 26.7 million. Due to the length of its duration, it was revalued in USD 31.57 million, of which USD 13.35 million was financed by GEF, USD 15.32 million by countries[33], and the rest by other international donors such as the International Atomic Energy Agency, the Federal Institute for Geosciences and Natural Resources (BGR - Germany), and the Bank Netherlands Water Partnership Program (BNWPP) (World Bank, 2009, p. 24).

The project had a General Secretariat (GS-GAS) based in Montevideo, Uruguay, and each country established its National Project Execution Unit (NPEU). These National Units were composed of stakeholders from various segments of society, including academia and NGO's. They led inter-ministerial and public participation of a deliberative and consultative nature for GAS-related themes. The NPEUs were organized in accordance with criteria applicable in each country. In Argentina and Brazil, the NPEUs reflected the federal structure. Brazil created State Project Execution Units (SPEUs) in each of the eight states that overlie the GAS. Argentina appointed to the NPEU two representatives from each of the six provinces that overlie the GAS. In Paraguay and Uruguay, which are unitary states, the NPEUs were comprised of central-government officials (OAS, 2009).

To supervise and support the progress of the project, a Superior Preparation Steering Committee (SPSC) was created, which was composed of executive representatives from water resources, environmental, and foreign affairs national institutions. The SPSC received support during project execution from a Coordination Council (CC) comprised of National Coordinators (NC) appointed by the executing agencies. Each NC acted as project focal points and worked in coordination with the

[32] "In practice, both organizations were charged with the supervision of the execution of the funds allocated to the project, but in different roles: the Bank provided general fiduciary oversight, while the OAS served as a financial and human resources manager with local representation" (Walter, 2012, p. 189).
[33] The national counterparts were not made in currency but in kind (provision of infrastructure, personnel, and the support service provided for the project) (CARI- Consejo Argentino para las Relaciones Internacionales, 2004).

General Secretariat (GS-GAS) to provide support for execution of activities foreseen (OAS, 2009).

The Project was organized in seven interrelated components designed to enhance and consolidate current scientific and technological knowledge of the GAS, its use and conservation, and its relationship with communities and institutions. It also assessed the capacity for groundwater management and transboundary aquifer cooperation of the four countries involved at the national, sub-national, and local levels. All this information would help to develop and implement a common GAS management framework, which would seek to harmonize water policies and management tools among the four participating countries and reduce future qualitative and quantitative threats to the GAS. The GASP concluded with the adoption of a Strategic Action Program (SAP) (OAS, 2005).

Specific components of the GAS Project were:

1. Expansion and consolidation of the current scientific and technical knowledge Base of the Guaraní Aquifer System
2. Joint development and implementation of the Guaraní Aquifer System management framework, based on an agreed Strategic Action Plan
3. Promotion of public participation, social communication and environmental education
4. Project monitoring and evaluation, and dissemination of projects results
5. Development of groundwater management measures and mitigation measures within identified critical areas ("Hot Spots")
6. Assessment of geothermal energy potential use, "clean energy", from the GAS
7. Project coordination and management (OAS, 2005).

To emphasize local management, the GASP concentrated its activities in four "hotspots" or pilot areas, two transboundary, Concordia (Argentina)/Salto (Uruguay); Rivera (Uruguay)/Santana do Livramento (Brazil); and two located within a state, Itapúa (Paraguay); Ribeirão Preto (Brazil). These areas are considered critical aquifer zones,

where groundwater governance seemed most necessary for the sustainable management of the resources. The pilots focused on preventing and mitigating specific sources of pollution, or overdrafting in critical recharge and discharge areas, or in confined areas of the aquifer with high concentration of uses and users. They disseminated data and information obtain on successful mitigation and management measures in order to help drive concrete actions in threatened areas, especially in transboundary zones (Kemper, Mestre, & Amore, 2003). In these pilot areas there were local offices which worked with the Support Committees for Local Projects, composed of members of the Public Power, universities, civil society and users (OAS, 2009).

The Pilot Project Concordia/Salto covered an area of 500 km2 on the border between Argentina and Uruguay, where approximately 200,000 people live. There, the GAS is very deep and highly confined, and replenishment of abstracted water is very slow. The Guarani Aquifer is not a significant source for public supply, which uses the waters of the Uruguay River. Groundwater stemming from the aquifer is used principally for thermal recreation. The SAG is covered by thick layers of volcanic basalt, the waters have artesian characteristics and the geothermal potential varies between 44º C and 48º C. A large number of wells are used by a tourism industry of growing social and economic importance. The wells reach approximately 1400 meters deep. The main problem in this location is the interference between the wells in the two cities. This Pilot has to implement standards for rational use and reuse of thermal waters of the GAS (OAS, 2009).

The second transboundary Pilot was the Rivera (Uruguay)/Santana do Livramento (Brazil) which had an area of 759 km2 on the border between Uruguay and Brazil. Approximately 200,000 people live there, and in many ways act as a continuous urban area (e.g. single electricity supply and emergency services). The main activities are agriculture and livestock. The SAG is the principal source of water supply (is used for multiple purposes including human and agricultural needs). There are near 300 water

wells[34] including those of Obras Sanitarias del Estado (OSE) in Rivera and the Departamento de Aguas e Esgotos (DAE) in Santana do Livramento. Additionally, the GAS is more vulnerable with recharge zones close to the urban area, where a low rate of urban sanitation and lack of sewerage persists. It results in a substantial wastewater load in the aquifer either directly from cesspits or indirectly from polluted streams (Foster et al., 2009). The purpose of this project is to analyze GAS protection associated with issues of extensive land-use, changing productive activities and territorial planning of human settlements.

The Itapúa Pilot Project (Paraguay) was established in an aquifer replenishment zone in the extreme south-east of Paraguay with a population of approximately 45,000 inhabitants. Today this zone is a flourishing agricultural area formerly covered by forest. Aquifer outcrop forms about 40% of the 'pilot area' (of 800 km2), and in the rest it confined (covered by basalt flows). The principal objective of the Pilot Project in this area is to identify ways to ensure the protection and sustainable use of GAS.

Finally, the Ribeirão Preto Pilot Project (Brazil) was established in the municipality and city of the same name in the northeastern part of the State of São Paulo-Brazil, located in an area of 652 km2, including 137 km2 of SAG outcrop, with a population of approximately 711,000 inhabitants. It is one of the main agricultural production areas, and the city is also an important industrial center. Drinking-water supply is intensively abstracted from the GAS (there are more than 1,000 wells). Studies previous to this project had detected considerable drops in GAS levels in certain neighborhoods. For these characteristics, this is considered one of the most vulnerable of the aquifer's zones. The pilot was thought to generate experiences of groundwater management under conditions of intensive use, in an outcrop and highly-confined zone, where the GAS receives direct replenishment (OAS, 2009).

In brief, the Program's main purpose was to support the four countries sharing the resource to elaborate an institutional and technical model for GAS's preservation and

[34] This number does not consider private boreholes operatives in multi-residential buildings or larger family residences.

sustainable management. What is remarkable of the GASP is its ability to bring together the states to peacefully talk and negotiate all aspects related to the development of knowledge, management and use of the aquifer waters. Ofelia Tujchneider, geologist and underground hydrology specialist, comments “It is essential that countries were willing to address the issue in peace and friendship. It was a very strong and politically important project. There was a lot of money. (…) It was important because countries agreed and information generated adds up. Although, the management of funds, what was done with the money, who worked, even the geological interpretations, are not exempt from questioning” (Interview 8).

It also fulfilled an important role in raising public awareness as to the existence, location and relevance of the GAS, its characteristics and vulnerabilities. The GASP helped to draw domestics and international society's attention to groundwater and aquifers, to encourage interdisciplinary debate, and to demonstrate the precariousness of public policies regarding groundwaters’ management (P. C. Villar, 2015).

“While not everything is known about the GAS the level of scientific knowledge about this aquifer system has increased in the last years” (Sindico, 2011, pp. 256–257). The GASP led to an exhaustive compendium of background information and generated an important volume of data and information that allowed significant progress in understanding the nature of SAG and its hydrodynamic and hydrochemical behavior. There have been clear advances in the hydrogeological knowledge of GAS (Veroslavsky & Manganelli, 2018). The project –and the Pilot Projects- effectively advanced in understanding the characteristics of the aquifer at the regional level, and promoted considerable technical progress, but it is not complete and it is necessary to continue research on this heterogeneous aquifer.

At the international level, the GASP mobilized International and Regional Organizations. For example, MERCOSUR -whose members are the four countries sharing the GAS- started working in a model of aquifer’s joint management. The active participation and interaction of the main institutional actors in the countries during different consultation steps was considered positive.

Some aspects initially considered in the GASP had little or no progress, such as advances in research on hydrothermal energy, or activities related to indigenous issues. Furthermore, despite efforts to disseminate the importance of GAS issues at the national level and the benefits of cooperation between countries sharing the resource, the development of coordinated governance has been stalled during these ten years. The reasons for this stagnation can be found in the weak institutional capacities of each state, absence of definition of the role and capacities of common institutions, lack of continuity of strategic public policies beyond the incumbent governments; insufficient financial support at the end of the GASP (Hirata et al., 2020).

GAS Agreement's Background

Existing Regional Water Management Agreements

The Plate River basin is a river system that empties into the Atlantic Ocean, in the cities of Buenos Aires and Montevideo, and on its lower part flows through or borders the territories of Argentina, Bolivia, Brazil, Paraguay and Uruguay. This system consists of major waterways -the Paraguay, Paraná, Pilcomayo, La Plata and Uruguay rivers- and a large number of tributaries to these rivers (Menon, 1972).

Since 1930's, South American river basins began to be considered as instruments of economic development, and not just means of communication or to demarcate the territory (as was during the colonial and post-colonial period). The river basin states wanted to undertake development projects in a cooperative way for mutual advantage. For example, in 1933, the declarations and resolutions adopted by the Seventh Inter-American Conference held at Montevideo, the basin riparian states adopted de Declaration of Montevideo -Declaration on the Industrial and Agricultural Uses of International Rivers- where they recognized the principles of prior consultation and equality for the management of the basin. These principles then became the normative basis of all water management agreements in the region, as was the case of the Regional Conference of the countries of the River Plate held at Montevideo in 1941, and bilateral

agreement signed between Argentina and Uruguay in 1946 for the joint construction of the Salto Grande hydroelectric dam on the Uruguay River (Menon, 1972; Walter, 2012).

Two decades later, progresses of infrastructure works in the basin forced states to negotiate a new regulatory regime. It was founded on the Joint Declaration of February 1967 of the Foreign Ministers of the basin states at Buenos Aires, the establishment of the Committee for the Intergovernmental Coordination of the La Plata Basin (CIC), and the River Plate Basin Treaty signed in 1969. The regime focuses on a joint and comprehensive study of the area, in order to carry out multinational, bilateral and national works, in pursuit of the common progress (Escudé & Cisneros, 2000).

Following, in April 1969, Argentina, Bolivia, Brazil, Paraguay, and Uruguay signed the La Plata Basin treaty. This treaty was inscribed in a context of the Argentine-Brazilian geopolitical rivalry, where the La Plata Basin and their hydroelectric facilities were means of power and geopolitical influence. Through the treaty, states made explicit the political and economic stakes attached to the resources of the basin, and established formal mechanisms for conflict resolution and the systematic exchange of data and information among states involved.

It's important to note that the La Plata Basin Treaty is not specifically a water treaty. It is a development treaty, where the water issue is one of the elements that is contemplated in this development process (Interview 9). In general, these agreements subordinated the role of water resources to economic growth objectives. What they mainly sought was to ensure the growing demand for natural resources and promote increases in national economic efficiency (Walter, 2012).

The issue of the Guaraní aquifer within MERCOSUR

MERCOSUR[35] was an important advance for the Southern Cone's integration and helped to deepen cooperation between member states, but the bloc still has difficulties in different areas, and cooperation in environmental matters is one of them.

In 1992 the Common Market Group of MERCOSUR (GMC/MERCOSUR), signed the Resolution No. 22/1992, which established the creation of a Specialized Meeting on the Environment (SME), with the objective of analyzing the legislation of states parties and proposing actions in the different areas in order to protect the environment. The SME would study the legislation of the four countries on the environment, which has not been completed. Then, the SME evolved into Working Subgroup No. 6 (SGT-6) which is technically responsible within MERCOSUR to discuss environmental issues. The SGT-6 has made a remarkable achievement. At environmental level, in 2001 -after ten years of negotiations (1991-2001) [36]- a framework agreement was approved. This kind of instrument was launched by MERCOSUR members but they are not part of formal regulations. They have few mandatory norms, and their text contains programmatic statements, generic principles and political orientations (Parlamento del MERCOSUR, PIDHDD, & RedVIDA, 2009; Sosa, 2004).

The Framework Agreement did not advance in terms of a legal provision for the use of the waters of the Guarani Aquifer. It was in 2004, when the Common Market Council, through decision no. 04/25 (2004), created the "Guarani High Level Ad Hoc Aquifer Group". It had the mission of elaborating a draft Agreement of MERCOSUR States Parties regarding the Guarani Aquifer. This process within MERCOSUR had as a

[35] The Southern Common Market -MERCOSUR- was established through the Treaty of Asunción in 1999, signed by Argentina, Brazil, Paraguay and Uruguay. In 2006, the Bolivarian Republic of Venezuela signed the Accession Protocol for MERCOSUR, having its entry approved as a full member in July 2012, during the suspension of Paraguay. Bolivia (1996), Chile (1996), Peru (2003), Colombia (2004) and Ecuador (2004) are associate members.

[36] During these years, the recurring economic and financial crises that faced member states changed their interests and motivations. When elaborate the treaty, states had the perception that the environmental issue influences the commercial relations of the countries, since it impacts the competitiveness of prices and products. At that time, there was a clash between Brazilian and Argentina positions. Brazil sought environmental standards equivalent to its national legislation, while Argentina defended softer environmental standards (P. C. Villar, 2015).

background the meetings of experts within the framework of the GASP, and, in the international context, the work program of the United Nations International Law Commission (CDI), which included the topic of groundwater. However, this agreement, like the previous ones, has not evolved. The suggested model did not advance due to the impossibility of reaching a consensus on the dispute settlement system, and it was off the agenda after the so-called "Pulp mill" crisis between Argentina and Uruguay[37] (Sindico, 2010).

After the deadlock of the Framework Agreement, the MERCOSUR Parliament (also called Parlasur) proposed to the Common Market Council the formation of a commission in charge of studying and comparing national water resources legislations, and presented a Model of Framework Agreement on Cooperation for the Sustainable Management of the Guarani Aquifer System. In addition, the Parlasur suggested the implementation of a transition project that would give continuity to the GASP. None of these initiatives prospered (P. C. Villar, 2015).

Nevertheless, these previous antecedents were really important since they marked the way towards the signing of a definitive agreement between the four states. Sindico (2010) considers that some events could encourage that agreement: a) the elaboration of the Draft Articles and the AGNU Resolution 63/124 (2008) on the Law of Transboundary Aquifer; b) the end of the GASP (2009), which constituted a technical basis for this body of water, and, c) the end of the conflict between Uruguay and Argentina.

But, as Villar (2015) asserts, the GASP appears to have been the main cause of encouraging countries to sign an agreement for various reasons. This project made the aquifer visible in various governmental instances. In 2004, one year after GASP official launch, states involved start considering the realization of a joint agreement for aquifer's management, and its negotiations concluded the year after GASP conclusion. The

[37] The installation of two paper mills (financed by the Spanish group ENCE and the Finnish BOTNIA) on the Uruguay River triggered a conflict between Argentina and Uruguay during years (2005-2010). Tensions escalated to the International Court of Justice. This conflict revealed difficulties and incapacity of the countries, the Administrative Commission of the Uruguay River, and Mercosur to resolve environmental controversies (P. C. Villar, 2015).

project provided a database to the states with the necessary information to deepen cooperation, and the Guaraní Aquifer gained national and international projection. There was international pressure on the countries to advance in the cooperation process, a fact that may have led countries to ensure their sovereignty over water resources.

What is clear is that the issue of transboundary aquifers was in full swing, and the regional and international context favored states to establish a cooperation scheme in this regard. Thereby, the four countries decided to meet again in June 2010, and they resolved to negotiate a definitive agreement. It was a "surprisingly quick outcome, even for some of the people involved in the negotiations themselves" (Sindico, 2011, p. 260).

Guaraní Aquifer Agreement

Content of the agreement

As a consequence of this process initiated with the GASP in relation to use, environmental protection, cooperation and the use of the waters of the Guaraní Aquifer, the Republic of Argentina, the Federative Republic of Brazil, the Republic of Paraguay and the Oriental Republic of Uruguay signed the Agreement on the Guaraní Aquifer, on August 2, 2010, in occasion of a meeting of Heads of State of the MERCOSUR in the city of San Juan, Argentina. Although MERCOSUR was used as the meeting place for this agreement, it was developed outside its organizational structure.

The agreement consists of a preamble and 22 articles. The preamble explicitly recognizes the International Law Commission Draft Articles on Transboundary Aquifers of 2008 as a source (the Resolution 63/124 of the United Nations General Assembly on the Law of Transboundary Aquifers), the Resolution 1803 (XVII) of the United Nations General Assembly, related to the permanent sovereignty over natural resources; along with principles of natural resources protection, the sovereign responsibility of states regarding their reasonable utilization, the sustainable development promotion recognized in the Declarations of Stockholm (1972), Rio de Janeiro (1992); the conclusions from the Summit of the Americas on Sustainable Development of Santa Cruz de la Sierra

(1996), and the conclusions from the World Summit on Sustainable Development of Johannesburg (2002). It also recognizes the Treaty of the La Plata Basin (1969), the Framework Agreement on the Environment of MERCOSUR (2001), and the contributions of the GASP.

The role of the United Nations Law of Transboundary Aquifers as a guideline is remarkable, especially with the emphasis given to the principles of sovereignty (mentioned in the Preamble, and Articles 1, 2 and 3), the equitable and reasonable use of water resources, the obligation not to cause harm, cooperation, and the exchange of data and information.

Article 1 affirms the sovereignty of states over the GAS and defines it as a "transboundary water resource". According to this article, just shared waters are subject to international law and not the geological formation that contains this water as is established in the UNGA Resolution 63/124 (2008) mentioned in the Preamble. Article 2 recognizes the right of each state party to exercise its territorial sovereignty and control over its respective parts of the Guarani Aquifer System, "according to its constitutional and legal systems and in conformity with the applicable norms of international law." The right of territorial sovereignty is reinforced in Article 3 but is accompanied with its concurrent obligations: the Parties "shall use such resources on the basis of reasonable and sustainable uses criteria, respecting the obligation of not causing significant harm". Articles 5 to 7 elaborate on this obligation to protect the aquifer and prevent significant harm: "Parties shall adopt all the necessary measures to avoid causing significant harm to the other Parties or the environment" (Article 6), and, if significant harm occurs, the Party responsible "shall adopt all appropriate measures to eliminate or mitigate such harm" (Article 7). Article 4 mentions the principal objective of both, GASP and the Agreement: "The Parties shall promote the conservation and environmental protection of the Guarani Aquifer System so as to ensure multiple, reasonable, sustainable, and equitable use of its water resources". So, here it is explained that the GAS management is aimed to pursue reasonable and equitable utilization principle.

In other words, although there is a clear emphasis on the principle of national sovereignty on the Guaraní Aquifer Agreement, it is counterbalanced by the application of the obligation not to cause significant harm and of the principle of equitable and reasonable utilization.

Articles 8 to 14[38] are based on the general principle of international cooperation that claims the need to exchange technical information on studies, activities and works regarding the use of the aquifer and the measures designed (Article 8). Articles 9 and 10 reiterate this obligation and mention that a Party, where it considers that an activity undertaken by another one may lead to significant harm within its territory, can request technical data available including the results from an environmental impact evaluation. If a Party, after examining the information provided for the state implementing or wishing to undertake an activity in the GAS, is still not satisfied that it won't cause significant harm, Article 11 determines the procedure –negotiations and consultations- which must be carried out in good faith between parties involved in a maximum period of six months (Sindico, 2017; Tinker, 2016).

Technical, scientific and managerial cooperation was highlighted in Articles 12 and 13 in accordance with the spirit of the Preamble which affirms the need to advance in scientific knowledge of the GAS. Article 14 maintains that Parties shall cooperate in identifying critical areas, especially in border areas that require specific treatment measurements. Something important to consider is that the agreement has no prediction or mention for the outcrop areas' protection in the borderlines, which are vulnerable and prone to the occurrence of cross-border conflicts (P. C. Villar, 2015).

Disputes Resolution's Provisions

In the Strategic Action Program (OAS, 2009), Governments of the countries acknowledged the La Plata Basin Treaty as the legal framework under which

[38] The mentioned provisions fall along the lines of UNILC Draft Article 8 (Sindico, 2017).

cooperation relating to the GAS shall be carried out. The Guaraní Aquifer Agreement, in its Article 15, confirms this decision stating that a Commission will be established, comprised by the four Parties, under the Treaty of the Plata River Basin, and in accordance with the Article VI of such Treaty. This commission will be in charge of coordinating cooperation among such Parties.

Next articles establish a dispute resolution mechanism: if Parties have a dispute, first, direct negotiations will be carried out and they should inform to the Commission (Article 16). If they don't reach a solution by mutual agreement, Parties involved may submit the dispute to the Commission and request that this body make recommendations (Article 17). According to this article, however, the Commission will still have a restricted role. It would present recommendations (with no binding consequences), but its participation has to be evoked by the Parties through mutual consent. If the controversy cannot be resolved after this procedure, Article 19 states that parties shall use an arbitration procedure which will be established in an additional protocol[39].

Final articles are operative: the agreement won't accept reservations (Article 20); it will enter into force on the thirtieth day following the date of deposit of the fourth instrument of ratification, its duration will be unlimited and Brazil shall be the depositary (Article 21); the procedure for denouncing the agreement (Article 22).

On balance, the Guarani Aquifer Agreement (GAA) -despite its imperfections or omissions- represents a significant contribution to the regulation of cross-border groundwater in Latin America and the world. Given the scarcity of specific initiatives to regulate the use and management of transboundary aquifers, the signing of this Agreement is by itself a milestone. In reaffirming classic principles of International Freshwater Law such as equitable use, the obligation not to cause harm and cooperation, it contributed to the consolidation of the international customary law in the case of groundwater.

[39] The impossibility of reaching an agreement on the dispute settlement system that was being discussed in 2005 was one of the reasons why the negotiations between the four MERCOSUR countries were interrupted. When the agreement was drawn up in 2010, the countries left the discussion on the arbitration issue for a second stage of negotiations. In this way, they were able to advance agreements on the general framework and be able to sign a cooperation agreement on the waters of the SAG (Sindico, 2017).

Another point to highlight is that the agreement's promulgation occurs in the absence of conflicts about transboundary groundwater resources. "It is the first time that transboundary groundwater has been considered in a preventive/precautionary context" (P. C. Villar & Costa Ribeiro, 2011, p. 656). This did not happen in the case of cooperation about surface water within the region. The agreements reached were precisely the result of conflicts and competition over the appropriation of these resources during the second half of the 20th century.

Nevertheless, it's important to consider that the Guarani Aquifer Agreement is a "flexible cooperation tool" (P. C. Villar, 2020) between the four states sharing the resource, and obliges them to manage its waters in accordance with the rules of international freshwater law. Unlike the Genevese Aquifer, the GAA is not a management agreement. It has a lax disposition[40]. And, what is more important, it still has two items in the agenda following its entry into force: the creation of the Commission under the La Plata River Basin Treaty, and the negotiation of a Protocol setting the dispute resolution procedure. Both tasks require the goodwill of all parties and a budget. Parties need to define the role of the Commission, its statutes, competences, members and budget. It also needs to address the relationship with the La Plata River Basin Treaty institutional setting. The elaboration of a Protocol, according Article 19, will require that the four countries reach an agreement on a mechanism capable of successfully reconciling the different positions.

According to the procedure established in the agreement, for it to enter into force, each state shall ratify it and deposit the instrument of ratification with the Federative Republic of Brazil, designated as the custodian of the agreement and the instruments of ratification. This process took ten years, basically due to the delay of Brazil and Paraguay in ratifying the agreement, and after Paraguay in depositing the instrument. Argentina and Uruguay ratified the treaty by enacting Law No. 26,780/2012 and Law

[40] As was defined here, a lax regulation establishes framework-type agreements, whose centerpiece is an interstate institution to administer aquifer monitoring, and data collection and exchange. These kinds of instruments are fundamentally based on customary international law, which binds all states with a transboundary aquifer in common, and its rules govern cross-border impacts of groundwater exploitation and management.

No. 18,913/2012, respectively. Brazil recognized it through Legislative Decree No. 52/2017 and Paraguay through Law No. 6037/2018. However, Paraguay's instrument of ratification was not deposited with Brazil until October 2020. Finally, the Guaraní Aquifer Agreement entered into force on November 26, 2020.

Institutional and Legal Framework

During the GASP years, there seems to be a consensus between involved countries about harmonizing their laws regarding groundwater management. Although the Guaraní Aquifer Agreement is a breakthrough, the four states are still far from achieving an integrated and sustainable management of the groundwater resources of the aquifer. In fact, the four countries have an adequate legal framework for the use and protection of their water resources (surface and groundwater), but, what is evident is their deficiency in their capacity to implement and enforce groundwater management measures (Foster et al., 2009).

Additionally, among these countries there are numerous differences due to their political and administrative organization. On the one hand, Brazil and Argentina are federal countries, and they have delegated the administration of groundwater resources to provinces or states. On the other hand, Paraguay and Uruguay are unitary and groundwater resources' administration rests on national governments.

As was stated above, there are also notable disparities regarding the use made of the aquifer waters. For example, in Brazil, more than 2000 boreholes penetrate the aquifer in its recharge or transit zones for different purposes and uses. The Uruguayan territory has an average of 350 wells and the Paraguayan territory has about 200 wells. However, Argentina only has around 100 wells in the aquifer recharge areas. In view of all this, it is clear that each country has particular needs regarding the protection and sustainable management of groundwater resources of the aquifer.

Legal framework in Argentina

In Argentina, according to the National Constitution amended in 1994, the national government has to regulate the rational use of natural resources, the preservation of natural heritage and to dictate the norms that contain the minimum budgets for environmental protection, and provinces has to dictate the complementary norms (Article 41). Article 124 establishes that the provinces have the original domain of the natural resources in their territory. Provinces represent the legislative authority in charge of water resources, their effective control, the regulation of its uses, the granting of concessions and permits, and all administrative matters (Pinedo, 2018). Then, each province has its own codes on water resources, which are under the supervision of the Sub secretariat of Water Resources of the Ministry of Planning, Investment and Services.

The Civil and Commercial Code (2014) lists the assets that are subject to the public domain: "rivers, estuaries, streams and other waters that run through natural channels, navigable lakes and lagoons, glaciers and the periglacial environment and all other water that has or acquire the ability to satisfy uses of general interest" (Article 235). Assets belonging to the public domain are considered as inalienable, unattachable and imprescriptible (Article 237). But, Argentina has a mixed ownership system and recognizes the existence of water as a private good. In the Article 239, this Code explicitly mentions the "water own by individuals", which are the waters that arise in the lands of individuals and belong to the owners of the lands, who can freely use them, except that they form part of a natural channel. The waters of private individuals are subject to the control and restrictions established by the enforcement authority in the public interest.

Another relevant national regulation on groundwater, to which the provinces must comply, is the law No. 25.688 (28.XI. 2002), Regime of environmental water

management, which establishes the minimum environmental budgets for the preservation of water, its use and rational use.

Then, as provinces have to regulate the management of their water resources, the legal frameworks vary widely between them. Some provinces have well-developed legislation, while others don't have regulated important aspects such as irrigation systems, user organizations, or water rights. To date, there are seven provinces that don't have legal provisions for the joint management of surface and groundwater resources (OCDE, 2020).

Regarding the Guarani Aquifer, The Province of Entre Rios is the principal user and its economic activity is increasingly dependent on income from thermal tourism. This province has a legal framework for groundwater and thermal water management: the law No. 9.172/98 and Regulatory Decree No. 7.547/99 "Use and exploitation of groundwater and surface water for productive economic purposes in the provincial territory", and the Decree No. 3413/98 on thermal waters. In 2006, provincial government established the Regulatory Framework for the management of thermal resources, and it was created the enforcement authority, the Regulatory Entity of Thermal Resources of the Province of Entre Ríos. In this way, Entre Ríos became the first province in the country to have specific legislation for the regulation of thermal resources. Today the province has 16 hot springs in operation[41] ("Ente Regulador de los Recursos Termales de la Provincia de Entre Ríos," n.d.).

To complement the Argentina scenario, there are two provinces which have sanctioned laws regarding groundwater management: Law No. 5641/2004 of the Province of Corrientes and the Law No. 4326/2007 of the Province of Misiones. Both provinces are covered in their entirely by the SAG. These norms reaffirm the full jurisdiction of the provinces on the groundwater that make up the Guaraní Aquifer (Cosso, 2012).

[41] These are the sixteen hot springs in Entre Ríos: Chajarí (1), Federación (1), Concordia (3), Villa Elisa (1), San José (1), Colón (1), Concepción del Uruguay (1), Gualeguaychú (2), Basavilbaso (1), Villaguay (1), La Paz (1), Maria Grande (1), Victoria (1).

Therefore, Argentina still has pending issues regarding the regulation of its water resources. In the first place, the concept of water as private property still exists, whereby groundwater is directly affected, and is not subject to the criteria of common use good. Also, there is no fluid coordination between municipalities, provinces and the national state nor is there a joint management of their surface and groundwaters. The wide dispersion of entities and laws makes this process more complex. And even more difficult is the possibility of making the laws compatible among the countries with which these resources are shared. The decentralization and lack of multilevel coordination negatively impact the possibility of implementation of transboundary agreements such as the GAA.

Then, in states decentralized, with divided governments, and without multi-level coordination, the international cooperation and the ratification of the international agreements reached by the executive are less likely than in a unitary state scenario. These characteristics affect the emergence of a univocal political interest to promote a change in the *status quo* in relation to groundwater regulation. The dispersion of interests in the internal political actors impacts their capacity for action and the final outcome: regulation (lax or no regulation).

Legal framework in Brazil

According to the Federal Constitution of 1988 (10/05/88) water resources are a public good, but the domain of the waters has been divided between the Federal Government and the States of the Federation: lakes and rivers –or any watercourse- that flow through more than one state or shared with other countries are in the domain of the union (Article 20). Surface or groundwater, flowing, emerging and in deposit, within a state are domain of the states. Then, groundwater management is in charge of the states (article 26) and it's coordinated by the National Water Agency. The Secretariat of Water

Resources and Urban Environment of the Ministry of the Environment is the body responsible for the implementation of the legislation on groundwater.

Despite being a good in the public domain, the Federal Constitution in its article 225, establishes that waters belong to the category of environmental goods, which are considered common use goods of the people (UNESCO & OAS, 2008; C. P. Villar & Machado Gransiera, 2019; Walschot, 2020).

Otherwise, mineral, thermal, and bottling use of water are not recognized as "water resources", and they are under the legislative competence of the Federal system. The law classifies them as mineral resources according to the Decree Law No. 227/1967 (Mining Code), Decree No. 62 934/1968 and Decree Law 7841/1945 (Code of Mineral Waters). These waters are governed by the mineral system under the management of the National Mining Agency (ANM) (C. P. Villar & Machado Gransiera, 2019). In the case of the Guarani Aquifer, each federal state is responsible of managing and regulating the use of its portion of the aquifer, but not all Brazilian states has regulated groundwater management.

In turn, the wide dispersion that exists about regulations (federal and state), and about the knowledge that has been developed, complicates the use and management of groundwater resources –as happens in the case of Argentina. This is an additional intricacy for a regional groundwater management's achievement.

Legal framework in Paraguay

Unlike Brazil and Argentina, Paraguay is a unitary state and the management of its water resources is in charge of the General Directorate for the Protection and Conservation of Water Resources of the Ministry of Environment.

At the constitutional level, there are no specific provisions about water, but at the legislative level, the Law No. 3239 (Ley N°3239/ De los Recursos Hídricos del Paraguay, 2007) "On the water resources of Paraguay" regulates the Sustainable and Comprehensive Management of All Waters and Territories that produce them, whatever

their location, physical state or their natural occurrence within Paraguayan territory, in order to make it socially, economically and environmentally sustainable for the people who inhabit the territory of Paraguay. This law establishes fundamental principles (Article 3):

- surface and groundwater are property of the public domain of the State;
- access to water to satisfy basic needs is a human right and must be guaranteed by the State, in quantity and quality;
- Surface and groundwater resources used for domestic purposes and for basic family production that are used directly by the user are freely available (Article 15);
- Priority order for the uses and exploitation of water resources (Article 18);
- The state has the non-transferable and non-delegable function of ownership and custody of water resources.
- The use of water resources or their channels may only be granted by means of a permit or a concession (Article 32) (UNESCO & OAS, 2008).

The concept of basin is not considered as a hydrogeological unit in the management of water resources. For instance, the Paraguayan Civil Code sanctioned in 1985 had not included groundwaters as property of the public domain of the State –it just recognized rivers and navigable lakes. It was only in 2005 that the Paraguayan Civil Code was modified by Law No. 2559/05, expanding the public domain of the State also to groundwater. This has been an innovation in relation to the issue.

The authority in charge of water resources is Ministry of the Environment and Sustainable Development (MADS, for its acronym in Spanish), created in 2018 by the Law No. 612317. It has the competence and the exclusive responsibility of ensuring that the country complies with the provisions of Law No. 3239/2007. Previously, the main problem of Paraguay was an excessive fragmentation in the regulation and in the competent entities, which made ineffective the administration and management of problems and conflicts over water. Since 2000, two organisms have competence over water resources. The Secretariat of the Environment which promoted the control and

supervision of activities aimed at the exploitation of forests, flora, wild fauna and water resources, and the General Directorate for the Protection and Conservation of Water Resources, which must formulate, coordinate and evaluate policies for the maintenance of the basic flows of water currents, the recharge capacity of aquifers, the care of the different uses of water resources for preserving the ecological balance. The MADS came to unify their competences and to guarantee compliance with the rights and duties related to water (surface and underground) established in the law No.3239 (Belda, Tamayo & Acosta, 2020; UNESCO & OAS, 2008).

Currently, Paraguay faces some environmental difficulties related to the GAS as the contamination of recharge/discharge areas, and uncontrolled drilling and extraction. The construction characteristics of the drilling wells negatively affect the water quality. Research conducted by the GEF has also identified pollution problems due to wastewater management (Walschot, 2020). Moreover, the scientific knowledge and the information available on the GAS is limited in Paraguay despite the fact that the country has more than 200 water wells in its territory[42].

In sum, Paraguay still have some relevant issues pending of regulation, it has not an institutional integration in water management, and this further complicates the possibility of achieving coordination in the management of shared resources at the regional level.

Legal framework in Uruguay

Like Paraguay, Uruguay is a unitary state, and its national water and sanitation policy results mainly from article 47 of the Constitution, amended in October 2004, which founds the basis of the Water Law according the following principles: water as an essential natural resource; integrated management of water resources; surface and groundwater constitute a unitary resource of public domain (UNESCO & OAS, 2008).

[42] Paraguay is the country that requires the least depth of excavation, and therefore less investment, to reach the waters of the aquifer. This facilitates the extraction of its water but also makes it extremely vulnerable to contamination.

The organism that deals with the country's water resources is the National Directorate of Water and Sanitation (DINASA, according to its Spanish name) of the Ministry of Housing, Territorial Planning and the Environment.

It’s important to consider that, since 2004, water has been defined as a public good with the adoption, by popular referendum, of a decision with constitutional value. The country's water resources cannot then be considered as a product and be the object of financial transactions. In 2009, the Law 18.610/2009 establishes the guiding principles of the National Water Policy -in compliance with the second paragraph of Article 47 of the Constitution of the Republic-, and promotes the sustainable and integrated management of surface and groundwater resources. There are also decrees on the use of thermal waters in this country, and has specific provisions for the GAS management in its regions:

- Decree 214/2000: Management Plan for the Guaraní Infrabasaltic Aquifer in the territory of the Eastern Republic of Uruguay. It is applied to the capture of thermal waters, regulates different administrative aspects for the use of infrabasaltic perforations and establishes specific conditions for the drilling of new ones.
- Decree 86/2004: technical standard for the construction of wells drilled to capture groundwater.
- Decree 183/2013 which creates The Guaraní Aquifer System Commission as an advisory body of the Regional Council of Water Resources constituted by Executive Power Decree No. 262/2011 dated July 25, 2011 (Veroslavsky & Manganelli, 2018).

Additionally, Uruguay has a series of strategic advantages in relation to the Guaraní aquifer. Although Uruguay is the country with the smallest surface area of the GAS, it is the second largest user of its groundwater. It’s the host country of several regional organizations, as was the case of the project program financed by the GEF, the Regional Center for the Management of Groundwater Latin America and the Caribbean –CeReGAS-, Tecsult Inc., the Canadian company responsible for research and

production of maps on the aquifer system. All are established in Montevideo, its capital city.

Here, it's important to note the role of CeReGAS, an institution that remains working today, and which aims to articulate national and regional capacities at the public and/or private level for the sustainable management of aquifers and the protection of water resources of South America ("ceregas.org," 2021). CeReGAS was the result of the dissatisfaction of the Uruguayan government in relation to the progress of the Guaraní Aquifer Project (Uruguay was one of the great negotiators of the GAA, it was the one that most pushed and supported the agreement). Given the delays in the ratification of Brazil and Paraguay, it decided to establish an organism for the Guaraní Aquifer through UNESCO (Interview 9). Thus CeReGAS is created with the support of the Government of Uruguay and the Hydrological Program, and has a scope the aquifers of the region (South America).

In spite of the development of a legal and institutional framework for water resources in the four countries sharing the Guarani Aquifer, considerable concerns remain about their institutional capacity for enforcement. Moreover -and because the main use of the GAS is strongly linked to agriculture and domestic consume-, these instruments don't define clear mechanisms for groundwater protection such as influencing agricultural policy and rural land-use decisions; fostering groundwater-friendly land-use practices; controlling that states, provinces and municipalities consider the vulnerability of groundwater when ruling the urban land-use, etc. (Foster et al., 2006).

The above mentioned lack of institutional capacity could be explained from a series of factors that vary in each country. In Brazil and Argentina, the effect of the federal structure and decentralization without multilevel coordination is evident– especially in the area of water management. Additionally, budgetary limitations, lack of institutional coordination, are problems also present in Paraguay. In the latter country, despite its unitary structure, its low state capacity could be the fundamental factor.

As an illustration, a Guaraní Aquifer System Environmental Management Control audit report conducted by the General Auditor of the Argentine Nation (AGN) in 2007 denounced the lack of articulation between the national authorities (especially with the Undersecretariat of Water Resources -SSRH) and the provincial governments, the absence of mechanisms that allow the active participation of the provinces, and the misinformation about the GASP, its components and financing at the local and provincial level. The AGN indicated that the GASP National Coordination did not have the technical team or the material resources necessary to effectively carry out its functions. Additionally, the slow progress in the execution of the GASP -which had to be extended for two more years-, was due to the delay in the implementation of the national counterparts (especially Argentina and Brazil) because of budgetary limitations (Auditoría General de la Nación, 2007b, 2007a).

Later, in 2015 –after being ratified the GAA-, another AGN's audit report assert that although the Argentinian national government and the provinces have agreed Guiding Principles for Water Policy, they have not been established by law. In addition, Law No. 25.688 that sets the Environmental Management of Water has not been regulated[43] nor has it established an authority for its implementation. The Federal Plan for Groundwater has maintained the lines of work developed by the GASP but has many weak points: it does not set clear and measurable goals, with deadlines, responsible persons, affected resources and indicators susceptible to follow-up, and the allocated budget is insufficient for its implementation. In addition, this plan does not implement the guiding principles of policy, does not contemplate the participation of scientific-technical water bodies, nor has it been discussed with the provinces in order to incorporate their commitment. At the same time, it indicates that, once the GASP has been completed, the SAG has not continued to be studied at the sub regional and local levels. The SSRH does not allocate specific and sufficient human and material resources for the management of the SAG. There is a lack of resources for the preparation of the database, preparation of maps, studies and monitoring, data loading, training and

[43] A low without its due and timely regimentation would be prevented from achieving its mission.

dissemination. There is no evidence of substantial inter-institutional articulation activities with organizations linked to water issues. On the other hand, a systematic dissemination of GAS' information has not been implemented at all educational levels (primary, secondary and tertiary), nor for SAG users (members of the thermal tourism, merchants in the area and other possible users of the thermal activities) (Auditoría General de la Nación, 2015a, 2015b).

The difficulties that arose during the GASP - as indicated in the 2007 Argentine audit report- and after the signing of the GAA, are an indicator of something that is generally replicated in the states of the region. Uruguay could be considered as the exception. It is a centralized state with greater organizational capacity and political initiative, and has advanced in the implementation of the agreement through the creation of an organism for the Guaraní Aquifer through UNESCO – the CEREGAS.

Hence, the above mentioned reasons for the stagnation after the agreement's signature (the weak institutional capacities of each state, absence of definition of the role and capacities of common institutions –as the Commission-; insufficient financial support at the end of the GASP -Hirata et al., 2020) allow us to understand why the interests of domestic political actors in changing the *status quo* has not been constant enough to achieve, first, a strict regulation of the aquifer and, second, its implementation. The other causal factor influencing that result is the presence of *status quo* stakeholders, something that explains next section.

Other Actors involved in GAS management

During the process of regional cooperation on the Guarani Aquifer there were different actors leading the process. Initially, the epistemic community (meaning researchers and academics from the four countries) helped advance research about its characteristics, and their principal achievement was discovering that the Guarani groundwater resources are part of a unified aquifer system and its transnational

characteristics. International Organizations also led the cooperation process, together with different state powers and institutions (here, the domestic political actors).

Then, in the GAS case study, there were found some stakeholders that have positively participated during the GAS Project, as in the Pilot Projects. Environmental Organizations, Civil Society, Entrepreneurs, who were invited to participate in seminars, meetings or other informational events organized by governments, universities or international organizations involved.

In addition to the epistemic community, International Organizations and state actors, the presence of economic actors, which are users of these resources, should not be overlooked. They have been present and involved in groundwater extraction and use even before the discovery of the transnational characteristics of GAS. As stated by Garduño et al (2010), these actors are the "groundwater stakeholders". They have an important interest in the resources of a specified aquifer "because they use groundwater, or because they practice activities that could cause or prevent groundwater pollution, or because they are concerned with groundwater resource and environmental management" (Garduño et al., 2010, p. 1).

In line with the hypothesis advanced in this thesis, it is important to consider the *status quo* stakeholders. These are mainly economic actors that extract and/or use aquifer's groundwater to develop activities that impact on the local or national economy. This economic power gives them the capacity or possibility to influence the political decision-making regarding the management and regulation of aquifer waters at any level of government (national o subnational). For example, mining companies, hotels, and thermal tourism, bottled water enterprises, hydropower companies, among others. These actors are not homogenous parties, and they attempt to maximize their private net gains. Some of them could be empowered and forming lobbies as a mean to protect their collective interests (Llamas & Martínez-Santos, 2005). In the present case, *status quo* stakeholders are expected to act against an aquifer's rule or regulation, making it more flexible or preventing its emission: no regulation or lax regulation.

Thermal Recreation Centers

In Argentina, as thermal recreation is the principal economic activity regarding the waters of the GAS, entrepreneurs of this area (provinces located over the Guarani Aquifer: Misiones, Corrientes y Entre Ríos) could be consider as economic *status quo* stakeholders. During the interview to a manager in a thermal spa in Entre Ríos, it was evident their participation and influence over the municipal and provincial government. Clearly, they have become the main engines of the province's economy in the last twenty years.

Towards the end of the 90's, in Entre Rios different municipalities started making their exploration activities without enough information or regulations about groundwater resources. The municipalities put out to tender private companies to make a risk investment in the exploration of these waters. It was known that in Uruguay, on the other side of the coast of the Uruguay River, they had found hot springs. Then there was information from some exploratory studies that YPF had carried out during the 1940's - 1950's. But they had not information about water' characteristics, its origin or precedency, etc. "It was working in a trial and error. We were lucky that the thermal water was sweet and of excellent quality. The only concern at that time was the drainage and the tipping into the river, and what impact it had on the river" (Interview 3). They solved that problem building artificial channels to recirculate water and lower its temperature, reaching a temperature similar to the river before arriving to it.

The entity to request authorization to start a new drilling is the Provincial Government. The Province, as the "owner of natural resources" also regulates distances between water wells, uses of the resource and the approval of projects to establish new thermal recreation centers. The municipality goes to the province to request permission to undertake the thermal recreation center. At the beginning, when thermal tourism was starting, the procedure was just to obtain an authorization to have a water well like any other. Nowadays, the procedure is carried out through some entities: the Regulator

Entity of Thermal Resources of the Province of Entre Rios, which requests environmental impact evaluations, soil treatment studies, environmental and economic sustainability of the project, among others; and the Regulatory Council for the Use of Water Sources (CORUFA), authority in charge of the application of the Provincial General Water Law (Law No. 9,172). The process takes about 2 years. Before obtaining the permit for drilling, the company must contract surety insurance on behalf of the Province for any damage that may be generated to the environment. Once the exploitation of the resource begins and the thermal complex opens, the regulatory entity supervises these complexes, through its inspectors who review water quality, flows, and the reports corresponding to the development of the exploitation.

In projects of thermal resources and depending on their characteristics, there are at least two negative effects on the environment in the absence of adequate infrastructure for their disposal. Firstly, the chemical contamination when handling large volumes of water with significant saline content. Secondly, the thermal contamination as a consequence of the discharge of water with temperatures higher than the background values in pre-existing natural ecosystems. Then, the modification of the compositional and thermal variables can affect the normal development of the organisms that inhabit these watercourses, causing harmful effects on the flora and fauna of the pre-existing ecosystems.

In general, after their usage, thermal waters discharged to natural watercourses. In cases where the thermal center has freshwater, it requires less treatment. There, only effluent treatment is done, but not treatment of the pool waters. The procedures are concerned only with cooling the water to achieve a temperature similar to that of the river. However, the regulations do not contemplate that those waters that are injected into the river were also contaminated by cosmetic products, chemicals from sunscreen products used by people, among others.

In other cases, the effluent waters of these thermal wells contain a high concentration of dissolved solids which indicates a strong mineralization. Fundamentally, these waters have high concentrations of chlorides and sodium, which

can be harmful, at different levels, for agricultural activities, health, and regional fauna (Pesce, Miranda, & Gárea, 1999). Despite the fact that in these thermal centers the water is treated prior to being discharged into the river (in some cases these treatments consist of mixing the thermal water with fresh water in a reservoir), there is pollution of the watercourse where it is overturns. This has been proven in several studies that have been carried out, for example, in the bed of the Gualeguaychú River.

In this regard, in 2006 the General Auditor of the Nation, after visiting some thermal wells, suggested to the province to close the salt water thermal drilling, as well as to stop all the projects under construction (Auditoría General de la Nación, 2007b; El Día Online, 2013). The argument is that the leaks put the Guaraní Aquifer at risk through contamination with the extraction of salt water that is reinjected. Due to the fractures of the basalt bed there may be filtration on the freshwater of the aquifer, which would cause contamination with the saline waters that are exploited in the thermal resource. Nevertheless, drilling advanced, new recreational thermal centers were built.

During the interviews, when we ask about the participation of thermal centers' managers in provincial or municipal government for thermal regulation, it was evident that they have the capacity to influence decision-making despite not having been constituted as an organized group with legal status. They act together when required. Some examples illustrate this:

> "In some cases, different areas of power have taken decisions in isolation, and they have come down without consulting us (thermal centers managers), there have been mistakes and they have had to go back. Since we are a string of several thermal complexes, we already have a force" (…). "Most complexes have the common sense not to be against what affects the main resource. We have had instances where we have been invited and we have been consulted based on our knowledge to see how it could be done (the regulation), and instances where poorly implemented regulations were issued and they have had to go back. In those cases, the complexes acted so that these regulations do not advance" (Interview 3).

Bottled Water

The bottled water sector is growing very rapidly around the world, being the most buoyant business today, but it is also one of the least regulated. The expansion of this business requires large food and beverage corporations (Coca Cola, Pepsi Cola, Danone, and Nestlé) to have increasing access to water resources, promoting the privatization of waterways and aquifers.

From the emergence of the bottled water industry, each country was developing and modifying regulations regarding water as a marketable product. These standards include regulations on extraction sources, industrial hygiene, labeling standards, quality of packaging and conditions of carriage (Canese, Ortega, & Portillo, 2018). When regulations and inspection are lax, these companies can completely deplete not only the water resources on their own land but also those in the surrounding region. This is what happened in Tillicum Valley in British Columbia, where the Canadian company Canadian Beverage Corp has been exploiting the groundwater of the region so intensively that the inhabitants and farmers of the area were left without it (De Arco Rodriguez & De León Pérez, 2006).

In South America, foreign multinationals are acquiring large areas of territory including hydrographic systems. In this sense, the Guaraní aquifer is the main attraction, where large multinationals are taking land to exploit the water. This does not mean that companies are owner of these resources. They acquire the right to use them but, in countries or subnational unities (in the cases of Brazil and Argentina), or where regulation or inspection is inefficient or lax (as Paraguay), groundwaters could be subject to various risks: overexploitation, depletion, contamination, among others.

As control and regulation of water resources depend on municipalities or provinces in the cases of Argentina and Brazil, they can give rights for exploiting them to these companies and they have to supervise their operation. Both countries have started commercializing and exporting water extracted from the Guarani Aquifer.

Several Brazilian cities have started water commercialization plans. Such is the case of Santana do Livramento. As stated previously, this city is one of the most supplied with water from the aquifer in Brazil. Its location is strategic since it is in an

outcrop area and has about 38 wells that allow it to capture 30 million liters of water per day. Of that extracted volume, the inhabitants of the city only consume 40%. Based on this surplus, the city government has negotiated the sale of the remaining 60% of the water –that the city does not use- with countries in Africa and the Middle East (REDES-AT, 2005). The Brazilian Chamber of Municipal Representatives and the Rio Grande State Government provided the necessary licenses to commercialize aquifer's groundwaters. This decision is supported by a Public-Private Partnerships Plan approved in 2004 during the Lula Da Silva administration. Both provisions facilitate bids and the creation of partnership contracts between the public and private companies (national or foreign) (Giménez, Goldeszer, & Iglesias, 2019).

In Argentina, the province of Misiones has been trading groundwater in the last ten years. Since 2011, the state company "*Aguas Misioneras Sociedad Estatal* (AMSE)" put into operation the first plant for the extraction and bottling of waters from the Guaraní aquifer with a packaging capacity of 4000 liters per hour. Its main purpose is to capture, package, distribute and commercialize groundwater from the Guaraní Aquifer System, surface, and rainwater, being all of them waters from the provincial public domain (AMSE, 2021; Eleisegui, 2011).

In Paraguay, mineral water export aims to become the business of the future. The company *"De las Nieves"* packages water from the Guaraní aquifer for sale as mineral water and flavored water. Initially, the bottles are sold in the domestic market and sales are projected abroad, especially Europe and the Middle East. The company has its own well measuring 521 meters deep with an extraction capacity of 45.000 liters of water per hour (Misiones Online, 2007). In a note published in the newspaper *La Nación* of that country, Ramiro Pangrazio, manager of the *Aguasul* firm and head of the Paraguayan Chamber of Mineral Water (CAPAM), stated that the mineral water industry grows by an average of 15% each year.

In addition, it is striking the great interest that has been generated in Paraguay by the use of water resources in that country. In fact, 4.700 companies (many of them transnational) have been registered in the Paraguayan Ministry of Industry and

Commerce (MIC), with the intention of carrying out commercial activities related to water. Among them, Exxon, Shell, Nestlé, Coca Cola Company, Pepsi, Ab InBev, and other US and European companies (D. Segovia, 2006). Four of these transnationals control a large part of this thriving business (Coca-Cola, Pepsi, Nestlé and Danone). These companies and their affiliates obtain water through generous state subsidies and get millionaire incomes (Ortega & Portillo, 2015). During an interview, a Paraguayan Parliamentarian indicates that national and multinational companies such as water and flavored beverages bottlers "are interest groups that undoubtedly influence the State, and in particular the regulatory entity, ERSSAN, to maintain this situation of lack of control (or very light controls, where everything "is negotiated") and of gratuity, in favor of for-profit companies" (…), "as it applies until now, despite the provisions of the law" (Interview 12).

Some of these companies are also present in Brazil and have been criticized because of certain agreements carried out with the government of that country to obtain benefits in the extraction and commercialization of the aquifer's resources.

The use of aquifer waters for productive purposes generates significant economic returns for the countries, but it requires adequate regulation and supervision of its use, quantity of extracted water and operation of the plants installed. In Latina America the exportation of waters from their basins has been a profitable business in recent years. However, the ISO 14046, the new international normative published in 2014 which establishes the water footprint[44], values negatively the export of water outside its basin. This new normative is being applied more vigorously in Europe but has not yet been widely spread in his region.

Shale Gas

[44] The water footprint can be defined as the amount of water used, both directly and indirectly, to produce a product including all its consumption through the supply chain. It can help organizations, governments and other interested parties to evaluate the impacts of activities and identify possible opportunities for improvement related to water management and responsible and sustainable use of this resource.

Recently, the four countries that share the Guaraní aquifer have developed initiatives related to the exploration of unconventional hydrocarbons. These projects of a purely economic nature raise additional concern for the resource and its adequate preservation.

In 2011 the United States Geological Survey (USGS) released a report on the prospective resources of Uruguay where published the possible existence of 378,383 million meters cubic of shale gas, 508 million barrels of oil (Shale Oil) and 500 million barrels of liquefied natural gas. Later, in 2013, a study conducted by the United States Energy Information Agency United States (EIA) confirmed the existence of a conventional and unconventional hydrocarbon basin located in a territory practically coinciding with the Guaraní Aquifer. In it, the Agency estimated the presence of 56,640 million cubic meters of shale gas and 600 million barrels of shale oil technically recoverable not tested.

Figure 4.4: Prospective Shale Gas and Shale Oil in the Region
Source: U.S. Energy Information Administration, 2015.

Shale gas has been accumulated over millions of years within sedimentary rocks of fine grain and low permeability, rich in organic matter, capable of generating and retaining gas that can be exploited through unconventional methods. The difference with conventional hydrocarbons is that these ones either gas or oil, they lodge in the pores of the rocks. These locations are interconnected allowing the mobility of the resource to an oil trap, which once drilled allows the hydrocarbons to rise to the surface as they are under pressure. The conventional method for extracting them is the horizontal drilling (Meroni & Piñeiro, 2014).

To extract unconventional hydrocarbons (shale gas and shale oil) it is necessary to fracture the rock. This method is known as fracking and has been discovered in 1940 but hasn't been extended till the end of the twentieth century, due to the high levels of techniques, know-how and the volumes of investment required. The fracking consists of pumping fluids (abundant volumes of water, gel, foam, compressed gases, diesel, steam, etc.) at sufficiently high pressures, also using explosives to fracture the rock, increase its porosity and permeability. The problem is that fracking method has consequences during the evolution of fractures that cannot be avoided. In particular, the communication between the toxic fluids used in the drilling with the layers of freshwater that remain in the subsoil and even in the surface (they are not biodegradable); the hydraulic fracturing wells are deep enough and cross aquifers, which increases its possibilities of pollution.

The published reports about non-conventional hydrocarbons estimated in South America make up new interest within the countries involved and in external investors. Uruguay started its explorations in 2012 when ANCAP (The National Fuel, Alcohol and Portland Administration – the Uruguayan oil company) granted US based Schuepbach Energy two contracts for hydrocarbon exploration and exploitation in the Piedra Sola and Salto concessions in Uruguay's north basin. The Australian oil company Petrel Energy bought 25% of Schuepbach Energy. Both concessions have a potential for unconventional (fracking) and conventional oil exploitation. YPF (Argentinian company), also started negotiations for exploration in that country.

In Argentina, the fracking technique for shale gas and shale oil extraction has recently been incorporated. Actually, Argentina has, in Patagonia and in the northeast, estimated reserves of shale oil, and recent regulations are inclined to take advantage of this condition. In the south, the activity is more developed due in part to the fact that the reserves have greater productive potential, mainly "*Vaca Muerta*"[45].

Nevertheless, the fracking -as a technic to obtain non-conventional hydrocarbons- generated reactions in different political and social contexts for the risks it involves. Principally, because of the pollution of groundwaters and lands, and in this particular case, because of the Guarani Aquifer pollution's threat. In Brazil, the Parana State declared a moratorium on 'fracking' in 2016 and in 2019 the law 19.878 prohibited it. In Uruguay the law 19.585 banned 'fracking' in 2017. In Argentina, the province of Entre Ríos prohibited 'fracking' with Law 10.477 in 2017[46]. Non-Governmental Organizations and Civil Society in Entre Ríos and its neighbors in Uruguay have mobilized against the exploration activities that have been initiated in the last country to find shale gas, and against fracking.

Although there are important economic interests related to the exploitation of this type of resources, the costs and investment required are high, as the risks associated to the fracking. In some cases, the mobilization of social and economic actors has made it possible to stop these initiatives avoiding the aquifer's contamination that could be caused by fracking.

To summarize, the stakeholders here analyzed have enough economic power which gives them the possibility to influence the local or national political arena. As an example, the thermal recreation centers have boosted the local and provincial economy by promoting tourism. In this particular case, entrepreneurs in this area do have the capacity to influence decisions and legislative proposals (at provincial level) relative to

[45] *Vaca Muerta* is a geological formation of shale (shale oil and shale gas) located in the Neuquén basin in the Neuquén, Río Negro, La Pampa and Mendoza provinces, in Argentina.

[46] This is remarkable, given that Argentina has promoted, through laws and decrees, the exploration and exploitation of these unconventional hydrocarbons. Because the National Constitution established the natural resources are property of provinces, each provincial government can legislate about this issue into its territory.

water management. In the case of water bottlers, they benefit from the inefficient or lax regulation and inspection that exist regarding the exploitation and management of water. These companies have even reached agreements with local or regional governments to obtain benefits in the extraction and commercialization of aquifer's resources at a very low cost.

The case of shale oil and gas is different. Despite the economic importance of these resources for the economy, the presence of domestic political (and social) actors interested in changing the *status quo*, allowed to regulate and restrict the fracking methodology for their extraction.

Then, according to the hypothesis proposed in this thesis, we can settle that -having sufficient knowledge about the aquifer-, in the presence of *status quo* stakeholders with economic power, and domestic political actors with instable interest in changing the *status quo* regarding the regulation of groundwater's use and management, the outcome is lax regulation of these resources.

If we move this to the regional cross-border context, we might find some indication of what has delayed the ratification and implementation of the GAA so long. It is the interaction between economic *status quo* stakeholders and domestic political actors interested in changing that *status quo* regarding transboundary groundwater regulation which explains the outcome: regulation /no regulation.

Why has the entry in force of the GAA been delayed?

As was stated before, the ratification of the Guarani Aquifer Agreement took eight years to materialize. Brazil and Paraguay were the main responsible for this delay. In Paraguay, the ratification of the GAA encountered a series of obstacles in the Legislative Power. Former President Fernando Lugo signed the Agreement in 2010 and later, in a complex national scenario, he was removed from his post. The political crisis

in this country, the presence of internal political bids and clashes of opposing economic interests generated greater reluctance for the AGG ratification.

In 2012, the Chamber of Deputies argued that the rejection of the agreement is based on Paraguay's loss of sovereignty over its own natural resources. This is because the GAA establishes conditions for the states that host these waters. Nevertheless, political domestic situation could explain this result. Fernando Lugo was democratically elected in 2008. His triumph meant the end of government of the Colorado Party in Paraguay after 61 years. In July 2012, the President was removed by the Senate through impeachment (which was quite questioned, it lasted less than 48 hours). This event causes the immediate reaction of regional leaders and organizations (especially, UNASUR and MERCOSUR).

Thus, it was the political situation of this country and the annoyances generated by the reaction of its neighbors and its subsequent suspension from MERCOSUR in 2012[47], which have an impact in the ratification procedure. The experts interviewed, Pilar Villar and Alberto Manganelli, agree that the delay in ratifying the agreement in Paraguay was undoubtedly for political reasons; the water issue took another dimension and was later postponed due to the political and regional context of the moment (Interviews 9 and 2).

A Paraguayan parliamentarian also confirms that the delay in ratifying the agreement is explained by the disinterest of Paraguayan Parliament (mostly opposed to Lugo). They simply set aside the treaty, along with others that were signed by President Lugo. He asserts that: “those parliamentarians who carried out the coup (June 2012) and then had a majority in Congress, they had common interests with those who exploit and want to continue exploiting groundwater without control and without paying anything for it. That is why they “boxed” the agreement, and only when pressure from the public opinion grew, it was approved”

[47] In 2012, Mercosur decided to suspend Paraguay until it holds new elections, scheduled for April 2013, due to the removal of Fernando Lugo. The decision was adopted by the presidents of Argentina, Brazil and Uruguay at the summit held in the Argentina city of Mendoza.

Regarding Brazil, Pilar Villar indicates that diplomats have a very traditional position in relation to water, considering that it is not a high priority issue (interview 9). Another reason is related to the scarce knowledge or expertise that is possessed on the subject in the diplomatic field. In general, it was argued the issue was postponed because it was not a priority for Brazil at that time.

In both countries, especially in Paraguay, it's possible to observe the role of institutional "veto players" affecting the state's behavior in matters of international cooperation. As Helen Milner (1997) affirms, in states with divided governments (the executive and the legislature share decision-making power and both have relatively different preferences), cooperation and the ratification of the agreements reached by the executive are less likely than in a unitary state scenario. Political changes in Paraguay and the parliamentarian opposition to President Lugo left GAA ratification pending.

Finally, the presence of the World Bank in the development and management of strategic information related to natural resources, in this case groundwater, of these four countries generated mistrust in different political and civil society sectors. The World Bank has been one of the main institutions that during the 1990s promoted the processes of privatization of drinking water in Latin America. It also acts as a representative of the main water corporations in South America: *Suez-Aguas de Barcelona* (main shareholder in the concessions of Argentina and Bolivia), Betchel (related to the water concession in Cochabamba Bolivia, which originated the so-called Guerra del Agua in 2000) and *Aguas de Bilbao* (holder of the concession in the department of Maldonado, in Uruguay), among many others.

Indeed, the actions of this organization have generated certain suspicions in the region, along with the possibility of a global commodification of water that could threaten the sustainability of the SAG.

Discussion and conclusion

The development process of the Guarani Aquifer Agreement is very interesting. From its inception it was based on science, instructed by the Project for Environmental Protection and Sustainable Development of the Guaraní Aquifer System (GASP). The GASP also increased scientific knowledge of the physical-environmental characteristics of the basin (P. C. Villar, 2016b).

The agreement is also innovative because it is based on the fundamental principles of the 2008 Draft Articles and includes obligations to do not cause harm, and provide additional information, which includes studies, activities and works that contemplate the sustainable use of the water resources of the Guaraní System. Then, as Vigevano (2013) assets, the GAA is based on a body of international hard and soft law, and incorporates regional practices that could promote the development of an environmental custom among the four states. The GAA can be considered as a starting point for a synergic process between national, regional and international institutions, which pretends consolidate a regulatory order that equitably links issues such as sovereignty, use, cooperation and environmental protection of the transboundary water resources (Vigevano, 2013, p. 20). Furthermore, the fact that four countries manage to reach a legally binding agreement with a preventive character and in a cooperation context -absent of conflicts related to the resource- is itself extraordinary.

Regarding the reasons that led to the agreement's signing, we mentioned: (i) scientific and academic research advances, and the discovery of the aquifer's interconnected characteristic and its transnational consequences; (ii) a regional project, supported by the GEF (World Bank), the OAS, and other international actors that promoted regional cooperation between the four states; (iii) new knowledge diffusion in domestic and international context about the GAS generated an extra pressure or political opportunity for the governments.

When the epistemic community proved the aquifer's transnationality (as an interconnected system), the four countries -Argentina, Brazil, Paraguay, and Uruguay-

recognized the need for a shared governance of these groundwater resources. The use, overexploitation and pollution of the aquifer in one country could impact in its neighbors (sharing the resource). This prompted regional initiatives focused on management cooperation for aquifer preservation.

The next step was the GEF and OAS participation in a regional project (the GASP) which operated from 2003 till 2009. In this stage, the initial knowledge production generated by the epistemic community was reinforced by international and regional organization together with the political and financial participation of the states involved (Batista da Silva & Hussein, 2019; P. C. Villar, 2016b; P. C. Villar & Costa Ribeiro, 2011). The GASP was successful in building dialogue among the four countries and initiating transboundary cooperation. In fact, this stage facilitated the four countries to sign the Guarani Aquifer Agreement in 2010.

According to Pilar Villar (2015), the GASP seems to have been the main cause in encouraging countries. The project publicized the aquifer in several government bodies, and the GAS gained national and international prominence. The OIG's investments were attractive enough to obtain the interest of the parties involved, and the project's execution involved several international agencies whose goal was to encourage states to establish a joint arrangement. There was an international pressure on countries to move forward in the cooperation process.

Moreover, it could be mentioned the international context of environmental and water concerns, specially associated to climate change, which could act as an additional motivation to cooperate for sustainable management of share groundwater resources.

But all these incentives seem to have vanished after the agreement's signing. The ratification process was delayed –particularly, in Brazil and Paraguay. It took ten years for the GAA to go into effect. As Hirata et al. assert "After the euphoria surrounding GASP money passed, and despite the irrefutable importance of GAS resources, the groundwater issue did not attract public opinion, nor governments" (2020, p. 391). Currently there is a legal and institutional stalemate. Thus, the mere existence of an agreement and the presence of international organizations do not necessarily imply a

change in states behavior to strength mutual cooperation or an improvement in their institutional and/or regulatory capacity. The agreement just sets out general principles and does not indicate clear rules for the common use.

Many reasons can explain the stagnation after the agreement's signature: the weak institutional capacities of each state; absence of definition of the role and capacities of common institutions –as the Commission-; insufficient financial support at the end of the GASP; lack of inter-governmental and inter-institutional coordination (between and within states); discontinuity in GAS's investigations; there was no systematic dissemination of GAS' information to GAS's users and society in general.

Furthermore, the agreed obligations in the GAA require state actions that are still not materialized, for example, monitoring activities into each state part, permanent information exchange mechanism, among others. The mere entry into force of the agreement does not imply that it is applied immediately. States till have pending tasks, as defining the arbitration procedure for settling disputes by issuing an Additional Protocol, something that they could not agree in 2010 and have postposed; the creation of a Commission of the Guarani Aquifer; identifying critical areas to take specific actions (P. C. Villar, 2020). Above all, the establishment of a real management authority (the commission), with a statute that define its structure, composition, financing, capabilities and powers, would be the starting point to advance on the path of cooperation and common management of the aquifer. Without it, the GAA will continue having limited o none effectiveness.

The commission would help on harmonization of legal instruments between the four countries. As was analyzed above, there is still a big legal heterogeneity between and inside countries. Principally, federal countries as Brazil and Argentina –were provinces are autonomous in the management of their natural resources-, need to have general guidelines to manage and protect those resources. The commission here could have a remarkable role. It also could establish a methodological guideline for groundwater database; fostering research and information's diffusion; improving groundwater monitoring into each country; defining critical areas (the recharge areas, for

example) and a common strategy to protect them. Undoubtedly, the commission is the heart or the engine of the Guarani Aquifer Agreement.

All things considered, the existence of an international agreement does not presuppose a true shared management of transboundary groundwaters. Management requires effective common institutions, with the capacity for action, with financing to carry out the tasks assigned to it. In cases as the Amazonas Basin or La Plata Basin, they have common institutions between all state parties, but they have serious difficulties in functioning. There are several reasons. First of all, they don't have a budget. The budget depends solely and exclusively on the contribution of the countries that have to integrate their participation quotas and do not do it. The CIC Plata itself (in the case of the La Plata Basin), which is the largest institution, has this problem. Second, the institutions are closely linked to the ministries of foreign affairs and therefore one doesn't know what they do, it is not disclosed, they do not have popular participation and the societies do not know what their role is in the basin. This happen with existing commissions it the Apa River Basin, the Pilcomayo River Basin, and La Plata River Administrative Commission (CARP) (Interview 9). The great fear is that this same thing will happen when the commission of the Guarani Aquifer is created.

On the other hand, common governance of groundwater resources implies a larger context than interstate cooperation, it includes the participation of all agents in the decision making process for the regulation of water use (Mello Sant'Anna & Villar, 2015). When analyzing the actors involved in the GASP, it was a clear absence of civil society actors, ONG's, users, private companies (except those that participated in the bids to carry out works or research), etc. Those actors were not consulted or contemplated during that period, nor in the agreement elaboration. But it was evident that there are many actors direct or indirectly involved in aquifer's exploration or exploitation: those who use water for different purposes (domestic consumption, agriculture, industries, recreational tourism), and those whose activities could have an impact on groundwaters (hydrocarbons explorations, users of agricultural pesticides,

etc.). Their participation is another interesting point to consider in the commission's statute elaboration.

The management cooperation for transboundary groundwaters occurs in a scenario of asymmetries between the actors involved (economics, regarding the use and exploitation of the groundwaters, the extension of the territory over the GAS, domestic regulations, etc.), which can influence the type of interaction between them (more or less cooperative, more or less trustworthy), the establishment of institutions, and, as a consequence, the fulfillment of obligations. And on this respect, Brazil plays a central role. It is the "giant of South America" and the largest user of GAS resources. São Paulo, the most populous state in Brazil, has a strong dependence on the GAS for municipal and domestic water supply; this is also the case of Santana do Livramento and Ribeirão Preto. Given its powerful role in the region and high interest in the GAS, Brazil can delay GAA's effective implementation. On the side of the less powerful states, Paraguay reacted after the sign of the GAA rejecting its ratification in a context of regional tensions (it was suspended in MERCOSUR).

There is also, however, further points to be considered. Brazil is going through a complex socio-political-economic context. From an environmental point of view, under the Bolsonaro administration, there were great setbacks. Environmental issues are not a concern of either the Minister of the Environment or the President (Interview 9). Latin America is going to enter in a recessionary situation due to the effects of COVID-19. Brazil and Argentina have failed to control the pandemic. Uruguay and Paraguay are having a better performance in health matters, but they have a strong commercial relationship with Brazil and Argentina, and that will have an impact on their economies. So, we are in a scenario that is not one of the best in terms of the Guaraní.

All in all, it is clear that the role of political actors from each state, as well as the actions of international organizations, has been crucial for the states to agree to cooperate on the sustainable management of shared groundwater. The signing of the agreement was the result of this. The delays in ratifying and implementing it -based on the obtained information-, are also due to the will of state political actors together with

the presence of numerous economic actors (here, the *status quo* stakeholders) with interests strongly involved in the use and management of these resources.

During the interviews made, it was observed the influence exerted by the owners of the thermal recreational centers concerning the implementation of provincial regulations regarding groundwater. As was shown in previous sections, the scarce regulation and lack of coordination between national and provincial legislation affect the effective implementation of the commitment assumed by the country to comply with the Action Plan of the GASP and the GAA. The case of water bottlers in Paraguay is another example. In that country, it was asserted that, after President Lugo's impeachment, "those who had a majority in Congress had common interests with those who exploit and want to continue exploiting groundwater without control and without paying anything. That is why they delayed the GAA's ratification, and only when pressure from the public grew it was approved" (Interview 12). It evidences the active role of economic stakeholders in the case of Guarani Aquifer's transboundary cooperation.

In conclusion, in the Guaraní Aquifer case the first causal factor "knowledge" is observed. I argue that knowledge about the aquifers' dimensions, hydrogeological characteristics, water reserves, exploitation rates, and their role in regional development is the starting point for advancing on reasonable visions and plans for transboundary groundwater regulation, identifying management actions needed. The works of epistemic transboundary community firstly, and the GASP later, made considerable advances in this matter, despite the fact that the dimensions and characteristics of the aquifer in its entirety have not yet been known.

Then, we probe the presence of domestic political actors interested in participate in the GASP. The discovery of the transboundary nature of the aquifer, its characteristics and the impact it generated at the international level, together with investment funds from organizations such as GEF, promoted their participation. However, this positive disposition seemed to fade throughout the process: the GASP had to be extended for two more years to achieve its objectives; the agreement was signed, but it took ten years to

gather the instruments of ratification for its entry into force. This inconsistency and instability observed in the interests of domestic political actors regarding the transboundary regulation impact the kind of regulation they reached and the delays in its implementation.

The other causal factor was also observed: the presence of stakeholders with enough economic power (their activities have an impact in local or national economies). This economic power gives them the possibility to influence the local or national political arena.

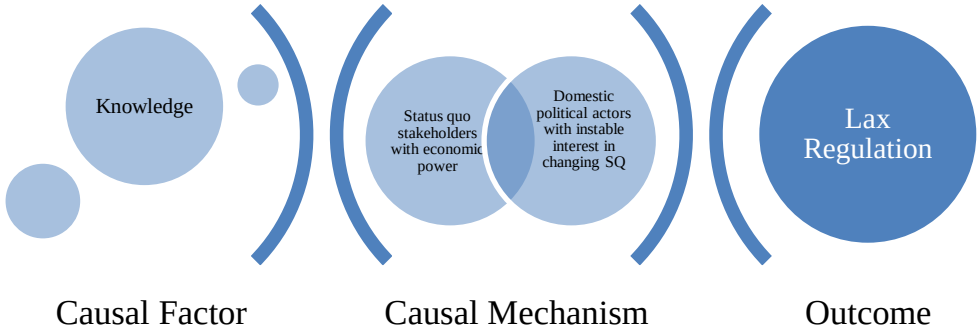

Figure 4.5: Hypothesis
Own Elaboration

Then, according to the hypothesis here proposed -and considering the existence of knowledge as causal factor-, we can confirm that: in the presence of stakeholders with sufficient economic power, and domestic political actors with an inconstant interest in changing the *status quo* regarding the regulation of groundwater's use and management, the outcome is lax regulation of these resources.

CHAPTER 5: OLLAGÜE – PASTOS GRANDES AND ASCOTÁN TRANSBOUNDARY AQUIFERS SYSTEMS (CHILE-BOLIVIA)

Introduction

Chile and Bolivia share 861km of border that separates the Bolivian departments of La Paz, Oruro and Potosí from the Chilean regions of Arica and Parinacota, Tarapacá and Antofagasta, in the middle of the Andes mountain range. These borders were defined by the "Peace and Friendship Treaty" of 1904, after the War of the Pacific (1879-1884).

The Altiplano region is a large plateau located at a high altitude (4,000 meters above sea level), and the Andes mountain range is solid, high and volcanic, with peaks over 6,000 meters above sea level. This region is characterized by an arid climate, with little rainfall, rich in mineral salt deposits, as well as copper and other metal mines. In general, there is a low availability of water because of the climate, the characteristics of the soil and aridity.

Nevertheless, the Chile-Bolivia border is crossed by some international rivers, and present considerable shared groundwater resources. Almost 8,000 l/s of water (which varies according the time of year) superficially cross various border points. They originate in the Arica and Parinacota Region and flow to Bolivia (the Silala River is an exception). Other rivers flow into Peru, cross Chilean territory and flow into Bolivia (Uchusuma River). Hence, over 4,000 mts. high, Chile and Bolivia share a water scenario of high environmental value, located within the great endorheic highland basin, whose use and exploitation still lacks a bilateral regulation, and is governed by the internal legislation of both countries. The Ollagüe-Pastos Grandes and the Ascotán Aquifers have been recently identified as transboundary groundwater resources shared by Chile and Bolivia, and have special importance for Chilean economy.

After more than 10 years of intensive work and research, the Internationally Shared Aquifers Resources Management Program (ISARM Americas) of UNESCO, with the contribution of its member states, published a report about existing transboundary aquifers on the continent, identifying the Ascotán and Ollagüe-Pastos

Grandes Aquifers (IGRAC & UNESCO-IHP, 2015; UNESCO, 2010). Beyond this report, neither of the two countries involved has yet carried out an in-depth investigation about its hydrogeological characteristics, exact size, capacity, etc.

According to information published by the General Directorate of Water in Chile (DGA) and some interviews conducted for this thesis, there are more shared groundwater resources that still are not identified, as is the case of the Silala's groundwaters, and the possibility that these bodies of groundwater are connected to each other is not ruled out. Despite the limited knowledge of these transboundary resources – which is one of the main factors of the hypothesis under study-, there are numerous economic actors (mainly, Chilean and foreign mining companies) who have strong interests in the exploitation and use these resources for the development of their extractive activities worth millions of dollars.

Further, these aquifers have another particularity. They are shared by two states in whose relationship the "Bolivian maritime demand" is a constant backdrop and the cause of their diplomatic relations' rupture. Furthermore, both states have a past conflictive relationship regarding shared freshwater resource (The Mauri and The Lauca Rivers), and a current dispute in their shared border relative to the Silala River, that is being treated at the International Courte of Justice in The Hague.

In sum, we are facing a case that we could consider as negative, since there is no regulation for the management, use and protection of these aquifers shared between Chile and Bolivia. As proposed by my theoretical framework, the scarce knowledge could be a significant causal factor, and it is necessary to observe the effect of other factors such as the presence of the *status quo* stakeholders, the role and interest of domestic actors in managing groundwater, and the conflict factor that seems to be a constant in this particular bilateral relationship.

This chapter is organized into five sections. The first one explains aquifers' general hydrological characteristics, location, uses. The second section explores the reasons regarding scarce knowledge development about these aquifers, and the fluctuant bilateral relations between Chile and Bolivia, from instances of direct conflict to

cooperative periods. The third section explains the characteristics of the legal and institutional framework within each country. This review gives us information about the tools and institutional capacity they have to cooperate in cases of shared water resources; the status of water resources within each state; the actors that arise as a result of this legislation and their roles (social, political and economic actors), among others. The fourth section explores the presence of other actors involved in this bilateral relationship. They are the *status quo* stakeholders whose activities impact the local or national economy, and this power allows them to form lobbies to influence political decision-making. Finally, the fifth section presents the concluding reflections and arguments.

Aquifer's Characteristics

Aquifers' Hydrogeological Characteristics

Ollagüe-Pastos Grandes Aquifer System

The Ollagüe-Pastos Grandes Transboundary Aquifer System is located in the border region between Bolivia and Chile. It is in the western cordillera, in the southeast of Bolivia, Department of Potosí, bordering Chile to the west (UNESCO, 2010).

This territory is located high up, has large daily temperature ranges and is characterized by significant rainfall in summer (from December to February) and not during winter. Rainfall is less than 100 mm/year. In this area there is a high index of endorheism, extreme aridity, due to the incidence that the longitudinal distribution of the relief exerts in the obstruction of coastal atmospheric humidity, and because of the extent of the high plateau rains, which are the only source of surface runoff, together with the accumulations of snow located at the top of the foothills and mountains (Ser Indígena, 2003).

The total area of the aquifer is 1956 km^2, 550 km2 corresponding to the Chilean portion, with about 300 inhabitants and 1407 km^2 to the Bolivian side, with a population of less than 1000 inhabitants. In detail, two aquifers are distinguished, a central one that

covers 20.59 km^2 in Chile, and a secondary one that covers approximately 1878km^2. The total area of the aquifer corresponds practically to that of the basin (UNESCO, 2010).

Populations are scattered. In the commune of Ollagüe (Chile), the total population is rural of which 85% is of Quechua descent, an ethnic group originating in the area. The remaining 15% of the population is made up of people arriving from other cities (municipal officials, public officials and workers from the Antofagasta Bolivia Railroad company). The highest percentage of the population (65.1%) is concentrated in Ollagüe, the rest is distributed in other towns of the commune such as Cebollar, Ascotán, Amincha, El Inca, Coska, Puquios and Chela (Subdere, 2020). The population of Ollagüe is supplied with spring water from a catchment area located in the Quebrada del Inca.

On the Bolivian side, two kilometers at the east of the border with Chile, is the Abaroa Station, a town of ten houses built around a small square. This is where the border customs control and a military post are located.

The fundamental basis for the development of the population that inhabits the area of this aquifer is livestock -the raising of *auquénidos* (or camelids) and sheep. The cultivation areas are minimal and for self-sufficiency. The main agricultural product is quinoa. Water is a resource of immeasurable importance for the entire region. The main surface rivers in Bolivia are Aguaditas, Hondo, Grande de Lípez, Puca Mayu, Yana Uma.

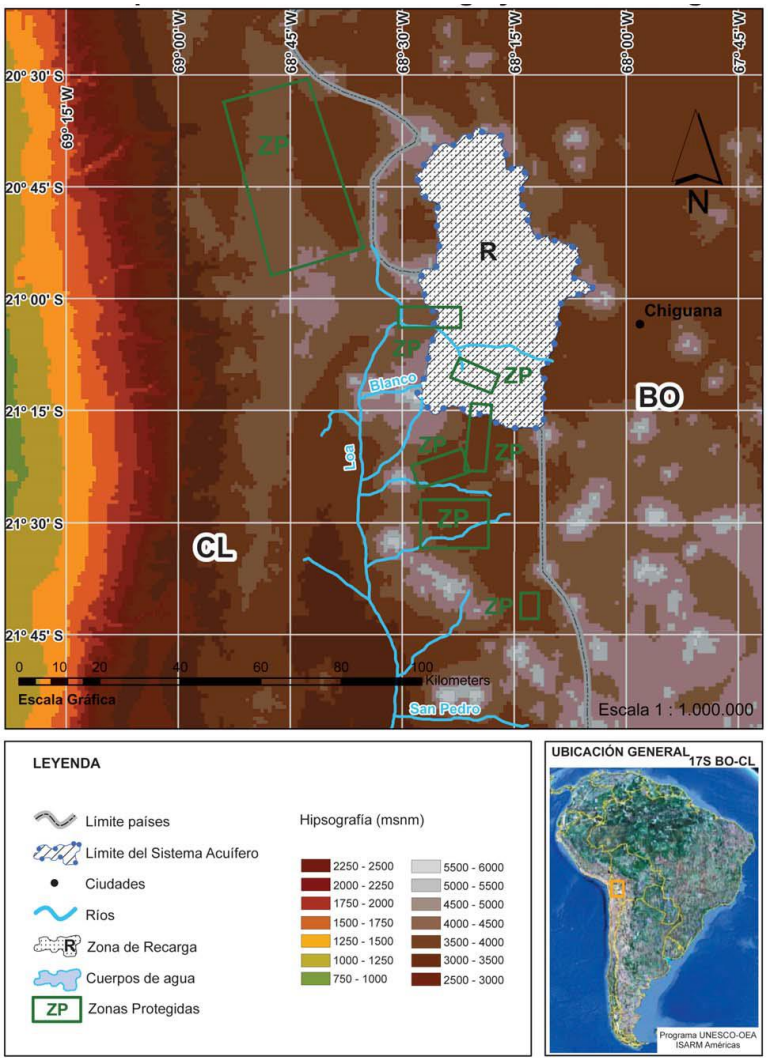

Figure 5.1: Ollagüe-Pastos Grandes Aquifer (Chile-Bolivia)
Source: UNESCO, 2010.

Aquifers are free to confined and occur in tertiary-age fractured rocks and quaternary sediments. At depth there is an alternation of sandy-gravel layers with levels of clay and levels of weathered and fractured volcanic rocks. The central aquifer corresponds practically to the area of the salt flat and is composed of a sedimentary basin with primary porosity. The secondary aquifer is composed mainly of volcanic rock with secondary porosity, and corresponds to the entire area around the salt flat. The

thickness range of the aquifer system is from 20m to 100 m, being the maximum depth of wells around 250 meters. In the Bolivian area there are no deep wells.

In Chile, the Salar de Ollagüe, the Quebrada El Quice and the brooks (*quebradas)* at the northwest of the Swere recognized as ecosystems dependent on groundwater.

The economic benefits derived from the use of the transboundary aquifer in Bolivia are practically null, because the use of the waters of this aquifer is minimal. But, in Chile it is very relevant since it is associated with the mining industry (UNESCO, 2010).

Figure 5.2: Salar de Ollagüe (Chile)
Source: Google Maps

Ascotán Aquifer System

The Salar Ascotán is located 76 km south of Ollagüe, it is a beautiful salt flat overlooking the Ollagüe volcano, bordered to the west by the Loa river basin. In this place we find wild fauna, condors, eagles, pink and white flamingos, *huallatas*, wild ducks, foxes and *viscachas*. The surface of the salt flat was formed, since ancient times, with the contribution of rivers, springs and underground waters that were deposited in this natural basin of great dimensions and without drainage (Ventisca, 2021).

The Salar Ascotán corresponds to an endorheic basin with the absence of permanent surface runoff channels. During the precipitation events associated with the highland winter, there is an important surface flow that quickly infiltrates the colluvial and alluvial sediments in the lower part of the basin (margin of the *salar*). These events also produce significant water runoff in the upper part of the basin that reaches the margin of the *Salar* (Minera El Abra, 2013).

In the Salar Ascotán basin there is an aquifer recharged by groundwater in the upper part, and which has a series of ecosystems that consist of a total of thirteen springs. The aquifer covers an area of 1791 km^2. As in the case of the Ollagüe -Pastos Grandes aquifer system, the Ascotán aquifer system is composed of two aquifers: a central one that covers 266 km2, and a secondary one with an approximate area of 1,525 km2. The area corresponding to the Chilean sector is approximately 1,340 km2. The aquifer is free to semi-confined on the Chilean side. In the Bolivian area, the aquifer recharge zone is made up of stratovolcanoes. The aquifer contains fossil waters and is confined (UNESCO, 2010).

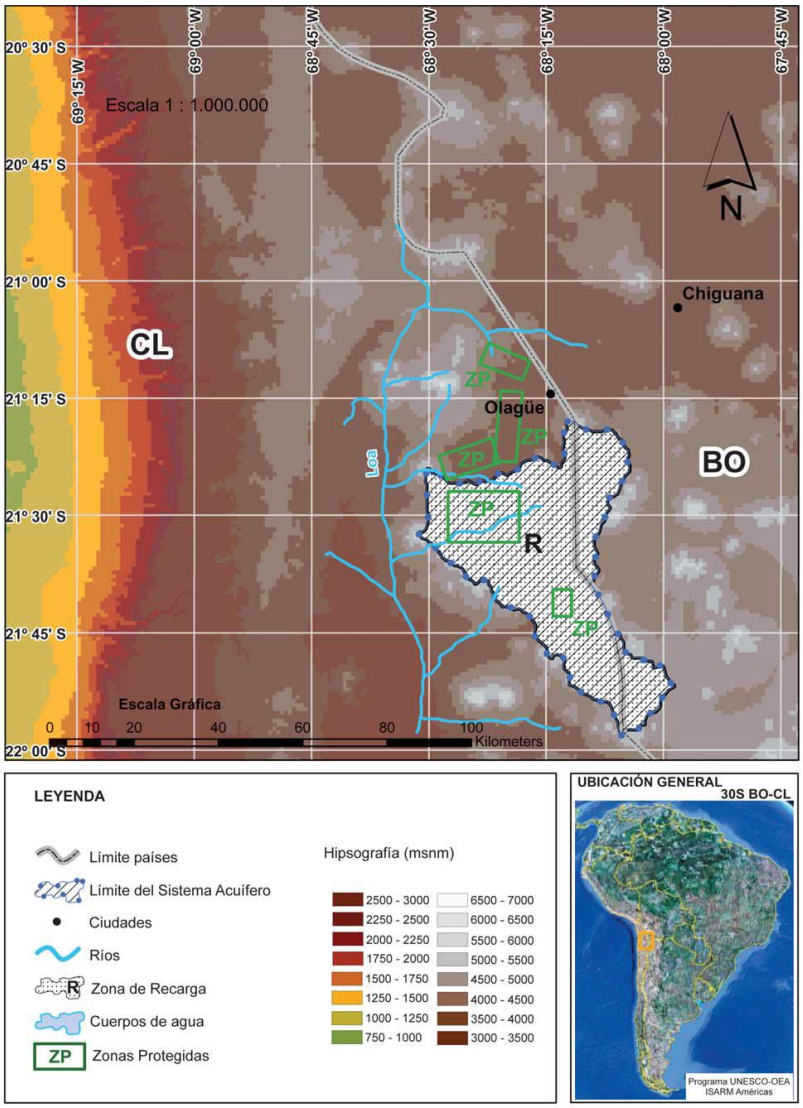

Figure 5.3: Ascotán Aquifer (Chile-Bolivia)
Source: UNESCO, 2010.

The unconfined, shallow, high-permeability aquifer is made up of unconsolidated to semi-consolidated sedimentary material. Locally, confinement conditions occur due to the presence of discontinuous layers or lenses of tuff and other volcanic rocks. The main intermediate /deep aquifer with moderate to high permeability is made up of unconsolidated to semi-consolidated material of volcanic fragments in a sand and silt

matrix. The breccia is 250 m thick in the well field sector of El Abra Mining Contractual Society (SCMEA) and reaching depths of 400 m approximately (Minera El Abra, 2013).

The recharge due to precipitation (infiltration by rain in summer and melting of snow in spring) that the Salar Ascotán basin receives occurs in the hills that surround the salt and mainly in the hills of the border with Bolivia at 4,000 meters above sea level. There is also a minor direct recharge from rain to the surface of the salt flat. The discharge of groundwater basin is manifested through a series of slopes or springs that feeds the ecosystems of meadows, grasslands and lagoons that are located on the limits of the basin.

The current use of water in Chile is mainly for the mining industry. In Bolivia there is no exploitation[48].

Knowledge and Bilateral Relations Evolution

Knowledge and data collected about the aquifer

In general terms, the knowledge of these transboundary aquifer systems (Ollagüe-Pastos Grandes and Ascotán) is still scarce and incomplete. On the Chilean side, information is scattered among mining companies that use water for their extractive and productive activities, local and national public institutions (municipality, DGA, Ministry of the Environment, SISS), specific academic research, international organizations (UNESCO, OEA-ISARM, GEF).

For example, the hydrogeological units of the Ascotán basin have been defined according to the drilling programs of *Compañía Nacional del Cobre* (Codelco) in the 90's and, later, the *Sociedad Contractual Minera El Abra* (SCMEA) (since 2000). The drilling of diamond drill holes -as part of the 2008 continuous monitoring well

[48] Since 2013, the Bolivian government and the Department of Potosí presented some projects based, fundamentally, on the construction of hydroelectric plants and water bottling plants. None of these projects were successful nor viable (Feher, 2016). Among the reasons that explain this, we can mention the lack of financing and/or investments to carry out these works, and the abandonment of these projects.

installation program- has allowed a detailed reconnaissance of the hydrogeological units in the southern and central part of the Ascotán basin (Minera El Abra, 2013).

It is even known that there are more aquifers (national and transboundary) than the information or knowledge that is available (Interview 11).

Bolivia, for its part, although is making progress in the investigation of the country's groundwater and aquifer resources (and also those shared with Chile) through geophysical prospecting studies, there is still no characterization of the hydrogeological dynamics of these systems, and they still don't have detailed information of those resources. Therefore, groundwater resources have not yet been quantified at the national level. There are very limited local studies and their technical information is not organized or systematized at all (Interview 13).

The departmental prefectures, obtained international financing to develop programs for drilling wells to provide water to rural populations. However, these institutions have not recorded the information of the wells drilled or their hydrogeological characteristics, and this information won't be available for the future to locate, qualify and quantify the numerous underground basins located throughout the national territory (Jiménez Cisneros & Galizia Tundisi, 2012).

Some attempts were made to collect and systematize information regarding the country's water resources. In 1985, the Geological Service of Bolivia (GEOBOL) published the Regional Hydrogeological Map of Bolivia, and defined five hydrogeological provinces in the country that present fundamental differences in lithological and structural conformation (Jiménez Cisneros & Galizia Tundisi, 2012). In recent years, the Ministry of the Environment and Water (MMAyA) has created an Information System for the Environment and Water Resources (SIARH). It is a database where available information is entered, such as surface water availability; the Bolivian groundwater information system (SIASBO), among others. However, this database is still very incomplete. The main reason given that would explain this is the lack of economic and financial capacity of Bolivian State.

Certainly, in both countries groundwater is an issue recently incorporated in the political agenda and public debate. Although, since the beginning of the 21st century, countries have expressed their intention to advance knowledge and research on these resources, this interest has not been translated into research commitments, projects or concrete investments. In Chile, the Country's National Development Strategy, and the compliance with human right to water and sanitation do not go through the transboundary aquifer resources. And the issue is not present in the public vocabulary either. It is a very little known topic. And if it weren't for Bolivia's maritime demand, this issue would be even less known. It is outside the normal political discussion (Interview 11).

In sum, as we will see in next sections, the little knowledge about Ollagüe-Pastos Grandes and Ascotán aquifers is one important causal factor that can explain the absence of an agreement or regulatory framework for their use, management and protection.

Antecedents: the origin of a relationship marked by conflict and cooperation

From their origins as independent states, the relations between Chile and Bolivia have been plagued by persistent conflicts. The War of the Pacific (1879-1883) is still present in the collective imagination of both societies and still has political consequences on Chile and Bolivia's relations. Despite having clarified the limits through territorial treaties (1904 with Bolivia and 1929 with Peru) signed and ratified by the states involved, the Bolivian claim for its consequent Mediterranean nature remains latent till the 21st Century.

The loss of the coastline by Bolivia after the War, its continuous demand for a sovereign exit to the Pacific –which supposes the revision of the Treaty of Peace and Friendship of 1904-, and the disagreement regarding shared water resources (the Lauca and Silala rivers), have been determining factors in the bilateral relationship between Chile and Bolivia. Since 1920, both countries transit different moments from

cooperation to disagreement and controversy, and they have formally broken their diplomatic relations in 1978[49].

However, as mentioned before, there have been spaces for rapprochement and cooperation between the two countries, in order to develop initiatives based on joint interests (especially, commercial and energetic interests), despite the persistence of the claim about the Bolivian Mediterranean as an historical factor of conflict between the two countries. The advances and setbacks in the cooperation field have been conditioned both by the international and regional environment, as well as by the internal politics of each country. Principally, the restoration of democracy in Chile was the kickoff to advance on mutual cooperation. The regional context of integration agreements, economic insertion and development models, gave rise to a change in the bilateral relationship and the development of institutions and agencies to address issues of common concern such as security, infrastructure, and migration (Correa Vera & García Pinzón, 2012).

The first step was the signature of the Economic Complementarity Agreement between Bolivia and Chile in April 1993 (the ECA N°22). It is an agreement on tariff preferences that were later extended by the VII Additional Protocol of 1997. But this agreement has as a principal aim to create a closer commercial link and a framework for bilateral cooperation.

Additionally, their neighborhood condition pushed both countries to formulate strategies to face common problems and concerns: infrastructure, transportation, the problem of drug trafficking and vehicle smuggling, migratory flows. These issues generated mechanisms and channels of dialogue:

- The Political Consultation Mechanism: created in 1993 and headed by the foreign ministers of both countries;

[49] Previously, in 1962, occurred the first rupture of diplomatic relations, after Chile diverted the waters of the Lauca River without the consent of the Bolivian authorities. Later, the Charaña agreement, signed by Augusto Pinochet and Hugo Bánzer in 1975, gave way to informal conversations about possible solutions to the Bolivian Mediterranean through the exchange of territory. This situation encouraged the reestablishment of their diplomatic relations. But this quickly failed both because of internal policy reasons in each state and because of Peru's opposition to this alternative. As consequence, there was a new diplomatic breakdown in 1978, which still persists today.

- Bilateral affairs working group (1993);
- Border committees (1997);
- The Joint Technical Group on Infrastructure, and the Agreement on International Land Transport of the Southern Cone;
- Mixed Commission of the agreement on control, supervision and repression of illicit drug trafficking (Correa Vera & García Pinzón, 2012, pp. 89–90)

This shows that despite the persistence of the conflict over Bolivia's access to the sea, and later due to the situation of the Silala and Lauca rivers, both states managed to establish an institutional framework that has allowed them, in parallel, to advance in the bilateral relationship cooperatively.

Water conflicts between Chile and Bolivia

According to information provided by the General Water Directorate of Chile (DGA), Chile and Bolivia share 15 hydrographic basins. From their origins as independent states to the present, there were three conflicts over shared water resources in their bilateral relationship: the conflict of the Mauri River, the conflict of the Lauca River, and the conflict over the Silala. None of them have caused an armed confrontation. But they have been neither generated a joint management of transboundary water resources.

The conflict of the Mauri River

The Mauri is a tributary of the Desaguadero River, it is born in the Vilacota lagoon at 4500 meters above sea level and its basin is distributed between Peru and Bolivia. It is 202 kilometers long, of which 124 run through Bolivian territory.

Since 1883, the city of Tacna was under the sovereignty of Chile by provision of the Treaty of Ancón, signed between Chile and Peru at the end of the War. In 1921, the Compañía Industrial y Azucarera de Tacna carried out canalization work on the Mauri River, with authorization from the Chilean government, in order to supply irrigation water to the city of Tacna.

That year, when the works of the company began, the Bolivian Foreign Ministry issued a claim note to Chile for the execution of canalization works. Bolivia feared that the diversion of the waters of the Mauri River from its natural course would affect the navigability of the Desaguadero River (being the Mauri one of its tributaries), and that this would cause obvious damage to the interests of Bolivia. Chile responded by arguing in favor of the right to catch water, because it was an international river, to the extent that the downstream population was not significantly affected. Given that a quarter of the total flow of the Mauri had been authorized to capture in territory administered by Chile, this would not have a significant impact on the Desaguadero River. Not compliant, the Bolivian government continued its claim and proposed to form a commission to investigate the water catchment works in the field and instructs the legation in Chile to initiate an international arbitration process (Artaza Rouxel & Millet García, 2007; BCN, 1922).

However, the parties did not reach an agreement and the issue was forgotten, mainly after the return of Tacna to Peru with the signing of the 1929 Treaty, and the Mauri River was left out of the Chilean administration.

Since 2002, and due to canalization works carried out in the Mauri River by Peru, this controversy once again confronts Bolivia with that country.

The conflict over the Lauca River

The Lauca River is born from the wetlands of the Parinacota volcano and travels 76 kilometers through Chilean territory. Near the town of Macaya it enters Bolivian territory, ending at Lake Coipasa.

In 1939, at the initiative of Chilean President Pedro Aguirre Cerda, the Government of Chile began studies aimed at achieving the irrigation of nearly 2,000 hectares of the Azapa Valley, in Arica, with the waters of the water system of the Lauca River, in Parinacota.

For Bolivia, the problem was that the Chilean government unilaterally decided to divert the Lauca aquifer without consulting the Bolivian government (Bolivia, 2004). In July 1939, the Bolivian government raised the first of its six "reserves" by means of a note to the Chilean Foreign Ministry, because the planned works in the upper course of the Lauca River would damage the Bolivian right of catchment and use in the lower course of the river . This initial note referred to the Declaration of Montevideo of 1933. However, Chile continued with its water resource capture works, which included a 31-kilometer-long channel to divert river water, a 3-mile tunnel km (for the hydroelectric plant), and an artificial fall of 1,100 meters in height to produce electricity and to irrigate the Azapa valley.

The Chilean government, through its ambassador Benjamín Cohem, responded by stating that these works did not mean a diversion of the Lauca river flow, but rather the natural use of its waters (Artaza Rouxel & Millet García, 2007, p. 381). Subsequently, there was a large exchange of reverse notes in 1953 and 1954 and in 1960 a mixed commission was established to study the entire problem.

Between 1948 and 1949, the Chilean government delivered to the Bolivian government the antecedents of the Lauca water use project and the Justification Report of the planned works. The works carried out by the Chilean government would take advantage of 46.7% of the river's total volume. In 1949, the Mixed Commission met in Arica and drafted the minutes with the technical specifications in accordance with the project presented by Chile. From then on, Bolivia had three months to present its reservations. Something that it did not do and Chile, in a note addressed to the Bolivian Foreign Ministry, warned that, after time, it assumed that the project did not merit objections from the Bolivian government (Artaza Rouxel & Millet García, 2007).

However, in 1953, when the works on the Lauca River began, the Undersecretary of Foreign Relations of Bolivia reiterated the reservations about the catchment of water. The Chilean government argued that the deadline for submitting reservations had passed. However, after an intense exchange of notes, he decided to accept the formation of a new mixed commission in 1960. The commission signed an act that was rejected by the Bolivian commission.

Finally, Bolivian President, Victor Paz Estenssoro, and his chancellor, Eduardo Arze, demand a solution from the Chilean government, then administered by Jorge Alessandri Rodríguez, and threaten to take the case to international organizations and tribunals. In the absence of agreements and because of Bolivian claims to link the Lauca issue with the maritime demand, Chile advanced in its project inaugurating the irrigation work of the Azapa Valley (with the Lauca River's waters). This led to a breakdown of diplomatic relations between Chile and Bolivia in 1962.

As assets González et al, "One of the most interesting aspects of "the Lauca river question" is that –through it– the diplomacies are actually litigating about another conflict that is the "Bolivian Mediterranean", forcing them to play a zero-sum game with respect to the Lauca" (González, Ross, & Ovando, 2016, p. 58). This explains why a less serious issue ends up escalating and triggering the breakdown of diplomatic relations between the two countries. The Lauca issue was used as a strategy to provoke negotiations on the maritime exit in the case of Bolivia, and to avoid this negotiation in the case of Chile.

The Silala River Conflict

Antecedents

The Silala River Basin is shared by Bolivia and Chile. It has its origin in the extreme northwest of the Canton of Quetena, in the Sur Lípez province of the Department of Potosí. The waters of Silala are born as high altitude wetlands (called "*bofedales*"), at 4350 meters high, formed by groundwater springs that discharge in Sud Lípez, Potosí, Bolivia about 3,5 kilometers east of the border between the two countries

(Meza Bórquez, 2014; Mulligan & Eckstein, 2010). Its flow is formed by 94 springs located in Bolivian territory, which form a common water course, with an approximate flow of 230 (l/sec.), Called Silala for Bolivia and Siloli for Chile, which runs 7.22 km in Chilean territory until it joins the Helado river, forming the San Pedro de Inacaliri river, a tributary of the Loa River.

The surface water manifestation of the Silala springs comes from a transboundary aquifer with a hydraulic gradient that determines the movement of the waters from east to west. The transboundary aquifer is located in the Silala Ignimbrites. The Silala Ignimbrites (volcanic igneous rocks) are highly fractured and appear in the area due to differentiated erosion of the volcanic rocks and to faults that have given rise to the formation of streams widened by fluvio-glacial processes. All the springs that emerge in the Silala area, both on the Bolivian and Chilean sides, are discharges from the Silala Ignimbritas aquifer. According to some analysis carried out at the end of 2006, the waters of the Silala are ancient (fossils), from 9.300 to 10.000 years old. The average flow in Bolivia is 200 l/s, and on the Chilean side it is 300 l/s (Jiménez Cisneros & Galizia Tundisi, 2012).

The Silala is located in the most arid desert of the world wherefore its resources are highly demanded, especially for mining and the provision of potable water. It rises in Bolivian territory and crosses into Chile, where it meets the San Pedro de Incaliri River. The dispute regarding the Silala arose after Bolivia revoked a concession to the Silala's waters in 1997 and affirmed that 100% of the Silala's waters belong to Bolivia (Kriener, 2017).

From 1908 to 1999, the resource was used by the Antofagasta-Oruro Railroad Company, at the time with coal, and for the benefit of Bolivia itself. The Prefecture of Potosí granted its respective concession[50]. Since 1961 it was not required for the railroad

[50] In 1907, the Prefecture of Potosí granted the permission for the use and exploitation of the Silala's waters of with the purpose of feeding the boilers of its steam engines. In 1910, to formalize the license the State of Bolivia and the company signed a public deed which established the approval of the use and the permits granted to the Company. The Company had the authorization to build canals and masonry works in Bolivian territory and to use, free of charge, the waters of the Silala River. With the masonry works that

that began to run on oil, but it continued to be used for mining and agricultural use. The Silala's waters have been used by the Antofagasta-Bolivia Railway (FCAB) -successor of The Antofagasta- Bolivia Railway Company Limited- to supply the communes and localities of Sierra Gorda and Baquedano. CODELCO-Chuquicamata, Mantos Blancos, Sociedad Chilena del Litio, among other mining companies, are also among the users of these waters. Based on this, the Bolivian government proceeded to decline the 1908 concession. The Chilean government remained oblivious to this recall process, as it understood it as a legal dispute between the Bolivian State and a private party. Any legal controversy had to be resolved by the competent courts according to the applicable substantive legislation in accordance with Private International Law.

Since 1997, after revoking the concession, Bolivia gave rise to its claims. The government argued that the watercourse is not "international" and that Bolivia is therefore entitled to use 100% of its waters. Then, the President Gonzalo Sánchez de Lozada decided to hand over the concession for the use of the Silala's waters to DUCTEC SRL for next forty years. Firstly, DUTEC SRL decided to charge Chile for the waters' use[51]. Because Chileans users refuse its payments, the company proposed to increase drilling in Bolivian territory to raise the flow and sell more water to the Chilean north based on its use by CODELCO. That project generated enormous social and political pressure, leading the Bolivian state to revoke the concession. From then on, the idea of charging Chile for the use of the waters of the Silala would belong to the State (Artaza Rouxel & Millet García, 2007; Correa Vera, 2020).

channeled the waters, the Silala reaches a total length of about 8.5 kilometers of which 3.8 kilometers are in Bolivian territory and 4.7 kilometers are in Chilean territory (Correa Vera, 2020).

[51] DUCTEC had sent the invoices to the companies The Antofagasta-Bolivian Railway and to the National Copper Corporation of Chile to make the payment for the use of the waters.

The case rises to the ICJ

The background discussion around the waters of the Silala is related to the nature that each State attributes to this watercourse. In this sense, Bolivia speaks of "springs" over whose waters the Bolivian State would have full jurisdiction. Chile, for its part, considers the Silala as an international river. So, the jurisdiction of its waters would be shared according to the principles of International Water Law (reasonable and equitable use).

Finally, and because of both countries could not arrive to a common arrangement and Bolivia continues its claims, on 6 June 2016, Chile submitted its long-standing dispute with Bolivia concerning the Silala/Siloli watercourse to the International Court of Justice (ICJ). In its application, Chile requested that the court declare the Silala River system as an international watercourse whose use by Chile and Bolivia is ruled by customary international law (Meshel, 2017).

In its arguments, Chile sustains that both Chile and Bolivia have recognized the Silala as an international watercourse. This was confirmed by the official and signed map annexed to the 1904 Peace Treaty between Chile and Bolivia. The parties concluded this treaty to inter alia delimit their borders. Chile affirms that Bolivia thus accepted both that the Silala is a natural river and its international status. “This understanding finds support in a Press Release in the newspaper El Diario issued by the Bolivian Ministry of Foreign Affairs, which declared that the Silala watercourse is a river owned by both Bolivia and Chile” (Kriener, 2017, p. 10).

Bolivia initially rejects this position and sustains that the Silala’s current course is product of artificial works performed by a private company (The Antofagasta and Bolivia Railway Company Limited -actual FCAB). But, as Mulligan and Eckstein (2011) asserts, there is geological, topographical, and historical evidence that suggests that the Silala springs naturally flowed overland from Bolivia to Chile prior to the canalization. Additionally, in 2009, the general manager of the Bolivian company hired to evaluate the Silala’s hydroelectric potential, based on detailed topographic studies,

declare that the canals were constructed to make more efficient, but not to alter, the natural course of the waters to Chile.

According to this, there is a significant difference between a canalized river and a canal. The canal is an artificial construction to guide the passage of water through a place where it has never flowed naturally before. A canalized river, for its part, supposes the preexistence of a natural watercourse and its channelization is carried out to avoid overflows or to reduce evaporation. In legal terms, a canalized river does not lose its status as a river or natural watercourse.

During the process that is carried out in the ICJ, in 2018, Bolivia filed a counterclaim in which recognized that part of the Silala River flows naturally into Chile, as ex-President Evo Morales himself pointed out. Afterwards, in February 2020, everything was confirmed by the Bolivian Foreign Ministry when the then Minister of Foreign Affairs, Teodoro Ribera, made it public. This means that there is no controversial matter at this central point of the claim.

Nevertheless, Bolivia requested the recognition of its absolute sovereignty over the ditches that are in its territory, since a certain artificial flow runs through these ditches. Bolivia is trying to declare that it is sovereign of that artificial flow, and that if Chile wants to use it, it would have to agree with Bolivia. Currently, the case at the ICJ has been reduced to the status of that supposed artificial flow.

Chile, for its part, considers that there is no artificial flow, since all the water in the Silala is natural, but Bolivia has absolute sovereignty over the ditches that are in its territory. According to the assertions of Ximena Fuentes, Chilean agent to The Hague, Bolivia's sovereignty over its territory has never been in dispute. International law does not recognize the distinction between artificial flow and natural flow (Sanhueza, 2020). Furthermore, the Silala is an international natural watercourse which flows underground and superficial. As a transboundary river, it is subject to the same rule: all riparian states have the right to a fair and reasonable use.

Principal uses of Silala's waters

Regarding to the Silala's strategic position, it's important to note that it is located in a geographical area, the "Atacama Desert", known as the driest on earth. Demographically, from the Bolivian side, there are no nearby towns because the decline of the Potosi population is constant. The area where the Silala is located, is an area dedicated to extensive cattle ranching principally (Correa Vera, 2020). Currently, the only Bolivian users of the waters of the Silala are the soldiers stationed at the Silala advanced military post. The Bolivian community nearest the Silala is Quetena Chico, located approximately 80 kilometers of the watershed. This community does not use the waters of the Silala River for its survival, nor does it affect its agricultural purposes and economic development. Quetena Chico is fed by local springs that are closer and easier to access (Correa Vera, 2020; Meza Bórquez, 2014; Mulligan & Eckstein, 2011).

In 2006, the government of Evo Morales inaugurated a military base on the banks of the Silala and publicly discussed a plan to bottle the water. The Government began the construction of 10 houses to deliver them free of charge to those who want to live in this area. Later, Bolivia initiated a project for generating hydroelectric energy. In 2009, the Prefecture of Potosí hired an engineering consulting company to conduct a feasibility study for a hydroelectric plant on the Silala within Bolivian territory. They reported that approximately 50kW of electricity could be generated (Mulligan & Eckstein, 2011, pp. 598–599). Additionally, the then governor of Potosí, Félix González, inaugurated a fish farming project, for which three pools were built for trout farming, and the land was laid out for the establishment of a population. Neither of these projects could move forward. The pools for the trout farm were abandoned, the water industrialization projects were not implemented, the houses were not occupied and the land remains uninhabited (Diario Pagina Siete, 2016; La Tercera, 2013).

For Chile, the Silala Basin is a significant source of process water for FCAB and for the Chuquicamata copper mine. Currently, these two companies have consumptive rights constituted over the waters of the Silala (the FCAB, which has one right for 237 liters per second, and Codelco, which has two, for 119 and 41 liters per second). The FCAB intake is located about 600 meters downstream of the border with Bolivia. Today,

the communities of Baquedano and Sierra Gorda have as their only source of supply the waters that are diverted by pipeline to their territory. There are not alternatives sources of potable water. Antofagasta, also use these waters but for industrial purposes (Mulligan & Eckstein, 2011). Codelco-Chuquicamata Division is located on the Inacaliri River, 4.9 kilometers from the border. It has water rights for a total of 160 liters per second, and also buys about 12 liters per second from FCAB (Ministerio de Relaciones Exteriores Gobierno de Chile, n.d.).

Concluding remarks

The Silala's conflict allows us to analyze several aspects in the relationship between Chile and Bolivia. First of all, it is an international river, recognized by both states, but it is also associated with an aquifer that is equally transboundary. Currently, there is little knowledge about the underground flow component.

In Bolivian territory, there have been identified more than 70 small-volume groundwater springs, which are discharged from fractured ignimbrites (volcanic deposits) covered by relatively impermeable andesitic lavas. There is preliminary evidence to support the idea that groundwater was primarily recharged by melting glaciers thousands of years ago (Mulligan & Eckstein, 2011, p. 596).

Thus, a lack of adequate data and information about the Silala and its related aquifer makes the dispute's resolution difficult. In the long run, the Silala dispute reflects the fact that water disputes are often based on issues that transcend typical water rights and allocation interests. It has been shown that the waters of the Silala are not essential for Bolivia due to its low use and lack of project execution. Therefore, its actions denote an interest in linking any agreement on the Silala basin with the maritime issue, to force Chile to negotiate on this aspect. This was demonstrated in the counterclaim filed to the ICJ after recognizing the international nature of the river. According to Mulligan and Eckstein "(…) while there may be water rights at stake in the

Silala dispute, historical and economic interests, as well as national pride, may be of even greater concern" (2011, p. 604).

In this same line, Loreto Correa Vera (2020) argues that the use and management of shared waters between Chile and Bolivia, and in this case those of the Silala, transcends the notion of water governance and is rather related to the critical relationship between both countries as throughout the 20th and 21st Centuries.

Guided by the bilateral conflicts above reviewed, it seems that the possibility of reaching concrete agreements on the regulation and management of transboundary water resources appears to be a complex issue. The "conflict" alternative explanation –based on the presence of previous conflicts between states- cannot be totally ruled out. It does not seem to impede both parties from negotiating and reaching an agreement, as they have done in other matters. But, the underlying conflict (the Silala's current demand in The Hague and the constant maritime claim) is a contributing factor that could be hindering bilateral negotiations regarding water issues.

Hence, although research from security studies affirms that past conflict between states should not be a determining factor, evidence found in this particular case indicates that it has some degree of incidence. Conflict is not a sufficient factor to explain no regulation outcome. I confirm that other factors, combined with the conflict issue (the claims for a sovereign exit to the Pacific Ocean), can explain the result of cooperation (no regulation). This implies going beyond the security's perspective and understanding the contextual complexity in which these agreements are circumscribed or for which it has not been possible to delineate any regulation. When Bolivia sets the maritime exit as a condition to advance in other water cooperation issues, then it acts as an immediate impediment to any negotiation. Chile refuses to put the maritime issue back on the negotiating table because it was solved by The Hague Court's ruling. However, both countries have been shown favorable to cooperate and maintain bilateral meetings and working groups on relevant issues -such as border security and bilateral trade- as will be explained in next section.

Negotiation spaces between Chile and Bolivia

Chile and Bolivia have not currently maintained diplomatic relations since 1978, but in some periods they have managed to establish bilateral talks to develop initiatives based on joint interests and build new ties between the two nations. Since 2000, some experts and ministerial meetings were conducted -with their respective technical teams-, in which both states expressed their willingness to cooperate on issues of regional development, water resources, mining, energy, infrastructure and transportation (Ministerio de Relaciones Exteriores, 2001).

Regarding water resources, these meetings revealed the lack of knowledge in both states, especially in the shared border. In 2001, Bolivian government informed about some prospecting studies for the water resources that have started in the western mountain range of the country. In turn, both parties agreed on the need to develop a general regulatory framework on the use of shared watercourses, both surface and groundwater. It is important to consider that the Chilean government has also expressed interest in buying water from Bolivia. In that case, the regulatory framework would provide legal certainty for any resource use activity carried out between them.

On December 13, 2002, the 1st Bilateral Meeting on Water Resources was held. In this occasion, the parties present the applicable laws in Chile and Bolivia, and shared the information available by each state on the characteristics of its water resources. Regarding the laws of both countries, the Chilean delegation made a presentation on the matter referred mainly to the internal legal aspects related to the concession of water and the management of these resources. At the same time, there was an exchange of ideas on the general principles on which a possible agreement on shared water resources could be based (Ministerio de Relaciones Exteriores, 2002). Hence, there was mutual interest in the issue of water resources shared, in identifying basins through a working group. The focus was rather on surface waters because the use was more direct, but the issue of aquifers was also identified as a topic of interest, and it was thought to develop a joint

work plan about transboundary water resources until 2004. Later, the topic fades because the Silala topic has emerged more strongly (Interview 10).

The Silala's agreement

Specifically regarding the Silala dispute, in September 2000 during the South American Summit of Heads of State held in Brasilia, both governments agreed to establish an agenda without exclusions where the Silala issue would be included. In 2004, both Foreign Ministries formed a Bolivia-Chile Working Group on the issue of Silala. The results of which are summarized in the minutes signed on 2004, 2005, June 2008, and November 2008. Likewise, this issue was included in point VII of the 13-point bilateral Agenda adopted by both parties in July 2006. As a result of bilateral work and meetings, in July 2009 both governments had reached a preliminary agreement about the use of these waters. This agreement considered issues such as: existing and sustainable use of superficial and groundwaters; the free Bolivian availability of the 94 wells from where the waters emerge, up to 50%; the consideration of the fragility of the ecosystem and the maintenance of the conditions of the moment; complementary studies; hydroelectric facilities; cartographic works; notification to the other party of any modification; binational working group for any controversy, and if there is no agreement, specialized international consultancies; valid for 4 years; among other minor aspects.

These significant advances were frustrated when Bolivia left the negotiations, as no agreement was reached on the maritime issue. There are also versions arguing that the Bolivian government withdrew from the negotiation after facing the opposition from Potosí, who wanted to charge Chile for past use of water. The latter has become known as Chile's "historic debt" to Bolivia. Certain sectors were beginning to demand that the

Bolivian government collect a retroactive payment from Chile for the water used as of 1962[52].

The 13-Point Agenda

Before Evo Morales assumed the presidency for the first time, on January 2006, he received a visit from the then president of Chile, Ricardo Lagos. That meeting, which took place in the private apartment of Morales, was the beginning of a process of rapprochement between the two states that broke down in 2011. In May 2006, Morales and Bachelet took an additional step, during the IV Summit of the European Union, Latin America and the Caribbean, by deciding to negotiate an agenda without exclusions (with the issue of the sea as point six). That list of topics was called the "13-point agenda". Loreto Correa (2012: 603) defines the 13-point Agenda as "a series of items placed in terms of dialogue topics (...) to reach a level of understanding and develop beneficial projects to both countries".

The 13-point Agenda begins by proposing mutual trust as the basic and essential objective and finishes showing the willingness of the parties to dialogue on all issues and manage the relationship flexibly (No. 13) (Correa Vera & García Pinzón, 2012). But its main contribution was to diversify the topics relevant in the bilateral relationship, including sensitive and disputed issues (No. 6: the maritime theme; No. 7: Silala and water resources), which had the same relevance as economic issues (No. 5: Economic Complementation; No. 2: free transit); security issues (No. 9: Security and defense, No. 10: Cooperation for the control of illicit drug trafficking), and cooperation issues (Instruments to combat poverty, No. 11: Education, science and technology).

[52] The idea of "historic debt" is based on the change of objectives for which the Silala water use concession was delivered. Since 1962 - the date on which the conversion to diesel locomotives took place - the concessioned waters would have been used by the Antofagasta-Bolivia Railway Company (FCAB), to supply the communes and localities from Sierra Gorda and Baquedano. CODELCO-Chuquicamata, Mantos Blancos, Sociedad Chilena del Litio, among other mining companies, are also users of these waters (Senado de Chile, n.d.).

In its early years, both states progress notably in building mutual trust and intensifying bilateral dialogue. Social security, multilateral dialogue, inter-parliamentary contacts, and legal and consular issues have been areas with sustained activity. The agenda turned out to be quite useful in diversifying and institutionalize the bilateral relationship[53].

Nevertheless, the breaking point was the sea access. After five years of bilateral meetings, the Bolivian Government considered that this mechanism was not sufficient for the positioning and resolution of its greatest demand and source of continuous disagreement: the water resources, in general, and the sovereign access to the Pacific Ocean, in particular. Finally, the Agenda was abandoned in 2011 –during Sebastián Piñera's administration in Chile- when Evo Morales announced his intention to sue Chile in international courts, fact that was executed in 2013 when Bolivia presented the case at The Hague.

Since 2010, bilateral relations have made little progress and the meetings of the political consultation mechanism were suspended. Recently, in May 2021, both foreign ministries announced the beginning of bilateral relations' normalization. To this end, the authorities agreed to hold the XXIII Meeting of the Political Consultation Mechanism, the XV Meeting of the Borders and Integration Committee, as well as the reestablishment of Working Groups and Technical Meetings to address issues of common interest. Both delegations agreed to advance a roadmap for 2021, which will address the following matters: Committee on Borders and Integration; economic complementation; free transit; limits; physical integration; cultures; environment;

[53] As an illustration, regarding point No. 8 "Instruments to combat poverty", both countries created in 2007 the Bilateral Working Group and design a Biannual Work Plan that included granting of scholarships in postgraduate studies; technical assistance to the Criminal Defense Office of Bolivia; cooperation and twinning agreement between the Exequiel González Cortés Hospital (HEGC), in Santiago, and the Dr. Ovidio Aliaga Uría Hospital for Children, in La Paz, Bolivia. Regarding point No. 11, (Education, Science and Technology), the Chilean International Cooperation Agency (AGCI), in coordination with the Plurinational School of Public Management of the Bolivian Ministry of Education, focused on human resource training handing out scholarships for Masters in Chile for Bolivian professionals.

tourism; education; science, technology and innovation; Cooperation; Consular Issues; Police Cooperation; Smuggling; Control of illegal trade and drugs, and Cross-Border Water Resources. It's important to note that the Chilean chancellor, Andrés Allamand, held that the maritime demand and the Silala's issue would be left out of the list of topics to be discussed (Ministerio de Relaciones Exteriores de Chile, 2021).

Domestic Institutional and Legal Framework

The analysis of the legal and institutional frameworks of each state involved regarding the regulation of water in general and groundwater in particular, allows us to have an overview of the tools and institutional capacity they have to cooperate in cases of shared water resources. Additionally, these elements allow us to understand the status of water resources within each state and what character it has (public or private good); the role of the main institutions in the management of these resources; the actors that arise as a result of this legislation and their roles (social, political and economic actors), among others.

Legal Framework in Chile

Regarding its water's legislation, since the 1981 Water Code[54], Chile is a special case, because it has created a real water market where users can sell, transfer, and buy

[54] Previous Water Code of 1967 made a series of changes regarding water regulation. For example, it declared all waters as public good, without exception. This decision implied the expropriation of all waters that were of private domain. The public character of the water was reinforced, the state intervention in the granting of the concessions was strengthened, and the legal nature of the water right was changed to one of an administrative nature. Once granted for a specific use and linked to the land, water concessions could not be transferred between individuals, and the State retained a broad power to reallocate water resources. The Administration's criterion to exercise this power was rational and beneficial use as it was a national assets for public use (Morales Blum, 2015).

their water use rights. Article 595 of the Chilean Civil Code states that: "All waters are national assets for public use". In turn, the Water Code in its article 5 reaffirms the nature of water as a national asset for public use by stating that: “Waters are national assets for public use, and individuals are granted the right to use them in accordance with the provisions of this Code”(Ministerio de Justicia, 1981).

Two fundamental characteristics arise from the affectation of the waters’ public domain: first, since they are national assets for public use, the private appropriation of the waters is prevented by excluding them from private legal traffic. Following this, individuals would never hold the domain of the waters. Public goods are inalienable, imprescriptible and unattachable. This is derived from Article 19 No. 23 of the National Constitution, which states: “the freedom to acquire ownership of all kinds of goods, except those that nature has made common to all men or that must belong to all Nation and the law declares it so". Second, the State is endowed with regulatory powers around the activities that the private sector can carry out with water resources.

Although there is no private property over water, the legal system allows the private or exclusive use of water by individuals, through the recognition of water rights. Water rights are established as a real right of water’s use. Article 19 No. 24 of the National Constitution allows individuals to acquire private property of the constituted or recognized water rights. Hence, the Constitution recognizes and protects the ownership of the individuals’ rights over water, which together with their free transferability and little state control, the water’s allocation responds only to the market’s logic.

According to the 1981 Water Code, water itself is considered as an asset independent from the land where it is located, and therefore, it is independently transferable. The free access and transferability of water rights in Chile generated a particular water market where: a- water right’s concession is not subject to any payment and in perpetuity; b- water right’s owner was not obligated to effectively use waters; c- water rights can be transferred without restrictions, and users may allocate their water rights for different purposes (agriculture, irrigation, human or animal consumption, energy production, industry, sports, tourism, etc.); d- in addition to the consumptive use,

the concept of non-consumptive use is introduced[55]; e- the state has a limited role y solving conflicts, it relies on judiciary system and private negotiations (Morales Blum, 2015; Ríos & Quiroz, 1995; Riquelme Salazar, 2013).

These characteristics of Chilean's water market have only encouraged speculation and hoarding of water rights. The Chilean system, prior to the Water Code's modifications introduced in 2005, gave way to speculation mainly due to the fact that the speculator's costs are practically nil since the rights were granted free of charge and in perpetuity without the obligation to invest in the use of the resource. This added to the fact that the prices of water rights maintain a sustained upward trend, led speculators to retain and monopolize the rights (Delgado & Sepúlveda, 2008).

The current water legislation was established during a specific political-economic context in the history of Chile. The 1981 Water Code embraced the economic theory of the free market, with the aim of improving efficiency in the use of water (Morales Blum, 2015; Ríos & Quiroz, 1995). The 1981 Water Code has a marked emphasis on private ownership of water rights, the market logic and the subsidiary role of the State. Its purpose was to modify the strong presence and role of the state enshrined in the previous Water Code of 1967, and to improve the efficiency in the use and stimulate private investment.

According to present legislation, rights over surface or groundwater are granted through a concession by the General Water Directorate (DGA, according its Spanish acronym). Water rights are registered in the Water Property Registry of the Real Estate Conservator. The DGA assigns water rights according to three requirements: i) that no legal impediments exist; ii) there is technical evidence about the existence of sufficient water in the natural resource; iii) there is no overlapping with existing concessionaires (Library of the Congress, 2020).

[55] The non-consumptive right allows the use of the water without consuming it and obliges to restore it in the way that determines the act of acquisition or constitution of the right (for example: electricity generation, fish farming, etc.); while the consumptive right is aimed at the total consumption of water in any activity (for example: irrigation, drinking water, animal watering, among others) (MOP DGA, 2015).

Water Code's Reforms

The 1981 Water Code had been subject to several criticisms, and it was reformed in 2005 (law 20.017) and 2018 (law 21.064). The most important aspects of the 2005 reform are: the President has can exclude water resources from economic competition when it comes to protecting public interests; the obligation of the General Water Directorate (DGA) to consider environmental aspects in the granting of new water rights (for example, it can prevent or stop water withdrawals or reserve ecological flows); and the charging of a license for unused water rights, limiting requests to original needs and curbing hoarding and speculation; justification of use, by which the applicant must present an explanatory memorandum that justify the requested flow according to the economic activity to be carried out. The reform also grants legal status (*personería jurídica*) to water user organizations and contemplates the formation of water communities among those who obtain groundwater from the same aquifer.

The Law 21064/2018 introduces modifications to the regulatory framework that governs waters in terms of inspection and sanctions. Among the main modifications, it is possible to highlight the increase in sanctions and fines for infractions, the updating of the information delivery systems on water extraction[56], and more control powers are granted to the DGA.

Currently, other reforms are being discussed by the Congress but till now have not been approved[57]. Among the reforms that this project promotes are: change of water rights for temporary concessions, with a maximum duration of 30 years, extendable if there is availability and protection of the source in the case of new rights. And also the extinction of rights for cases in which the authorized flow is not used after a certain

[56] through the installation of devices that allow the control and gauging of the water, in addition to the establishment of an instantaneous information transmission system that delivers the data to the General Water Directorate -DGA

[57] Draft Law that Reforms the Water Code, Bulletin 7453-12 entered the National Congress in its first constitutional process in the Chamber of Deputies on March 17, 2011. The bill is currently under discussion in the Constitution, Legislation, Justice and Regulations Senate Committee.

period (5 years for consumptive rights; 10 years for non-consumptive rights), which would complement the system of fines that operates today, and that seeks to avoid speculation and water grabbing.

Groundwater regulation in Chilean legislation

Specifically, regarding groundwaters, the 1981 Water Code only contains scant pronouncements on this matter, since it was fundamentally designed to regulate surface waters. This situation denotes a great disregard for groundwater. Recently, in 2013, a regulation on exploration and exploitation of groundwater was approved, the Decree 203 (in force since 2014). Despite this regulation, and a series of scattered norms in other specific laws (the Mining Code, the Law on Geothermal Energy Concessions, and Law 20.017/2005 that modifies the Water Code), Chile still doesn't have a complete and coherent regime in this matter (Rivera Bravo, 2015).

As in the case of surface waters, the groundwater use rights are granted through the concession. The administrative authority is the one in charge of establishing the use rights (the DGA) to the extent that the applicants meet a series of conditions established in article 20 of Decree 203: i) that the existence of water is verified; ii) that the flow rate that can be extracted is verified; iii) that there is availability of groundwater in the Common Utilization Hydrogeological Sector; iv) that the exploitation is adequate for long-term conservation and protection; and v) that third-party water use rights are not affected, considering the relationship between surface and groundwater (according to art. 3 of the Water Code) (DGA, 2013).

Additionally, it's important to consider the necessary differentiation between exploration and exploitation stages. Groundwater is not visible as superficial waters, and requires studies and execution of geophysical prospecting and/or drilling of the subsoil to verify their existence. The applicants first acquire a concession for exploration and, after have verified groundwater presence, they can obtain a concession for water

extraction and use right. The 1981 Water Code and the Decree 2003, regulate these two stages.

- Groundwater exploration (in private property and national assets);
- Groundwater exploitation (general provisions; protection areas; exploitation limitations; groundwater communities; change of collection or restitution point; change of supply source; alternative collection or restitution points; artificial recharge) (Rivera Bravo, 2015).

Regulation 203/2013 is an interesting contribution to the still incomplete groundwater regime. However, despite incorporating certain aspects, regulatory novelties and conceptualizations that in the 1981 Water Code had not been considered, there is still certain vagueness and lack of precision. This can be seen in the category of groundwater communities; matters related to the artificial recharge of aquifers; the deepening of wells; limitations on the exploitation of groundwater; access to the use of groundwater on private land belonging to third parties, among others.

The issue of water quality is till underdeveloped in Chilean legislation, and it is an area where the competences of the Ministry of the Environment and the DGA intersect. In the 1981 Water Code there is a clear concern regarding the quantity of water (the protection of minimum flows, the extractable quantity, the availability of the resource, etc.), but it says nothing about the risks of changes in water's composition. Regulation 203/2013 on groundwater makes a contribution by incorporating the quality variable in its articles. The risks of contamination, ecological flows, the establishment of restriction and prohibition zones, etc. are considered, albeit incompletely.

Certainly, there is still much to do in terms of regulation and management of the country's water resources. The right to use water continues to be privatized -despite the reform bill currently process in the Congress that changes the perpetuity of the water use right, and limits it to a renewable period of 30 years-, and the state does not have sufficient capacity to control the uses of those rights. Institutionalism continues to be precarious and scattered. Moreover, the 10 years that have elapsed to approve substantial

reforms to the aforementioned code denote the presence of a strong conflict of interest as well as a lack of will to advance towards a national water policy (Muñoz, 2018).

Inside the lobby that acted against the modifications to the Code within Parliament, it is possible to identify different business sectors, mainly from mining, agriculture and the hydroelectric sector. During those years, there was a kind of "terror campaign". A series of inserts in newspapers of national circulation warned of the “expropriation” vision of the reform and the possible problems that it could cause to small owners, mainly farmers (M. Segovia, 2017).

The mining sector (strongly located in the north of Chile) is clearly one of the main affected if the conditions for the delivery of water rights are changed. But they are not the only ones. If we observe the distribution of water rights, the interests that are displayed in this matter are clearly identified. Regarding the consumptive rights (water that is consumed), 73% of the water rights are destined for agricultural use; 9% to mining; 12% to industry, and only 6% to human consumption and health. Non-consumptive rights (which must be returned to the channel once used) are mainly used for the generation of electricity (Ministerio de Obras Públicas, 2013).

Institutional organization

From an institutional perspective, the following institutions play an important role in water issues:

MINISTRY OF PUBLIC WORKS	**General Directorate of Water (DGA)**: is a regulatory entity in charge of facilitating the operation of the system, maintaining hydrological data and a water registry, enforcing the national water policy, granting and monitoring water rights. The DGA Water Registry contains information on all water use rights granted by the DGA, hydrological and water quality data, information on civil user associations (ACU), water withdrawals and other transactions. However, this registry does not imply any legal title and is often incomplete.

	The Hydraulic Works Directorate (DOH) is responsible for the study, planning, construction, repair and operation of hydraulic works (irrigation works and certain canals in urban areas, drainage and rainwater collection) in rural and urban areas.
	Superintendence of Sanitation Services (SISS): regulatory and auditing body that controls companies and provides drinking water and sanitation services; propose and control compliance with technical standards on design, construction and operation of sanitary services (production and distribution of drinking water, and collection and treatment of sewage) and industrial liquid waste.
NATIONAL ENVIRONMENTAL COMMISSION (CONAMA)	Acts as coordinator of national environmental policy, water quality and conservation of the environment. In the case of water quality management, CONAMA has established emission standards for the discharge of wastewater into sewerage, surface and underground water systems, and the application of policies and penalties for non-compliance.
MINISTRY OF AGRICULTURE	**National Irrigation Commission (CNR):** its main objective is to develop and improve the irrigation and drainage infrastructure throughout all of Chile, for the optimal use of water resources.
	The Agricultural and Livestock Service (SAG), in charge of controlling pollution from industrial and mining activities and from discharges from sewage treatment stations.
MINISTRY OF HEALTH	**Department of Environmental Programs**: monitors drinking water distribution services and water quality in natural channels, particularly in sensitive areas (mining, sewage treatment), and controls and monitors the landfills. It also participates in the Environmental Impact Study System, and develops education programs on garbage management in rural areas.
WATER USER ASSOCIATIONS in charge of distributing water, and to collect fees for construction, maintenance and administration of irrigation infrastructure	**Supervision Comitees (*Juntas de Vigilancia*)**: Users associations who have water rights in the same natural source of water. Its purpose is to administer and distribute the waters, to which its members are entitled, and to exploit and conserve the common use's works.
	Channel User Associations (*asociaciones de canalistas*) who administrate primary infrastructure (dams and irrigation channels);
	Water Communities (*comunidades de agua*), responsible of secondary infrastructure (distribution channels).

Table 5.1: Principal Chilean institutions
Source: own elaboration

In addition to these institutions, there are approximately 40 institutions that have some degree of interference in the administration and management of water, a fact that often makes work difficult and slows down decision-making regarding water resources. Given these characteristics, the current institutional framework is marked by excessive fragmentation which generates important deficiencies, among which we can mention: a) lack of consolidation and integration of the information generated by the institutions involved in water management and by private actors (for example, mineral companies, consulting firms, academic research, etc.); b) inadequate delimitation and coordination

of functions between the agencies involved in water management; c) absence of a higher political authority that coordinates the functions and institutions of the State in relation to water; d) lack of communication and coordination of the actors responsible for water management at the local level, in the same geographic unit (Banco Mundial LAC, 2013, p. 6).

Another problem that stands out, in addition, is the lack of updating of the cadastres (*catastros*), which generated that, in several basins, the authority (DGA) granted more rights than were possible. Advancing in the identification of such stocks, as well as updating the records and creating a system of direct communication between the Real Estate Conservator and the DGA are some measures that would improve the administration of the property.

It can be seen from the above information that, regarding water, Chile still has several pending issues to be resolved, both in legal and institutional matters. Specifically, groundwater is an issue recently incorporated in the political agenda. The SDG No. 6 “clean water and sanitation” of the 2030 Sustainable Development Goals (SDGs) adopted by the United Nations in 2015, helped put the "human right to water" issue on the table (in Chile, and in the world), and further promoted the issue “groundwaters” (being one of the indicators the need to protect and restore aquifers and wetlands).

In relation to these goals, the United Nations in Chile has recently published a document with a series of recommendations, in which it maintains that the country has pending challenges in the search for solutions to the water scarcity which has affected, more than a decade ago, especially the most vulnerable population. This document identifies seven dimensions of the problem of the water crisis in Chile: the effects of climate change; the pressures of productive and /or extractive activities; non-integrated management of water resources; the lack of adequate infrastructure; the legal framework that does not specify the human right to water and does not prioritize human consumption; institutional dispersion in decision-making; and finally the availability and limited use of data for decision making (Naciones Unidas, 2021).

In the face of the aforementioned institutional and juridical problems, in March 2021, President Sebastián Piñera signed the bill that creates the Ministry of Public Works and Water Resources, together with the Sub-secretariat of Water Resources, which was proposed by the National Water Board[58]. The objective is to create a governing institution that can guide a long-term State water policy, which is stable and with transversal support.

The Sub-secretariat of Water resources has to lead and coordinate the governance of water resources at the national level. The following organizations will be subject to this institution:

- General Directorate of Water
- General Directorate of Hydraulic Works
- Water Information Unit (new, created in the Bill)
- National Institute of Hydraulics
- Superintendence of Sanitary Services.

Such changes regarding the institutional framework of water could, above all, end this lack of communication and coordination between the different agencies and the great dispersion of actors and information. However, there are still questions regarding the need to continue increasing the state apparatus, as well as whether this will guarantee the development of a long-term state policy, independent of the changes of government, what is finally needed to ensure a sustainable management of natural resources.

Likewise, the reform of the water code, improvements in the management of water resources (national and transboundary waters) and the recognition of water as a human right remain pending issues.

[58] Faced with the problem of water scarcity that Chile presents, in 2019 President Piñera created the National Water Board (*Mesa Nacional del Agua*), a public-private body made up of representatives of civil society, unions, Congress and the Government with the aim of seeking medium and long-term solutions. The First Report of the National Water Board identified three main challenges to address the water situation: 1- Legal and institutional framework; 2- Water Security; 3- Quality of waters and ecosystems. These challenges are being addressed through work on 12 thematic axes. To date, the Board has met 46 times, and 7 technical working groups have been created with more than 120 members (MOP - DGA, 2021).

Legal Framework in Bolivia

According to the regulatory framework of Bolivia, the water resources' management is defined in its Constitution promulgated in 2009. The Constitution has incorporated into its text the treatment of natural resources, including water, and has established the right to water as an internationally recognized human right. The State, at all levels of government, has to provide basic services through public, mixed, cooperative or community entities.

On regard to the distribution of State powers, Article 299 establishes that it is the responsibility of the Plurinational State in a private and non-delegable manner "Land and territory; strategic natural and energy resources, minerals, hydrocarbons, water resources, electromagnetic spectrum, biodiversity and forest resources". Article 349 specifies the ownership and control of natural resources in the head of the Bolivian people: "Natural resources are the property and direct, indivisible and imprescriptible domain of the Bolivian people, and their administration will correspond to the State according to the collective interest".

Particularly, relative to water resources, Article 373 establishes that "I. Water constitutes a fundamental right for life, within the framework of the sovereignty of the people. The State will promote the use and access to water based on the principles of solidarity, complementarity, reciprocity, equity, diversity and sustainability. II. Water resources in all their states, surface and groundwater, constitute finite, vulnerable, strategic resources and fulfill a social, cultural and environmental function. These resources may not be subject to private appropriations and both they and their services will not be concessioned".

Thus, all the articles that are linked to water repeat its character as a human right, and propose its impossible commodification, commercialization or private appropriation. Article 374 indicates that the State will protect and guarantee the priority

use of water for life and that it is a State's duty to manage, regulate, protect and plan the adequate and sustainable use of water resources, with social participation, guaranteeing the access to water for all its inhabitants. Article 375 mentions that it is the duty of the State to develop plans for the use, conservation, management and sustainable use of hydrographic basins, to regulate the sustainable management of water resources and basins to irrigation, food security and basic services, respecting the uses and customs of the communities (Asamblea Constituyente de Bolivia, 2009).

The Bolivian Water Law is based on a Decree of 1879 that was elevated to the rank of Law in 1906, and which has been almost repealed in several parts by subsequent regulations. This law established a regime of rights by which water was considered an accessory to the land, so that if the waters flowed or arose from private property, they also acquired this character, being subject in all respects to the property regime under the Civil Law. According to this logic, the waters considered as public could be granted through a concession. This conception of water rights was modified by the 1938 Constitution, which established that the waters belong to the original domain of the State.

So that, although some of 1906 Law's provisions are still in force, they are not applied mainly because other sectoral laws and regulations establish different norms on the subject, and they are in charge of regulating water uses. In fact, different public institutions became responsible for the management of water resources, from ministries, municipalities, to independent institutions (Bustamante, 2002; Cossio Araoz, 2019).

Other current norms that incorporate water regulations are:

Civil Code Decree Law 12760/1975	Regulates the waters of farms, their uses, cooperatives for the use of water, and the easements of aqueducts.
Law 1333/1992	Environment and Water Law. Article 38 mentions that the State will promote the planning and comprehensive use of water, for the benefit of the national community in order to ensure its permanent availability, prioritizing actions in order to guarantee drinking water for the entire population.
Law 1604/1994 Electricity Law	Regulates the use of water and other renewable natural resources destined to the electricity's production, taking into account its multiple, rational, comprehensive and sustainable use.

Law 1700/1996 Forestry Law	Establishes the objective of sustainable forestry development: protect and rehabilitate hydrographic basins, prevent and stop soil erosion and degradation of forests, grasslands, soils and waters, and promote the afforestation and reforestation; foster knowledge and promote awareness of the national population about the responsible management of watersheds and their forest resources.
Mining Code 1777/1997	On the rights and obligations of mining concessionaires. Mining concessionaires, to carry out their activities, can use the public domain waters and those that are illuminated or flow through their concessions, with the obligation to protect and restore them to their natural riverbed or basin, complying with the established in this Code, the Water Law, the Environment Law, its regulations and other provisions regarding water resources.
Municipalities Law 2028/1999	It provides on the granting of water rights. It establishes that among the assets of Municipality's public domain there are the rivers and streams, and indicates that the Municipality may grant concessions on public property that correspond to it for a maximum period of 30 years.
Law 2066/2000 Potable Water and Sanitary Sewerage Law	Defines the institutional roles of the sector, creates the Superintendence of Basic Services and establishes the conditions for the granting of concessions, licenses and registrations.
Law 2878/2004 Irrigation Law:	Approved to regulate the use of water in the agricultural sector, after a process of consultation with the irrigation organizations. It manages water resources for irrigation, establishes a new decentralized institutional framework and ensures water use rights through a registry. Records on water sources are granted to indigenous and local families or communities and are intended to guarantee access to water for domestic use or traditional agriculture.
Law 3330/2006 Expansion of the Inter-institutional Water Council	It establishes the functions and composition of the Inter-Institutional Water Council (CONIAG), an official space for dialogue and agreement that brings together the State through the Executive Branch and the different user sectors, the social, economic, technical and academic organizations represented in order to build and adapt the policies and regulations necessary for water resources' management.
Law 031/2010. Framework Law of Autonomies and Decentralization "Andrés Ibáñez"	Decrees that it is the exclusive competence of the State to establish by law the regime of water resources and their services, for the regulation of the basins' integral management, investment, water resources and their use.
Law 300/2012 Framework Law of Mother Earth and Integral Development to Live Well	It mentions that the Plurinational State of Bolivia will promote actions to prevent and reduce the conditions of risk and vulnerability of Mother Earth and the Bolivian people facing natural disasters and impacts of climate changes. The comprehensive management of water is mention among the actions necessary to be implemented.
Law No. 2878, 2013. Law for the Promotion and Support of the Irrigation Sector for Agricultural and Forestry Production	Decrees that it is the responsibility of the governments to prepare and develop irrigation plans, programs and projects in concert with the Departmental Irrigation Services (SEDERIs).
Multi-year Program for Integrated Management of Water Resources and Integrated Management of Watersheds (2017-2020)	Its objective is to promote the Integrated Management of Water Resources and the Integrated Management of Watersheds in Bolivia, under modalities of participation and self-management, from the perspectives of local cultures and life systems.

Table 5.2: Bolivian norms regulating water
Source: Cossio Araoz, 2019; SEMAPA, 2020. Own elaboration

Institutional organization

At the national level, the Ministry of the Environment and Water (MMAyA), created in 2006, is the body in charge of formulating all policies, plans and programs related to water resources. The execution of the competences of the MMAyA corresponds to the Vice Ministries of Drinking Water and Basic Sanitation (VAPSB), Environment, Biodiversity, Climate Change, and Forest Management and Development (VMABCCGDF), and Water Resources and Irrigation (VRHR).

Particularly, the VRHR contribute to the development and execution of plans, policies and regulations for the integral management of watersheds and irrigation, and in the design of strategies for the conservation, use and exploitation of surface and groundwater with the different stakeholders involved in the environmental management of the hydrographic basins.

At the regulatory level, the Authority for the Supervision and Social Control of Drinking Water and Basic Sanitation (AAPS) was created in 2009, as a technical and operational public institution, with legal personality, administrative, financial, legal and technical independence, subject to the Ministry of the Environment and Water. It carries out its tasks of: i) control, supervision, inspection and regulation of the Potable Water and Sanitary Sewer Service Provider Entities (EPSA); ii) regulation of actions in water sources, springs, and intermediate zones of rivers that cause damage to ecosystems and decrease in flows due to exploitation or overexploitation; iii) control and supervision of the treatment and discharge of industrial, mining and other wastewater that affects water sources for human consumption (Ministerio de Medio Ambiente y Agua de Bolivia, 2017).

Additionally, the Ministry of Environment and Water has other dependent units such as the General Directorate of Watersheds and Water Resources and the National Irrigation Service of Bolivia (SENARI).

Regarding drinking water and sanitization services, the management and control of water resources in Bolivia is dispersed in the different administrative units. The Framework Law of Autonomies and Decentralization "Andrés Ibáñez" establishes the distribution of powers in terms of basins and comprehensive management of water resources, based on four regional levels: departmental, municipal, regional and native indigenous peasant.

At departmental level, the Prefectures prepare and develop departmental plans and programs for the expansion of drinking water and sanitary sewerage services, and coordinate together with the Ministry and the municipal governments the supervision and control of the execution and quality of infrastructure works. The Municipal Governments within their jurisdiction are responsible for ensuring the provision of drinking water and sanitary sewerage services through an EPSA[59] or directly.

After examining legal and institutional framework, it is evident that Bolivia still has deficiencies regarding the management and administration of its hydric resources. The insufficient policies and weak regulatory legal framework are reflected in failures to achieve an integrated management of water resources. There is a weak institutional and administrative framework, added to the lack of definition of attributions at the departmental and municipal level regarding the use of land and the management of natural resources. Then, the management of water resources in a fragmented way and with scattered regulations, together with a lack of linkage of drinking water to other sectors such as irrigation, mining or energy, hinders an integrated management of water resources and a long-term vision (GIZ, 2011; Llavona, 2020).

Additionally, the low level of information and knowledge on existing and available water resources and basins in the country, and the limited technical and institutional capacities makes comprehensive water management planning difficult. This

[59] EPSA is defined as a legal person, public or private, that has any of the following forms of incorporation: municipal public company, joint stock company, private company, public service cooperative, civil association, indigenous and native peoples, indigenous communities and peasant associations, peasant organizations and unions, water committees, small independent urban systems, neighborhood councils and any other organization that has a legal structure recognized by law except municipal governments.

inability to develop greater knowledge and technical and administrative capacity is attributed, mainly (at the official level) to the lack of financial capacity that the state has to invest in it (Interview 13). Whatever the reasons, the truth is that this deficiency directly impacts its ability to establish a cooperative agreement with other states. If there are no clear internal rules for the management and administration of these resources and the management authority is dispersed, it is difficult to reach a cooperative agreement for transboundary groundwater administration.

The same happens in Chile, institutional dispersion in decision-making, legal deficiencies, non-integrated management of water resources; the lack of adequate infrastructure; lack of information about national water resources; and finally, the availability and limited use of data for decision making influence its possibility to arrive in cooperative agreements with other countries.

Other actors involved in water's use and management (stakeholders)

According to the hypothesis of this thesis, the result (aquifer's regulation) could be influenced by the presence or absence of "*status quo* stakeholders". These actors are, mainly, economic actors that extract and/or use aquifer's groundwater to develop activities that have an impact on the local or national economy. This economic power gives them the possibility to influence the political decision-making regarding the management and regulation of aquifer waters at any level of government (national o subnational), and they would be expected to act against an aquifer's regulation, making it more flexible or preventing its emission: no regulation or lax regulation.

Regarding the groundwaters of these two aquifers, there have been no bilateral (diplomatic or political) meetings to address their use or joint management. However, in the Loa region and during the meetings held around the Silala (regarding surface and groundwater), there is evidence of the presence and participation of various political (national and local) and economic actors, mainly mining companies.

If we look at the information provided by the DGA (2021) in Chile, we can verify that in the commune of Ollagüe numerous water rights have been awarded, mainly to mining companies, such as Corporación Nacional del Cobre (Codelco); Sociedad Contractual Minera El Abra; Comunidad Quechua De Ollagüe; Antofagasta Chili And Bolivia Railway P.L.C.; and Scoiedad Azufrera Borlando y Cia.

In the area of the Ascotán Aquifer, there is porphyry copper mine that belongs to Sociedad Contractual Minera El Abra (SCMEA). SCMEA is in the sulfur mineral exploitation stage under the project called "Sulfide Leaching, Sulfolix Project". For the Sulfolix project, they extract groundwater from a well field located in the Salar Ascotán basin at a distance of 80 km to the east of the mine. The project has environmental permits to pump a total of 400 l/s from a total of seven production wells (Minera El Abra, 2013).

There are many cases in the north of Chile -Atacameña, Aymara and Quechua areas- where the liberalization of the water market during the 1980s (after the enactment of the current Water Code) caused great damage to the ecosystems, the drying out of *vegas* and wetlands (*bofedales*), and a decline in the agricultural capacity of indigenous peasant families. This panorama becomes even more complex due to the fact that these original inhabitants have often faced pressure and monetary offers from mining companies to sell their water rights.

For the indigenous community of Ollagüe, according to its worldview and beliefs, water constitutes a value in itself. Grazing continues to be one of its main activities. Thus, water constitutes the sustenance of its economy and one of the foundations of the Andean worldview. Nevertheless, according to a DGA's Strategic Plan for Hydric Resources Management in Antofagasta Region, the mining extraction of the salt flats has had a negative impact in this region (DGA-MOP, 2012). The boom in lithium extraction in this area raises great concerns. Among the damages found is the decrease in the water table and the volume of water stored in the aquifers; the degradation of high Andean wetlands and lagoons; the negative effects on fauna such as the local reduction of camelid herds; the disappearance or degradation of water sources

used for human consumption (wells and springs) located near the extraction points or coming from the same aquifers. To face this situation, the DGA has declared as protected areas and restriction zones many of these *vegas* and wetlands to limit the exploitation of groundwater.

The situation of water scarcity, the high demand for water that mining requires, together with the limitation to obtain new water rights in restriction or prohibition zones has led many of these mining companies to seek other sources of this resource. That is why, since 1997, there has been evident the interest of these companies (Chilean and foreign) in negotiating the purchase of water with Potosí. They offered to buy 50% of the water production on the Bolivian side, that is, 100 l/s, at a price not yet determined (Jiménez Cisneros & Galizia Tundisi, 2012). This information was presented both in different documents analyzed and in interviews with experts.

Since 2000, local elites in Potosí have tried on several occasions to open the water export business. However, they faced strong opposition from regional social, peasant, and professional organizations that lobbied for the government to back down with this project. The government of Bolivia, at that time, commissioned a study to define global policies -considering environmental criteria and socio-economic needs-, and the existence of possible remnants. But the government left this entire process in the hands of private consulting companies. The costs of the study would be in charge of those companies, and, in case of verifying the existence of remnants, the company would have the right to exploit and commercialize that waters (Kruse & Ramos, 2003).

Later, in August 2000, the Bolivian Chamber of Deputies had approved a bill on water source concessions for export purposes in the department of Potosí. The project authorized the Superintendent of Basic Sanitation to grant concessions for water sources for export purposes in the department of Potosí, establishing an amount of royalties and fees to be paid. This project has been strongly promoted by parliamentarians from the department of Potosí. The demand for water came mainly from multinational mining companies operating in Chile that require water for their current and future operations, such as Doña Inés de Collahuasi (Anglo American plc, Glencore, and Japan Collahuasi

Resources B.V.), La Escondida, Río Chilex S.A., Codelco, Sanitary Services Company of Antofagasta (ESSAN S.A.), among others.

Finally, on October 6, in an agreement signed with peasant organizations, the government promised not to approve the Water Export Bill, stopping its approval in the Senate. This did not mean that the issue disappeared from the political and economic agenda, on the contrary, it was present in the meetings and working groups that were held to resolve the Silala's conflict that was still under debate (principally, during 2006-2009).

In Bolivia, Potosí is an internal front, a very demanding political society that creates friction with the central government. In Potosí, there are located the most important resources shared with Chile -along with Oruro. An expert and ex- Alternate Representative of Bolivia, during an interview, indicated that Potosí had political leaders who opposed any dealings with Chile. But at the same time, they wanted to receive financial resources. Potosí was the one who introduced the issue of exporting water to Chile during the bilateral meetings. There was enthusiasm for selling water. But that have generated confusion between the enthusiasms of those who were in favor of doing a kind of business on water versus others that were looking for a bilateral deal on water (Interview 14).

Regarding this, a Chilean diplomatic representative, also pointed out that during bilateral meetings between Chile and Bolivia, there were political interlocutors and advisers to economic actors who preferred to put aside diplomatic agreements with Bolivia and advance in the business of buying water from Bolivia (Interview 10). They thought that diplomatic channels only slowed down the solution to the direct problem of water demand. They pressed for a trade agreement; they were not interested in a political treaty.

According to publications in the Chilean media, in 2009, the Bolivian government reached an agreement with social leaders from the southern department of Potosí to sale freshwater to Chile. The Bolivian Foreign Minister, David Choquehuanca, in a meeting held in a town near the Chilean border, explained the details of a

preliminary agreement for sale freshwater to be used in the North of Chile (La Tercera, 2009).

Finally, these pre-agreements on Silala's water and the sale of freshwater to Chile, as well as the diplomatic meetings and bilateral working groups, were abandoned due to the announcement of the then President Evo Morales regarding his decision to take the Silala issue to the International Tribunals.

Discussion and conclusion

The Ollagüe-Pastos Grandes and Ascotán aquifers are two of the many cases of transboundary aquifers that exist in the world without regulation for their sustainable use and management. And precisely for this reason, they constitute an interesting case study.

As expounded in this chapter, they are located in a geographic region characterized by extreme aridity and scarcity of rainfall and water resources, but abundant in mineral resources. Moreover, the aquifers are shared by two countries that have not reestablished diplomatic relations –broken in 1978- and they have faced at the International Court of Justice in The Hague for two cases in which water was the protagonist: the maritime demand of Bolivia, and the case of the Silala River.

The Ollague-Pastos Grandes and Ascotán aquifers are natural sources of essential importance because they directly feed many springs, *vegas* and wetlands (*bofedales*) located on both sides of the border line. They also represent essential resources for mining activities carried out on the Chilean side, and, to a lesser extent, for the native communities that inhabit the Altiplano region.

This thesis sustains that knowledge about the aquifers' real dimensions, hydrogeological characteristics, water reserves, exploitation rates, and their role in regional development is the starting point for advancing on reasonable visions and plans for transboundary groundwater regulation, and identifies management actions needed.

Despite their discovery and relevance, there is still scarce information about the aquifers' hydrogeological characteristics, exact location, recharge capacity, possible interconnections, extractive capacity, etc. Then, in this case it's evident firstly, the lack of knowledge of shared groundwater resources in Chile and Bolivia which has limited the possibility of transnational regulation. Second, in both countries we observed a big dispersion of the information available among the different actors (private companies, consultants, local and national institutions). And this is the consequence of the excessive institutional fragmentation and the deficits in communication and coordination of the national actors responsible for water management.

The little knowledge about Ollagüe-Pastos Grandes and Ascotán aquifers is a causal factor that harms the possibility of bilateral cooperation to reach an agreement or regulatory framework for their use, management, and protection. Neither of the two countries involved has yet carried out an in-depth investigation about aquifer's characteristics. Nor have they implemented juridical and institutional improvements in the regulation or management of their domestic water resources, or investments in research and management projects of shared water resources.

In both countries, groundwater is an issue recently incorporated into the political agenda and public debate. Both states have advanced in some legislations, projects, or technology regarding groundwater resources during the last years. However, it is a very little-known topic. And even more unknown are transboundary aquifers; they are outside the normal political discussion.

As was stated above, the main problem of surface and groundwater regulation is the states' lack of knowledge about water resources present in their territories (characteristics, location, etc.), to manage these resources and/or implement agreements. The scarce or controversial data regarding aquifers may constitute a limitation to resource regulation. If there is no consensus or common information about the risk of the aquifer's overexploitation or management, then it will be even more difficult to agree to a distribution of the rewards and costs as part of any proposed regulation (Hurrell &

Kingsbury, 1992; A. T. Wolf, 2007b; A. T. Wolf, Yoffe, & Giordano, 2003; A. Wolf et al., 2004).

Many factors could explain this lack of knowledge and low interest of domestic political actors: scarce financial resources (especially in the Bolivian case), remoteness from cities, little or no use of groundwaters. But during this research, other factors became evident.

Firstly, when we observe preference settings within each state and the role of domestic actors in Chile and Bolivia (these actors include politicians from different national and subnational units who participate in the legislation or decision-making process), what is noticeable is the great diversity of opinions and the scarce commitment to prioritize the regulation to use and protect groundwaters in general, and transboundary aquifers in particular.

In Chile, a series of tepid reforms to the 1980 Water Code have been delayed in Congress for more than 10 years. The heart of that regulation, which is the delivery of water use rights, and the water market that was generated around that right, remain intact. The recognition of water as a human right has not yet been legally enforced –and this is an internationally recognized human right.

Certainly, there are strong interests against those changes. In the northern regions of Chile, numerous water rights have been awarded mainly to mining companies. Mining is one of the main economic activities in the country. About 10% of GDP, 50% of exports, and 9% of tax revenues come from this industry (Consejo Minero, 2020). Changes in Chilean Water Code, and particularly in the conditions above mentioned regarding the access to water rights, would harm their interests. As was stated above, the mining sector has formed an important lobby against the project to amend the Water Code (represented mainly by the President of the Mining Council)[60]. Because of all the reasons here mentioned (their role in Chilean economy, the water rights acquired, fundamentally in the north of Chile; their direct participation in bilateral negotiations between Chile and Bolivia; their interests regarding the sale of water from Bolivia; and

[60] For more information, see (M. Segovia, 2017).

their opposition to Water Code reforms) they are considered as economic *status quo* stakeholders who act directly against domestic reforms and intervening in international cooperation.

Despite this stagnation regarding regulatory water reform in Chile, we can observe, as mentioned before, an increased interest in improving groundwater regulation and the role of the institutions that deal with it. Regulation 203/2013 is an interesting contribution to the still incomplete groundwater regime.

In Bolivia, although water has the constitutional status of human right, there is a great legal and institutional dispersion of water resource regulation and regimentation. The 1906 Water Law is outdated. Some of its provisions are still in force, but they are not applied mainly because other sectoral laws and regulations establish different norms on the subject. In addition, there are different public institutions that became responsible for the management of water resources, from ministries, municipalities, to independent institutions. Concerning groundwaters, the state (national and local) still has not enough knowledge and financial capacity to obtain information about national aquifers, hydrogeological characteristics, extractions, risks of pollution, etc. Some progress in this area has been achieved mainly with external financing.

These legislative and institutional deficits and dispersion in both countries complicate the use and management of national water resources, and even more so, in the cases of transboundary water resources.

But, what can be highlighted in Bolivia is the greater action capacity of social organizations vis-à-vis national and municipal political authorities. This was evident when the Potosí prefecture tried to promote legislation regarding the sale of water to Chile, and the later desertion of the pre-agreement reached by both countries on the Silala's River. On the contrary, in Chile, the native communities that inhabit the territory where these water resources are located have difficulty even in conserving and claiming their rights to use water.

Although there were various instances in which Chilean and Bolivian diplomatic representatives and economic actors interact in bilateral meetings and manifested their

intention to reach agreements to advance in research on the shared water resources, to regulate their use, and protect them, these good intentions have not been materialized in concrete agreements. Neither of the two states has implemented research projects or invested money for specific projects to generate this knowledge. The lack of economic resources has been considered one of the main reasons for the lack of implementation of research projects and monitoring systems from the Bolivian state. However, when it comes to reaching some type of agreement with Chile regarding water resources, the variable "maritime demand" seems to be always interfering with the possibility of advancing in other aspects or matters.

Something that was also observed throughout the interviews carried out is the instability that exists in the bilateral relationship. Before the arrival of Evo Morales to the Presidency, Bolivian political fragmentation and instability generated constant changes in interests and positions regarding the relationship with Chile. But there is also evidence of a lack of consistency in Chile's policy towards Bolivia. In this way, the relationship between the two countries was built from mutual mistrust.

Furthermore, as was said above, the historical Bolivian maritime demand arises occasionally and interferes in bilateral negotiations. At times, the Bolivian government has privileged the commercial, security, and infrastructure dimension in its relation with Chile, leaving aside the maritime issue. But the government of Evo Morales has been established on a nationalist basis expressed in processes such as the nationalization of hydrocarbons and the vindication of the sea as a fundamental part of the Bolivian territory and identity.

Since then, for Bolivia, the rapprochement and bilateral cooperation with Chile make sense to the extent that they are a step forward in achieving a response to its maritime claim. While for Chile, the growing institutionalization of its relation with Bolivia has the objective of having a cordial relation, building mutual trust, and developing joint initiatives in issues of common concern (security, border control, commerce, among others) (Correa Vera & García Pinzón, 2012). Nevertheless, as Chancellor Allamand has confirmed, Chile is not willing to include in the bilateral

agenda the sea access issue (since Chile considers that it is a subject resolved by the ICJ), nor the Silala's dispute that is ongoing in that Court.

Based on these differences, the possibility of reaching concrete agreements on the regulation and management of transboundary water resources seems to be complex. As was indicated above, the "conflict" alternative explanation –based on the presence of previous conflicts between states- cannot be ruled out. The underlying conflict (the Silala's current demand in The Hague and the constant maritime claim) is a contributing factor that could be hindering bilateral negotiations regarding water issues. But it does not seem to be an impediment for both parties to negotiate and reach an agreement, as they have done in other matters as border security and bilateral trade.

Although research from security studies affirms that past conflict between states should not be a determining factor, evidence found in this particular case indicates that it has some degree of incidence. When Bolivia sets the maritime exit as a condition to advance in other water cooperation issues, then it acts as an immediate impediment to any negotiation. Chile refuses to put the maritime issue back on the negotiating table because it was solved by The Hague Court's ruling.

But conflict is not a sufficient factor to explain no regulation outcome. I confirm that other factors, combined with the conflict issue (the claims for a sovereign exit to the Pacific Ocean), can explain the result of cooperation (no regulation). This implies going beyond the security's perspective and understanding the contextual complexity in which these agreements are circumscribed or how it has not been possible to delineate any regulation. The different predisposition and expectation regarding the bilateral relationship, as well as the priority placed on internal political interests[61] over the benefits that cooperation with the neighbor could bring, they seem to be interfering in the achievement of the result: regulation of transboundary aquifers. In other words, what has the most significant impact are insufficient knowledge about shared groundwaters and aquifers and the little predisposition of domestic political actors, especially of

[61] the maritime issue has been used for Bolivian governments as a momentary political rallying-point to induce internal support

policymakers, to modify the status quo and advance in the regulation of these shared resources.

Finally, the causal factor "*status quo* stakeholders" has been present, with greater or lesser intensity at different moments of the negotiations between the two countries, or when they try to advance in some internal economic or legislative project. In this case, the *status quo* stakeholders are those actors that use or exploit the aquifers for developing economic activities which impact on national economies. These stakeholders take advantage of the information and measurement problems regarding transboundary and national aquifers to opportunistically advance their own interests on those resources.

As was shown, mining companies (Chilean and multinationals) located in the north of Chile, are the majority owners of the water use rights assigned in those territories and the principal users of groundwater resources. They were interested in achieving an agreement with Potosí government to buy more water for their production processes. These actors, together with some political representatives, considered that diplomatic meetings and working groups slowed down and were even an impediment to achieving a water purchase business with Bolivia. Those *statu quo* stakeholders would also be greatly harmed if the current Chilean Water Code is modified, which allows them to obtain almost unconditionally the rights to use water and obtain revenues in the Chilean water market.

In sum, and attending to all factors analyzed in this chapter, the cases of Ollagüe-Pastos Grandes and Ascotán aquifers show that no regulation is the expected result when:

- there is no enough knowledge about transboundary aquifers resources;
- the domestic actors in favor of changing the *status quo* and of regulating aquifers' management are fluctuating and organizationally dispersed; there is no state political will for change;
- and powerful *status quo* stakeholders -whose activities contribute significantly to the national economy- are present, and act to prevent changes or agreements that are not favorable to their interests;

- there is a latent conflict regarding water issue that acts as a contributing factor.

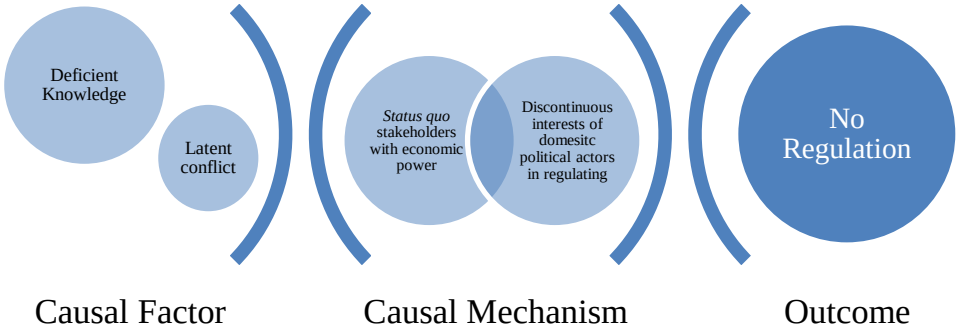

Figure 5.4: Hypothesis.
Source: own elaboration

Hence, the hypothesis proposed is confirmed: the interaction between both *status quo* stakeholders with the power to influence national or international policies, and a domestic coalition favorable to the regulation of these aquifers is the causal mechanism influencing the causal factors and promoting the outcome (no regulation). More to the point, difficulties involved in addressing transnational aquifers are the existing or generated knowledge about those resources, and the actors involved, here the *status quo* stakeholders, who are actors with enough economic power that can affect the possibility of regulating, and the domestic political actors with low or discontinuous interests in regulating. Underlying conflict between states could not be ruled out. But it does not seem to be an impediment for both parties to negotiate and reach an agreement, as they have done in other matters and instances.

CONCLUSION

Conclusion

I have started this thesis with a central question: why states do not regulate transboundary aquifers? I have elaborated some arguments regarding the factors that I consider crucial for answering this question: the conjugation of knowledge, domestic political actors' will, and the presence of powerful *status quo* stakeholders.

Then, in addressing the international politics of groundwater regulation, this thesis is concerned with the factors that exert influence on transboundary aquifer's regulation; the processes by which interstate agreements on shared aquifers (if any) are negotiated and the final result, that is, the kind of rules and regimes established and implemented for aquifer's management (how strict is it).

International watercourses law has evolved in recent years. Its object of regulation has changed from the restricted concept of International River to a wider one such as the International Basin. The regulated uses of these watercourses were diversified. Formerly, only their uses associated with navigation were regulated, and later, new dimensions of water resources in the environmental, economic, human rights field, among others, were recognized. There is actually a normative pluralism that allows us to talk about the existence of an International Water Law.

As was indicated in previous chapters, superficial watercourses have been regulated through bilateral or multilateral treaties between states that share them. But, less than half of the international basins identified have a treaty that regulates them, and not every state sharing the basin is part of the treaty (Movilla Pateiro, 2014). Nevertheless, watercourses regulation with universality aspiration has evolved since Twentieth Century, specially attending to their uses for navigation or other purposes. Some conventions (as Helsinki Convention or Madrid Declaration) have established norms today considered as customary law in watercourses regulations.

Whereas considerable progress has been made in managing transboundary surface resources, commensurate progress on aquifers is lacking. The methodology to reliably forecast the impacts of interventions (extractions, infiltrations, contamination)

on these bodies of water has not yet been developed. Among the reasons that could explain this, we could mention national interests and sovereignty concerns, the multiplicity of institutions involved, available technology (Biswas, 2011).

Of the 592 aquifers identified by the International Groundwater Resources Assessment Centre (IGRAC), only one percent of these transboundary aquifers have some international regulatory framework or agreement. This situation is not surprising. Managing aquifers is complex because of the difficulties inherently associated with their scientific and technical understanding, the cost of collecting adequate and reliable data, and the lack of experience of functional institutions which could manage such systems effectively. Furthermore, legal regimes for managing transboundary aquifers are not well developed, and global experience in managing them is also extremely limited.

Aquifers present many complexities when regulating them. These difficulties are greater when groundwaters cross the borders. Many times some states consider that their aquifers are totally located in their territories and are unaware of their transboundary implications. For example, in cases where the aquifers are in the territory of one state, but the loading or unloading zones are in another state. Chapter 2 describes the six models of Eckstein and Eckstein (2005) as illustrative of the main scenarios in which groundwater resources have transboundary implications regarding the process of charge and discharge of aquifers and their hydrogeological characteristics.

The aquifers considered in my case studies can be classified according these models. The Genevese Aquifer and the aquifer associated to the Silala River (Bolivia-Chile) represent unconfined aquifers intersected by an international border and linked hydraulically with a river that is also intersected by the same international border (model B). The Guarani Aquifer is an example of this model, and the aquifers located in the border between Chile and Bolivia (Ascotán and Ollagüe- Pastos Grandes) are confined aquifers, unconnected hydraulically with any surface body of water (except perhaps within the recharge zone in an unconfined portion of the aquifer) that traverse an international boundary or that are located completely in another state. This type of

aquifer has transboundary consequences which are a function of the rate of pumping or pollution (model E).

Law on transboundary aquifers is still in a nascent stage, and the ILC Draft Articles constitute the most significant compilation of legal thinking about this issue. Their provisions, together with the few treaties and agreements regarding specific aquifers, constitute an incipient but significant progress in the understanding of groundwater and aquifers' nature and risks. As we have seen, it is not yet possible to speak of a customary nature of the Draft Articles provisions due to the recent development and the scarcity of state practice on aquifers. Although they include norms on which there is a broad consensus on their customary nature in international law -as the principle of equitable and reasonable utilization-, there are other emerging rules that don't have yet sufficient consistency and consensus in state practice to ponder them as customary law. Provisions referred to ecosystem pollution, joint management of recharge and discharge zones base on the precautionary principle, are some examples.

Analyzing Causal Factors and Causal Mechanism

Knowledge as a necessary factor

According to the causal factors identified in this thesis, we have seen that knowledge is a necessary but not sufficient condition to achieve the outcome: regulation. Effectively, knowledge plays an important role in identifying aquifers' characteristics, localization, capacity, use. Because it is unseen, groundwater has long been –and continues being- a vulnerable resource that is not given the priority and attention needed to ensure that the benefits it provides to human societies and to ecosystems will be sustained. Groundwater data is often imprecise, outdated, limited by legal aspects, technological capacity, or by paradigms of knowledge. Compared to surface waters, groundwaters and aquifers present many complexities because of their hydrogeological characteristics and require different management solutions.

In general, it was always believed that there were rivers of water that run under the earth. There has never been much concern about the origin of these bodies of water: whether they are stored somewhere, how long they have been there, their characteristics, the recharge and discharge areas of those waters, their extraction capacity, and the risk of depletion when extraction it is faster than recharging, among others. At the state level and the social level, the ignorance that exists is made explicit here under the "knowledge/lack of knowledge" causal factor. The knowledge that we have of some aquifers is very niche. Only specific academics or companies that use the water have been interested in having data and information on the resources. Even in those aquifers on which information is available (e.g., the Guaraní), despite the more than 20 years of studies carried out in different academic and research units of the four countries, it still has not been possible to have complete knowledge.

Getting good information and developing a technical understanding of how groundwater systems work is crucial for improving its management. But the main problem in water issues is that states don't have enough knowledge about water resources located in their territories and shared with other states. The causes of ignorance of these resources (or lack of knowledge) are diverse. First, regarding specifically technical difficulties, research in deep groundwater systems is expensive. Information from the subsoil is required and is obtained from the analysis of rock samples from deep wells. Then, the analysis and treatment of the data includes the use of appropriate methodologies and extensive experience on the geological evolution of this area. Second, because each aquifer has its own particularities, it cannot be studied or managed with standardized methods or models.

Additionally, there are other social, political, legal, and economic reasons, such as the presence of large extensions of uninhabited territory or with low population density, where there is not a high demand for water resources; the lack of economic resources to implement research or invest in equipment and technology to know in detail these resources; legal difficulties that interfere in knowledge research or in the implementation of changes in resources administration (for example, if specific

territories where this aquifers are located are considered as private property and access to researchers is denied); bureaucratic obstacles or problems of institutional dispersion and lack of communication between them, among others. Sometimes, states cannot advance on knowledge about their groundwater, not because they are not interested, but because they do not have enough resources, economic or technological capacity, or the research approach is not appropriate to obtain necessary information.

Thus, if there is scarce or controversial data regarding aquifers (national and transboundary), this could be a limitation to resource regulation. Likewise, if there is no consensus or common information about the risk of the aquifer's overexploitation or management, then it will be even more difficult to agree to a distribution of the rewards and costs as part of any proposed regulation.

Scientific knowledge and ideas have an effect on the emergence of new policy initiatives and institutional frameworks. They are the resources used by political actors engaged in negotiation processes, and they operate as a cognitive framework from which political preferences are shaped (Walter, 2013). Additionally, as Libecap (2008) asserts, some parties involved –the status quo stakeholders- take advantage of these information and measurement problems to opportunistically advance their own interests on that resource.

This thesis demonstrates that knowledge about the aquifers' real dimensions, hydrogeological characteristics, water reserves, exploitation rates, and their role in regional development is the starting point for advancing on reasonable visions and plans for transboundary groundwater regulation, identifying management actions needed.

In the first case study, the Genevese Aquifer, the increased understanding of hydrogeological conditions was fundamental, firstly, to identify the aquifer's features, zones of groundwater recharge, hydraulic linkages and the specific hydrogeologic features of the terrain. Secondly, it made it possible to understand the causes and possible solutions to falling water levels. During this first stage, the Geneva's Service of Geology was in charge of the original studies on the aquifer. Then, the adjoining French region was involved in this research.

At first glance, in the Canton of Geneva, the situation seemed to fit well with Hardin's claims about the tragedy of the commons (1968). But, all new information generated by research on available resources and alternative management approaches reshaped the incentives of Genevese Aquifer's users to cooperate. This knowledge made it possible to delimit the problem and find a solution that met two main criteria: the lowest cost and the security of the water supply. The problem was not the general availability of water (both states had other regional sources of surface water). The main concerns were the political and economic costs of changing water supply systems from groundwater to surface resources, and the risks associated with exclusive dependence on surface water. Precisely, the lack of an economically competitive alternative encouraged the French authorities to cooperate and participate in the recharge of the Genevese Aquifer.

Once both parts had sufficient information about the aquifer's properties and the viability of the recharge solution, they decided to cooperate and sign a formal binding agreement. This agreement allowed the parties to focus on solving the specific technical problems of groundwater management at the local level, following the option that had the least economic impact for users (final water consumers) and, therefore, the least political effect. Then, all these knowledge generated about the Genevese Aquifer was the necessary condition to advance in bilateral negotiation and cooperation.

In the case of the Guarani Aquifer, scientific research carried out since 1990 in the area of hydrogeology allowed to change the idea about groundwater resources in the region. Regional theories emerged suggesting the existence of hydrological linkages among the regional aquifers despite geological discontinuities and started to gain force the idea of their transboundary dimension. It was a true paradigm shift that made it possible to understand the complexity of this groundwater system.

Then, the discovery of the Guarani Aquifer system was particularly the result of the articulation of various actors and intense international cooperation processes at different levels. Epistemic community and international organizations (UNESCO, the OAS, and GEF) played an important role in including the notion of transboundary

aquifer on the regional agenda, and by raising awareness about the importance of these groundwaters and the need for to cooperate and protect them.

The second stage of knowledge development in the Guarani Aquifer was during the years of the Project for the Protection and Sustainable Development of the Guaraní Aquifer System (GASP), supported by the GEF (World Bank), the OAS, and other international actor generated. All these new information about the aquifer (although it is not yet complete), and its diffusion in domestic and international context, generated an extra pressure or political opportunity for the governments involved. It also fulfilled an important role in raising public awareness as to the existence, location and relevance of the GAS, and the precariousness of public policies regarding groundwaters' management. Thus, knowledge in the GAS case study has triggered a series of actions that have aroused the interest of the states involved. Academic research encouraged or sought funding. This funding was conditioned on the involvement of state entities or institutions, which caught the attention/interest of states involved.

Unquestionably, in both case studies (the Genevese and the Guarani Aquifers) knowledge was the starting point to advance transboundary cooperation. Without sufficient knowledge about the hydrogeological characteristics, location, vulnerabilities and threats of the aquifers, there would be no possibility or interest in the countries to advance in bilateral or multilateral negotiations. Nevertheless, the Genevese Aquifer has a successful management agreement, and the outcome in the Guarani Aquifer is different. This allows me to asseverate that there are other factors explaining the outcome. Information (or knowledge) is not a sufficient condition.

In the third case study regarding the Aquifers shared between Chile and Bolivia, the situation is different. There is a mutual recognition about the existence of the Ollagüe-Pastos Grandes and Ascotán Aquifers. During ISARM Americas' meetings, the representatives of both countries agreed on their location and provided the available information about these groundwater resources. However, the information generated in the lasts years is scarce. Groundwater is a topic recently added to the political agenda and public debate in both states.

Additionally, other problems were identified. First, both states have problems in collecting data on the water resources present in their territories. Specifically, regarding these aquifers, there is scarce or no information regarding their exact location (the groundwaters of the Silala River is an illustration), recharge capacity, possible interconnections between aquifers, among others. Second and closely related to the scarce information, available information is dispersed among different actors (private companies, consultants, local and national institutions). It is a consequence of the excessive institutional fragmentation and the deficits in communication and coordination of the national actors responsible for water management.

Hence, this case study proves that scarce or controversial data regarding aquifers may constitute a limitation to resource regulation. When there is no consensus or common information about the characteristics and risks of the aquifer's use or overexploitation, it will be even more difficult to establish cooperative management. According to the hypothesis here, it is evident that insufficient knowledge about Ollagüe-Pastos Grandes and Ascotán aquifers negatively influences the possibility of arriving at a cooperative agreement or regulatory framework for their use management and protection. As it is considered a necessary condition, when knowledge is low, the expected outcome is lax or no regulation.

Domestic Political Actors in favor of regulation

Domestic actors in favor of changing the status quo and regulating aquifers' management is the other identified causal factor. As was established in previous chapters, these actors include politicians (political actors) from different national and subnational units who participate in the legislation or decision-making process.

These actors, based on different motivations (political interests such as electoral expectations; economic interests such as international funds or investments; or by national or international pressure arising from knowledge about the aquifer and its publicity), are expected to act favoring the aquifer regulation for its management and

protection. Domestic political actors interested in regulating transboundary aquifers promote cooperation. Hence, they constitute another necessary but not sufficient condition to reach a transboundary groundwater regulation.

In the investigation of the case studies, it was observed that the participation and motivation of domestic political actors are crucial. The nature of the regulation and its subsequent implementation depends rather on their political will and interest in establishing a common groundwater management agreement to protect the resource but, fundamentally, to guarantee the state's right of use and access.

When analyzing domestic actors, it's important to consider the government composition (e.g., in presidential regimes, the role of the executive and legislative), and the government system (federal or unitary, where decision-making power rests with the central government or is shared between federal units). Internal political divisions can also influence the outcome and, in case of achieving an aquifer's management regulation, the success of its implementation. Opposition parties can use domestic approval or objection to cooperation to pursue their own political motives, as well as governments in favor of cooperation may be hampered by internal objections.

Likewise, in governments where the decision is centralized in a political unit, the possibility of regulating groundwater resources is higher than in states where decision-making power and resources administration is disperse between the different political units. Decentralized states, with divided governments, and without multi-level coordination, the international cooperation and the ratification of the international agreements reached by the executive are less likely than in a unitary state scenario. These characteristics affect the emergence of a univocal political interest to promote a change in the *statu quo* in relation to groundwater regulation. The dispersion of interests in the internal political actors impacts their capacity for action and the final outcome: regulation (lax or no regulation).

In the case of the Guarani Aquifer it was evident that in Brazil and Argentina (both federal countries) the domestic regulation of groundwater resources seems to be complex because they have delegated their administration to provinces or states. The

effect of the federal structure and decentralization without multilevel coordination is evident–especially in the area of water management. Thus, domestic politics, and the presence of institutional "veto players", affect the state's behavior in matters of international cooperation.

In case studies' analysis, I have also examined the legal and institutional framework relative to water resources of each country. It allows understanding some internal problems that states have when regulating their own resources and the impediments to advance in international cooperation.

In the Genevese Aquifer case, when groundwater depletion was evidenced in Geneva, political actors and economic stakeholders started a research process to have more information about available water resources and find alternative solutions to this problem. The Canton of Geneva contacted the neighboring French communes to inquire about their interests in the aquifer's possible joint management. Since 1972 and during five years, they held several meetings and discussions and continued advancing more research on the aquifer. For both parts involved, the possibility of switching to other water sources was either too expensive or inaccessible.

When French regions finally decided to cooperate with the Canton of Geneva and the participation of each part was defined, there were some legal obstacles that they have to solve. The Swiss Cantons are autonomous to sign international agreements of this type with foreign bodies. But, in France, the Local authorities could not deal autonomously with transboundary issues during those years. Finally, the French local authorities maneuvered to grant a certain legal framework to the agreement. It was the Prefecture of Haute Savoie representing the French State who signed a renewable 30-year agreement, which entered into force in 1978, and was later renewed in 2008 for 30 years more.

The agreement was immediately implemented: parts established the bi-national Commission as the principal aquifer's management organism; the recharge installation was built, and they established limits to water pumping to obtain an adequate average groundwater level, among other things. From its origins, the agreement was very

rigorous and regulates every aspect of resource management. Its provisions guaranteed access to water mainly to users who depended on the aquifer for their supply in French and Geneva neighboring communes. It ensured the continuity of the aquifer by creating an artificial recharge plant and establishing mechanisms for the regular exchange of information on its usage. In turn, the definition of costs and the establishment of prices per cubic meter extracted acted as a powerful economic deterrent to prevent the increase in withdrawals from the aquifer (dissuading free-riders).

What stands out, in this case, is precisely the political will, the interest of domestic political actors (motivated by different reasons) in reaching an agreement that is mutually favorable regarding the management of this shared aquifer. The handling of the administrative and policy aspects of aquifer's management at the local level was crucial in the Genevese Aquifer case. Social and cultural characteristics could also explain the commitment to the agreement reached (despite its questionable legality). The recharge system and technology implemented allow controlling water extractions on both sides of the border. Then, both parties can monitor each other and thus demand compliance with the agreed rules. This is how they avert the free-riding problem.

Regarding the Guarani Aquifer case, we can observe how domestic political actors will play a fundamental role in advancing or holding up cooperation. At first, when the regional epistemic community made significant progress in its knowledge about the aquifer –its characteristics and its transboundary nature-, and different international organizations (such as GEF) got involved in financing this project, only then did the states involved decide to participate. We can mention different motivations: economic (there were big investments associated to the GAS Project), international pressures (they wanted to preserve their control over these coveted resources that were getting huge publicity); ensure their sovereignty over the portion of the resource that corresponds to each one; guarantee the sustainable use of these waters.

Nonetheless, this good predisposition and enthusiasm began to fade throughout the process: the GASP had to be extended for two more years to achieve its objectives; the agreement was signed, but it took ten years to gather the instruments of ratification

for its entry into force. Furthermore, the agreed obligations in the GAA require state actions that are still not materialized, for example, monitoring activities into each state part, permanent information exchange mechanism, among others. Actually, to apply the agreement states till have pending tasks as defining the arbitration procedure for settling disputes by issuing an Additional Protocol; the creation of a Commission of the Guarani Aquifer; identifying critical areas to take specific actions, among others.

Many reasons can explain the stagnation after the agreement's signature: absence of definition of the role and capacities of common institutions –as the Commission-; insufficient financial support at the end of the GASP; lack of inter-governmental and inter-institutional coordination (between and within states); discontinuity in SAG's investigations; there was no systematic dissemination of GAS' information to SAG's users and society in general. This reasons explain why the causal factor "domestic political actors" interested in changing the *status quo* has not been strong enough to achieve, first, a strict regulation of the aquifer and, second, its implementation.

When we observe domestic politics, legal and institutional organization within each state, some elements can help us understand the difficulties that arise when advancing transboundary cooperation in this matter. First, Paraguay and Brazil delayed the Guarani Aquifer Agreement's ratification. In Paraguay, the political crisis, government change, and the subsequent suspension of this country from MERCOSUR have influenced the ratification procedure. Changes in Brazil's political interests where water did not have a priority can explain Brazil's delay. Second, Argentina, Brazil, and Paraguay still have pending issues regulating their water resources and a wide dispersion of entities and laws. These deficiencies make more difficult the possibility of achieving coordination in managing shared resources at the regional level.

In sum, in this case study, we can asseverate that the changing and fluctuating predisposition of domestic political actors to cooperate and regulate the aquifer impacts the final outcome. Unlike the Genevese Aquifer, the GAA is not a management agreement. It has a lax disposition and obliges states to manage their waters following

the rules of international freshwater law. Moreover, completing the pending tasks to the effective implementation of the agreement requires all parties' goodwill and a common budget. And there is no evidence to indicate that this will happen in the short term, especially in the present context where countries have had to concentrate all their efforts in the health area to facing the pandemic.

Regarding aquifers shared by Bolivia and Chile (Ollagüe-Pastos Grandes and Ascotán), all evidence gathered indicates a very low predisposition of domestic political actors to modify the *status quo* and advance in the regulation of these shared resources.

Both in the documents relating to the moments of rapprochement and cooperation that existed between the countries when they tried to reach an agreement to regulate the waters of the Silala (surface and groundwater) and in the interviews carried out, what is observed is a constant mutual distrust that marks the bilateral relation. Bolivia's political instability and how this country has used maritime demand as a negotiating tool have also prevented significant progress in building mutual trust.

In addition, when we examine the legal and institutional framework in both states, we can see that water resources have not occupied a priority place on the political agenda of either country. Bolivia still has deficiencies regarding the management and administration of its hydric resources. The insufficient policies and weak regulatory legal framework are reflected in failures to achieve an integrated management of water resources. This deficiency directly impacts its ability to establish a cooperative agreement with other states. If there are no clear internal rules for the management and administration of these resources and the management authority is dispersed, it is difficult to reach a cooperative agreement for transboundary groundwater administration.

The same happens in Chile, institutional dispersion in decision-making, legal deficiencies, non-integrated management of water resources; the lack of adequate infrastructure; lack of information about national water resources; and finally the availability and limited use of data for decision making impact in its availability to arrive in cooperative agreements with other countries.

Although at the discursive level, the states show an interest in advancing in aspects related to water regulation, in practice, this does not translate into executive decisions or in concrete projects or investment funds that have this purpose.

Status Quo stakeholders (against regulation)

The last –but not least important- causal factor is the role of the *status quo* stakeholders. This category includes all actors that use or exploit the aquifer for developing an economic or financial activity, which has a significant impact on the national or local economy: national and multinational enterprises like mining companies, hotels, and tourism (thermal recreation), bottled water enterprises, hydropower companies; etc. This economic power allows them to influence directly the decision-making process in a political unit (national or subnational government). Some of them could be empowered and forming lobbies to act and look for their collective interests. They are heterogeneous actors that attempt to maximize their private net gains. They would be expected to act against an aquifer's regulation or making the regulation more flexible: no regulation or lax regulation.

The role and capacity for action of these actors will be strongly linked to the interest and involvement of national political actors within the context defined by the legal and institutional framework of the states involved. Their presence and participation in the political decision-making process is a necessary but not sufficient condition to explain the failure in regulating groundwater resources.

We could observe significant differences regarding their participation and role in the cases studies addressed in this thesis. In the Genevese Aquifer, the actors involved in groundwater extractions were drinking water distribution companies –especially the Société des Eaux de l'Arve, and Services Industriels de Genève-, and some syndicates and communities that exploited the five wells located on French regions.

From the beginning, when the levels of the ugroundwater tables began to fall and the possible depletion of the resource was alerted, the economic stakeholders acted

jointly with domestic political actors to investigate and seek a solution to the problem. Therefore, there was an alignment of interests between the economic stakeholders and the decision makers. They both needed a solution that would have the least political and economic impact. Despite the ups and downs observed on the French side, the French counterparts finally agreed on the political and economic convenience of reaching an agreement to establish an artificial aquifer recharge plant and to jointly manage the aquifer.

Accordingly, once having sufficient knowledge about the aquifer, the risks associated with its exploitation, and the available alternatives, it was the absence of *status quo* stakeholders what influence the outcome. Indeed, the recognition of existing mutual interests and the consequent alignment of the economic stakeholders with the strategy of the domestic political actors (worried about managing and regulating the use of those resources) can explain the outcome in the Genevese Aquifer: a rigorous regulation.

In the Guarani Aquifer case, information collected in the interviews and official and public documents evidences the active role of *status quo* stakeholders in transboundary cooperation. Many actors were identified: thermal recreation centers, the bottled water industry, the industry of alternative hydrocarbons as shale gas and shale oil.

Thermal tourism is the principal economic activity regarding the waters of the GAS in Argentina and Uruguay. It gave a big impulse to local and regional economy in the last twenty years. For that reason, entrepreneurs of this area could be considered as economic *status quo* stakeholders. During the interview to a manager in a thermal center, it was evident the capacity that thermal managers have to influence decisions and legislative proposals (at provincial level) relative to water management. In this way, they indirectly affect national and transnational regulation because, as was explained before, the scarce regulation and lack of coordination between national and provincial legislation finally affect the effective implementation of the commitment assumed by the

country to comply with the Action Plan of the GASP, and, later, with the GAA's provisions.

In the case of water bottlers, foreign multinationals are acquiring large areas of territory including hydrographic systems. In this sense, the Guaraní aquifer is the main attraction. National and foreign companies benefit from the inefficient or lax regulation and inspection that exist regarding the exploitation and management of water. These companies have even reached agreements with local or regional governments to obtain benefits in the extraction and commercialization of aquifer's resources at a very low cost. The case of water bottlers in Paraguay is a clear example. They have common interests with the same parliamentarians who delayed ratification of the GAA.

On the subject of alternative hydrocarbons, four countries that share the Guaraní aquifer have developed initiatives related to the exploration of unconventional hydrocarbons. Nevertheless, fracking -as a technic to obtain non-conventional hydrocarbons- generated reactions in different political and social contexts for the risks it involves specifically because of the Guarani Aquifer pollution's threat. Thus, despite the economic importance of these resources for the economy, actors involved in their extraction did not intervene in Guarani Aquifer's regulation. Conversely, the presence of domestic political (and social) actors interested in changing the *status quo* made it possible to regulate and restrict the fracking methodology for their extraction.

Then, the evidence obtained in the Guarani Aquifer case study confirms the effect of the role of *status quo* stakeholders as a necessary causal factor that helps to explain the outcome: transboundary groundwater regulation.

According to the hypothesis proposed in this thesis, we can settle that -having sufficient knowledge about the aquifer-, in the presence of *status quo* stakeholders with economic power, and domestic political actors with instable interest in changing the status quo regarding the regulation of groundwater's use and management, the outcome is lax regulation of these resources.

Regarding the third case study, the aquifers shared by Chile and Bolivia, evidence obtained shown the presence and participation of economic *status quo*

stakeholders, mainly mining companies, during the bilateral meetings held to address the Silala's waters issue.

Specifically in this case, the link between domestic politics and economic stakeholders is highlighted. Deficits and dispersion in legal and institutional framework in both countries was used for certain economic actors who knew how to benefit and empower themselves. In Chile, the liberalization of the water market during the 1980s (after the enactment of the current Water Code) paved the way for many investors, agricultural and mining companies, among others, to acquire water use rights.

In the North of Chile, mining companies are the principal owners of those water rights. During the last years, the water scarcity situation, the high demand for water for mining production processes, together with the limitation to obtain new water rights in restriction or prohibition zones, has led many of these mining companies to seek other sources of this resource. As consequence, since 1997, these companies (Chilean and foreign) have shown a constant interest in negotiating water purchases with Potosí. These actors, together with some political representatives, considered that diplomatic meetings and working groups slowed down and were even an impediment to achieving a water purchase business with Bolivia.

Those status quo stakeholders have also had active participation in domestic politics. They have acted against Chilean Water Code reforms. They would be greatly harmed if the current Water Code is modified because it allows them to obtain almost unconditionally the rights to use water and obtain revenues in the Chilean water market. In the lobby that acted against the Water Code's reforms within Parliament, it is possible to identify different business sectors, mainly mining, agriculture, and hydroelectric. They have been constituted in powerful status quo stakeholders that have the capacity to influence political decision-making.

In sum, in Chile, a series of factors are combined: few domestic political interests; weak civil society to demand protection of the resource, in part, due to the lack of sufficient information and how the water market has been configured; and there were identified economic interests around the use and purchase of water from Bolivia that

could be intervening diplomatic bilateral negotiations. In Bolivia, for its part, the institutional dispersion in decision-making, legal deficiencies, non-integrated management of water resources; the lack of adequate infrastructure; and insufficient economic and technological capacity to advance information on national water resources influence its availability to arrive in cooperative agreements with other countries.

It was the combination of insufficient knowledge, the fluctuating interests of domestic political actors about regulating groundwater resources, and the active participation of status quo stakeholders in domestic and international politics that explain the outcome in the aquifers shared by Chile and Bolivia: no regulation.

Explaining the outcome

As could be observed throughout the chapters and in the information provided by the case studies, none of these causal factors, taken individually, was sufficient to explain the regulation of groundwater resources and aquifers. However, its presence or absence and the way they are articulated with each other lead us to better understand the final outcome. Something that is logically evident is that in the absence of knowledge about the existence of an aquifer, the possibility of regulating it is nil.

Then, in presence of knowledge, what influence the outcome and the disposition of regulation as a more rigorous or more lax is the articulation between political domestic actors' interests and the presence and real influence exerted by *status quo* stakeholders. My case studies provide evidence of the causal mechanism enunciated in the hypotheses.

In the first case study, the recognition of groundwater degradation problems and the increased understanding of the factors behind hydrogeological conditions, conduit to policy- makers and economic stakeholders involved to look for an optimum solution. This situation aligned French and Geneva stakeholders (specially, water services' companies) and policy-makers' interests to support the artificial recharge alternative and the co-management approach. So, according to the hypothesis proposed here, the presence of domestic political actors prone to change the status quo in aquifer's

management, and the confluence of interests with the stakeholders -together with the knowledge generated-, explains the outcome: a rigorous regulation.

In the Guarani Aquifer case, there is enough -albeit not complete- knowledge. However, the difference in the outcome reflected the unstable and inconstant interest of domestic political actors in advancing a regulation agreement, along with the presence of status quo stakeholders who influence domestic politics and, hence, the success of the transboundary groundwater agreement. The outcome here was lax and not yet wholly implemented regulation.

Finally, the Ollagüe-Pastos Grandes and Ascotán Aquifers located in the border between Chile and Bolivia fail in the first necessary causal factor: there is a rudimentary knowledge about these groundwaters. Then, we observed a low and discontinuous interest in domestic political actors in regulating groundwater resources. But also, as a consequence of the deficient internal regulation and management of groundwaters, there are numerous *status quo* stakeholders involved in political decision-making that influence domestic politics and bilateral relations.

Case study	Knowledge	Domestic Political Actors	Causal mechanism	*Status Quo* Stakeholders
Genevese Aquifer	Sufficient	High interest in cooperate and solving aquifer's depletion	aligned interests	SQ Stakeholders absent. Economic stakeholders interested in cooperation
Guaraní Aquifer	Sufficient but not complete	Unstable and inconstant interest in advancing a regulation agreement	no aligned interests	SQ stakeholders influencing domestic politics and transnational cooperation
Ollagüe-Pastos Grandes and Ascotán Aquifers	Insufficient	Low and discontinuous interest in regulating	no aligned interests	SQ stakeholders influencing domestic politics and transnational cooperation

Table C.1: Summary. Own Elaboration

About the alternative causal factor posited by Elinor Ostrom (1990), information obtained probes that it does not apply in those cases. This argument sustained the problem of resources' regulation is solved with their users' commitment to creating

management rules and institutions and their mutual monitoring regarding that commitment. According to Ostrom, the local appropriators have better information to design the rules of appropriation and provision of CPRs. What guarantees their commitment to these institutions is related to their mutual monitoring of compliance with these rules. Because of its dimensions and the multiple actors involved in groundwater exploitation and use, the Guarani Aquifer presents severe difficulties in verifying this argument. We could only analyze it in the pilot projects implemented during the GASP years. However, its lack of institutionalization and its discontinuity makes us think that there are other motivations behind it.

In the Genevese Aquifer case, as was asserted above, managing the administrative and regulatory aspects of the aquifer at the local level was essential. But here, too, Ostrom's argument is not tested. The mutual monitor system and the compliance with the agreement were reached because of the technology implemented that allowed controlling water extractions on both sides of the border. And, although the users (water distribution companies and syndicates) advanced in alternatives to avoid depletion, it was the states that intervened and carried out the negotiation.

The other alternative explanation is the conflict variable present in Security Studies. Even though there is some literature and evidence showing that conflict does not constitute a driving factor in states behavior and it is not an impediment for transboundary regulation, I have tested it in the case of the aquifers shared between Chile and Bolivia where there is a latent conflict affecting their bilateral relations since 19th Century.

Evidence found here indicates that conflict has some degree of incidence. When Bolivia sets the maritime exit as a condition to advance in other water cooperation issues, then it acts as an immediate impediment to any negotiation. But conflict is not a sufficient factor to explain no regulation outcome. I confirm that other factors, combined with the conflict issue (the claims for a sovereign exit to the Pacific Ocean), can explain the result of cooperation (no regulation). This implies going beyond the security's perspective and understanding the contextual complexity in which these agreements are

circumscribed or how it has not been possible to delineate any regulation. What has the most significant impact are insufficient knowledge about shared groundwaters and aquifers and the little predisposition of domestic political actors, especially of policymakers, to modify the status quo and advance in the regulation of these shared resources.

Concluding thoughts

As has been shown throughout this thesis, despite their importance, groundwaters and aquifers have suffered some legal and political invisibility. In last twenty years, this issue has received more attention in domestic and international scenario, as show the incorporation of water resources and aquifers in "The 2030 Agenda for Sustainable Development" adopted by United Nations General Assembly in 2015. Nevertheless, international groundwater legislation remains a weak and underdeveloped body of law.

When we ask why transboundary aquifers are not regulated, the immediate answer was "because they are unknown"; states do not have enough knowledge. However, these resources have been historically used. Furthermore, some organizations such as the International Groundwater Resources Assessment Centre (IGRAC) or the Internationally Shared Aquifers Resources Management Programme (ISARM) have advanced knowledge about existent transboundary aquifers and compile a world inventory of transboundary aquifers and groundwaters with the information provided by states. Hence, limited or lack of knowledge cannot be the only explicative factor for transboundary aquifers' lack of regulation. For this reason, this thesis provides a logical alternative argumentation that shows how other factors as domestic political actors and *status quo* stakeholders, together with the knowledge considerations, can explain the outcome.

My argument is that there is a higher likelihood of transnational aquifers' regulation if there is sufficient knowledge of the aquifer's characteristics and location, domestic political actors favorable to regulate, and *status quo* stakeholders are absent or

do not influence the decision-making process. The variance or disposition of that regulation (lax or rigorous) depends on the presence of status quo stakeholders with enough economic power acting against regulation and/or the high/low interests of domestic political actors in regulating.

The information obtained during the investigation of the case studies give me enough evidence that probe my general hypothesis: rigorous regulation is the expected outcome when states sharing an international aquifer have enough knowledge about its location and hydrogeological characteristics, there are domestic political actors favorable to regulate aquifer's management, and status quo stakeholders with power to influence policy making (and whose interests are against regulation) are absent.

The way in which these causal factors combine allows us to arrive at a specific result. But what was clear in the final analysis of the case studied is that two of these causal factors are necessary and important to reach the outcome: knowledge and the interest of domestic political actors. If they are absent, there will be no regulation. Many reasons can explain the lack of knowledge about some transboundary aquifers: their location, hydrogeological characteristics, and the lack of necessary technology or economic resources, among others. Other motivations could shape interests in domestic political actors: historical relationships between the countries that share the resources that often transcend water-related considerations; the sovereignty principle over natural resources; intensity and magnitude of the water problems faced by the countries and their societies; narrow interests of the political leaders who are often thinking about electoral results and short-term gains, etc. Later, the presence of *status quo* stakeholders impacts the outcome, especially when domestic political actors do not show interest in regulating these resources, or these interests are inconstant, intermittent.

Finally, I found evidence that sustains the conflict factor in the case of aquifers shared by Chile and Bolivia. The countries of Latin America are not characterized by having a conflictive past, of constant confrontations or mutual distrust as happens in other parts of the world. The exception is the bilateral relation between Chile and Bolivia. The War of the Pacific during the 19th Century has left consequences that affect

the current relationship between these two countries. The sovereign maritime exit to the Pacific Ocean has been a constant claim of Bolivian governments and has been present in every moment of the relationship between these two countries. This claim has made it difficult for Chile and Bolivia to advance in aspects related to the management of shared water resources. This is why I consider that conflict cannot be ruled out and has to be considered, in this particular case, as a contributing factor.

I hope that my findings could be helpful to analyze the other identified transboundary aquifers where states have advanced in cooperation for joint management or, at least, for protection and sustainable use of the shared aquifer. It would be interesting to analyze cases where there is no regulation yet, and states sharing the aquifer have past or present conflicts. These cases could probe how decisive the conflict factor is. My results could also help those thinking of moving towards cooperation and joint management agreement (in those aquifers where there are still no transnational regulations) to consider the importance of the causal factors identified here to achieve a successful agreement.

Appendix: List of Interviews and Meetings

1. Muñoz D'Albora, Adriana, Official, President of the Senate in Chile, remarks made at "Diálogos del Agua", National Congress, Santiago, 7 June 2018.
2. Manganelli, Alberto, Expert, Executive Director of CeReGAS, Geologist, Groundwater Specialist, Montevideo, 9 March 2020.
3. Executive businessman, Thermal Recreational Center, Entre Ríos, 11 March 2020.
4. Paris, Marta, Expert, Geologist, Cycle of online conferences on Integrated Groundwater Management (GIAS), "Tools for the integrated management of groundwater", 14 July 2020.
5. Samaniego, Lucía, Expert, CeReGAS, Cycle of online conferences on Integrated Groundwater Management (GIAS), "Management of transboundary aquifers", 21 July 2020.
6. Sindico, Francesco, Expert, University of Strathclyde, Centre for Environmental Law and Governance, webinar UNESCO-IHP / CEREGAS "Governance of groundwater and Transboundary Aquifers", 14 October 2020.
7. Danielle, Linda, Expert, Geologist, Santiago, Universidad de Chile, 29 October 2020.
8. Tuchjneider, Ofelia, Expert, Geologist, UNL, Latin American representative on the Scientific Board of UNESCO's International Geosciences Program, Santa Fe, 14 December 2020.
9. Villar, Pilar Carolina, Expert, Lawyer, Professor of Environmental and Water Law at Universidade Federal de São Paulo, 17 December 2020.
10. Infante Caffi, María Teresa, Official – Expert, Ambassador of Chile, Co-Agent of the State of Chile in the case Peru v. Chile in the International Court of Justice (ICJ), former Director of DIFROL, 2 April 2021.
11. Estévez Valencia, Carlos, expert, ex-Director in General Directorate of Water, Chile, Santiago, 30 April 2021.
12. Official, Parliamentarian, Paraguay, 7 May 2021.
13. Official, Ministry of Water and Environment, Bolivia, 13 May 2021.
14. Expert, ex- Alternate Representative of Bolivia, 22 May 2021.

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