The Guarani Aquifer System, highly present but not high profile: a hydropolitical analysis of transboundary groundwater governance

Introduction

This article explores the governance of the Guarani Aquifer System (GAS) through the lens of critical hydropolitics and specifically through the framework of hydro-hegemony. This study is important as the GAS, which is one of the first examples of transboundary groundwater cooperation, has been studied through hydrological and geological disciplinary approaches (e.g. OAS, 2009; Hirata et al., 2011; Rabelo and Edson, 2009; Gomez et al., 2010), and recently by international lawyers (Green, 2012; Villar and Ribeiro, 2011; Sindico, 2011; Sindico and Hawkins, 2015; Eckstein, 2014), but hydropolitical analysis around the GAS is still lacking. While a hydrological analysis of the GAS is important, it does not explain the governance and political agreements among the countries. A hydropolitical analysis is important because it allows explanation of cooperation and conflict over shared water resources, including the governance and political agreements among the countries, explaining the power asymmetries between these states. In addition, it allows understanding of the current political context behind the arrangements governing the GAS, and why the 2010 agreement has been signed but it has not been ratified by all parties. In other words, this article is important because it explains the governance of the GAS, unpacking power relations among the countries sharing it. For this reason, this article makes an empirical contribution to the study of transboundary groundwater cooperation, complementing the existing hydrological, geological, and legal studies published on this aquifer.

First, this article presents the literature on groundwater governance and the framework of hydro-hegemony (FHH), which is adopted here as the theoretical framework for analysis of this case. Second, it provides a background of the GAS, discussing the geographical, institutional, historical, context and the importance of Brazil in the region. Then, it uses the GAS as a case study to examine the extent to which a hydropolitical analysis can explain the circumstances guiding cooperation over transboundary groundwater resources. For this purpose, this article analyses the 2010 agreement[1] and the politics surrounding it. Finally, it

[1] Acuerdo Sobre el Acuífero Guarani - the 'Guarani Aquifer Agreement' - was signed in San Juan on 2 August 2010 by Argentina, Brazil, Paraguay and Uruguay, but is not yet in force. This agreement aims to regulate the governance of the GAS and is discussed in detail in the section below.

examines the current governance through the lens of the theoretical framework before summarising the main findings.

This article argues that through critical hydropolitics, and in particular by consideration of the power asymmetries between states and their exploitation potential of groundwater, it is possible to understand the current political context behind the arrangements governing the GAS. However, it also argues that critical hydropolitics fails to explain informal cooperation arrangements, as demonstrated in this article for the case of the GAS.

Groundwater governance and critical hydropolitics

Groundwater governance

Groundwater governance has been defined as "the overarching framework of groundwater use laws, regulations, and customs, as well as the processes of engaging the public sector, the private sector, and civil society" that "shapes how groundwater resources are managed and how aquifers are used" (Megdal, Gerlak, Varady, and Huang, 2014: 2). As noted by Varady et al. (2013), in the case of transboundary groundwater governance, and in addition to legal and cultural limitations, there are also challenges due to the institutional and financial resources required for effective governance of the shared resources. For Rogers and Hall (2003) there is effective governance when institutions are responsive, efficient, and accountable. Linton and Brooks (2011) emphasise that transboundary groundwater governance requires the involvement of both governmental and non-governmental actors, while Mukherji and Shah (2005) and Puri (2001) underline that it is necessary to have transparent and reliable information in order to facilitate wider stakeholder participation. In the case of the GAS, good and effective governance also needs to include informal rules, practices, and institutions (e.g. Blatter & Ingram, 2001; Sehring, 2009) within an interplay between formal and informal actors and institutions on different scales (Lebel, Garden, & Imamura, 2005; Young, 2002). Nevertheless, governance - especially at the transboundary level - is strongly shaped by the most powerful countries and actors involved, as they can exercise their influence to support joint institutions, regulations, and processes, as well as delaying or stopping their creation. For instance, while international water law (IWL) provides objective guiding principles for the governance of transboundary groundwater resources, there is a need to contextualize them within the reality of power asymmetries. Legal norms and provisions in treaty agreements can

be used as leverage in political arguments, and thus powerful states with greater resources can usually more effectively shape hydropolitical dynamics in their favour through the use of legal tools (Farnum, Hawkins and Tamarin, 2017; Stephan, 2011, 2017). As the legal literature on transboundary aquifers and groundwater largely lacks consideration of power asymmetries, gaps remain in understanding the role of power dynamics in decisions regarding water allocation and use among states sharing transboundary aquifers. Hence, elements from theories on critical hydropolitics need to be considered to complement the literature on transboundary groundwater governance.

Framework of hydro-hegemony

Hydropolitics has been defined by Elhance (1999: 3) as "the systematic study of conflict and cooperation between states over water resources that transcend international borders". This definition of hydropolitics is characterised by the study of conflict and cooperation – which is seen as a dichotomy - over transboundary water resources. Instead, critical hydropolitics, a sub-branch of hydropolitics, is a recent body of literature that has been developed within the last decade. It is critical, in the sense that it differs from mainstream hydropolitics. Specifically, this is through the consideration of cooperation and conflict over water as co-existing, and by focusing on the role of power asymmetries by riparian states in order to explain current allocations and institutional arrangements over transboundary water resources. In particular, Zeitoun and Warner (2006) developed the Framework of Hydro-Hegemony (FHH) to explain how control over shared water resources is achieved and maintained. The FHH is based on Lukes' definition of power, which he divides into three dimensions. The framework is based on three pillars: geographical position, exploitation potential, and Lukes' three dimensions of power – hard, bargaining, and ideational power (Zeitoun and Warner, 2006). The authors conclude that consideration of power asymmetries help to explain the allocation of the shared water resources among the riparian countries of a basin. The main weakness of this framework is its focus on states, overlooking the role of non-state actors. The FHH has been also criticised for its conceptualisation of hegemony, which fails to capture the impact of foreign interference and of the international hegemonic discourses like the role of neoliberalism (Davidson-Harden et al., 2007, Kehl, 2015). In addition, the concept of hegemony is not rigorously defined in line with classical international relations tradition (Selby, 2007). Finally, the focus is on nation states and their interactions, overlooking the domestic sphere (Conker, 2014, Selby, 2007).

Building on the FHH, Conker (2014) shows how non-state actors are able to use discursive power to reach their interests and challenge hydro-hegemonic settings (Conker, 2014). Warner and Zawahri (2012) call for moving beyond a state-centric approach, considering tools that non-state-actors deploy to shape the behaviour of the hydro-hegemon riparian states. Cascão (2009) shows that hydro-hegemony is not incontestable, and develops a model for counter-hegemonic processes, analysing how non hydro-hegemonic countries can challenge the status quo and contest hegemonic settings (Cascão, 2009). Daoudy (2009) applies Putnam's theory to show how issue linkages can be utilize to increase bargaining power during negotiations, while Kehl (2015) shows the importance of external actors and alliances to supporting in particular the weaker riparian states (Daoudy, 2009, Kehl, 2015). Daoudy (2008) also contributed to this literature by highlighting the role of IWL in providing more legitimacy and bargaining power to non-hegemonic countries (Daoudy, 2008), while Woodhouse and Zeitoun (2008) call for IWL to include covert hegemonic practices in its principles (Woodhouse and Zeitoun, 2008). Hussein (2016) emphasises the necessity of considering the broader socio-political-economic context to explain outcomes of transboundary water governance. In fact, as summarised by Mirumachi (2015), "the management and governance of shared basins need to contend with factors outside of the 'water box'" (Mirumachi, 2015: 33).

The critical hydropolitics literature has also focused on cooperation and conflict over shared water resources. Zeitoun and Mirumachi (2008) critically examine the role of treaties, which are often seen as a positive example of cooperation. They argue that cooperation is not always good, as treaties can codify an existing asymmetrical status quo, and treaties can also become the subject of the conflict. Zeitoun and Mirumachi (2008) develop the Transboundary Water Interaction Nexus (TWINS) matrix to analyse the nature of conflict and cooperation between riparian states over shared water (Zeitoun and Mirumachi, 2008). In this way, they go beyond the idea of a continuum of conflict or cooperation, emphasising the co-existence of conflict and cooperation. Nevertheless, their attempt to go beyond the continuum leads the authors to rely heavily on the FHH, which is seen by Chokkakula (2017:187) as "limiting, especially for engaging with the 'power-laden' political ecologies and the spatiality of power in transboundary water sharing [..]. Similarly, the spatial nature of power can be complex in its ways of working, and cannot be simply attributed to riparian positions of nations, as is provided by the FHH".

Zeitoun et al. (2016) build on the FHH and integrate theories about change and counter-hegemony. They found that both compliance and contest elements lie within transboundary water interactions (Zeitoun et al., 2016). They emphasise the effects of a non-hegemon's consent to an arrangement, and underlines that the seeds for change might lie there. The framework also stresses the necessity to contextualise transboundary water interactions within the broader socio-political processes. Finally, Menga (2016) presents the Circle of Hydro-Hegemony, an analytical framework that places the concept of hegemony at the centre of its structure, illustrating how various forms of power are connective in the function of hegemony (Menga, 2016).

The FHH has been developed and applied mainly to surface water resources, for instance in the cases of the Nile Basin (Cascão, 2009), in Central Asia (Menga and Mirumachi, 2016), on the Yarmouk River (Hussein and Grandi, 2015; 2017), on the Jordan River (Zeitoun et al., 2013), and on the Tigris and Euphrates Rivers (Conker, 2014). In these cases, the geographical position and power asymmetries played a major role within the framework. One of the few instances of deployment of this framework for transboundary water management of groundwater resources is the study of groundwater resources in Palestine and Israel (Zeitoun, 2008, 2007; Messerschmid, 2007). This study adopts the FHH, using the GAS as a case study to examine to what extent it can explain cooperation on transboundary groundwater governance. The FHH is useful for this analysis as it contributes to understanding the power relations around the GAS Agreement. In addition, this article shows how the GAS case can contribute to further improving the FHH.

Context of the Guarani Aquifer System

Currently, the Guarani Aquifer System (GAS) is shared by four countries: Argentina, Brazil, Paraguay, and Uruguay. Brazil claims the largest area of the aquifer, followed by Argentina, Paraguay, and finally Uruguay.[2] 66% of the GAS's water resources are used for municipal

[2] More specifically, the GAS is situated 1,087,879 km^2 in the Southern Cone area in South America (Brzezinski and Navarro, 2010) and it extends for about 840,000 km^2 in Brazil, 225,500 km^2 in Argentina, 71,700 km^2 in Paraguay and 58,500 km^2 in Uruguay (OAS, 2009; Flor et al., 2004; De Chazournes, Leb and Tignino, 2013: 197). The total reserve of the GAS is of more than 30 trillion cubic meters of water (OAS, 2009; Cox, Olson and Taffesse, 2009).

water supply, 5% for irrigation, 16% for industrial uses, and 13% for thermal tourism (OAS, 2009; Menani, 2012).

History of cooperation over the Guarani Aquifer System

The role of the epistemic community, meaning researchers and academics from the four countries, was key in advancing the knowledge about the characteristics of the Guarani (OAS, 2009; Villar, 2016; Walter, 2015). An epistemic community is a group of professionals that are experts and particularly knowledgeable in a specific issue or topic. Epistemic communities contribute to policy-making by providing and informing policy-makers with specific data and knowledge about an issue. It has been argued "that epistemic communities help to explain the emergence and character of cooperation at the international level" (Thomas, 1997: 223).

Only a few decades ago, scholars and experts came to the conclusion that the Guarani groundwater resources are part of an aquifer system (Walter, 2015). Beforehand, the four countries were managing the groundwater resources believing they were not part of a bigger transboundary system, but seeing them as entirely within their own respective territories. Since then, the approach to managing the Guarani resources has shifted, considering them as part of a shared water resources system and therefore treating it as a transboundary groundwater system (Walter, 2015: 23). As noted by Villar (2016), this is because of the work of the epistemic community. Scholars have worked together exploring and increasing the knowledge about the aquifer, supporting scientific cooperation and resulting in understanding that the aquifers belonged to a unified system of groundwater resources (Villar, 2016; Villar and Ribeiro, 2011). In the 1990s, after agreement in the scientific community regarding the transboundary nature of the Guarani aquifer, the need for shared monitoring and cooperation mechanism for the protection of the shared aquifer emerged, as well as a shared name: the Guarani Aquifer System (ibid.). As Walter (2015: 23) highlights, the idea of a regional aquifer also meant that local challenges were to be seen and situated within a regional context, therefore becoming regional challenges. It also resulted in more allocation of resources to the management and governance of the regional aquifer (ibid.). As noted by Walter (2015), these transboundary initiatives were also boosted by the need to protect the shared aquifer system. In fact, its water resources were utilised for several economic activities, from the supply of freshwater for municipal and household uses in southern Brazil, to irrigation in Paraguay, as well for thermal tourism operations in Argentina and Uruguay. As a consequence of these

uses, the quality and quantity of the GAS gradually deteriorated, calling for prompt regional measures (OAS, 2009; Walter, 2015: 23).

The academic and scientific efforts resulted in involving and attracting the attention of relevant international and regional organisations, such as the MERCOSUR and PARLASUR, which supported regional cooperation (OAS, 2009; Villar, 2016; Villar and Ribeiro, 2011; Gómez-Mera, 2013). With the support of international organizations like the Global Environmental Facility, the Organization of American States, and the World Bank, the four countries initiated the Environmental Protection and Sustainable Development of the GAS Project in 2000 (Patole, 2015). The goal of the GAS project was to conduct a study of the shared aquifer and to provide recommendations for its long-term management (World Bank, 2002). The GAS Project operated from 2003 till 2009. Among its main achievements were four pilot projects of bilateral commissions at the local level for the monitoring, exchange of data, and promotion of joint projects. Among those, the bi-national Argentinian-Uruguayan Salto/Concordia Commission on the GAS is one of the few examples worldwide where the transboundary aspects of groundwater governance are dealt with by two cities through an ad-hoc institution. The commission has so far worked mainly on monitoring the aquifer and collecting data. The commission is still functional beyond its funding-term as part of the GAS project that ended in 2009, and works as an informal institution promoting transboundary groundwater cooperation between the two communities. As noted by Patole (2015), when the project ended, it did not reach its goal for a framework regarding institutional, technical, legal settings for the GAS. Nevertheless, the GAS project had the benefit of building dialogue among the four countries and initiating transboundary cooperation. In fact, current arrangements of governance for the aquifer system include the Guarani Aquifer Agreement, which was signed in 2010 by the governments of Uruguay, Argentina, Paraguay, and Brazil, but is not yet in force as it has been ratified only by Argentina and Uruguay. Overall, the GAS project pushed forward this regional cooperation, especially in regard to technical studies and data exchange, building partnerships in the four pilot projects of bilateral commissions at the local level, and successfully raising awareness about issues and challenges around the management of the shared groundwater resources (OAS, 2009; Walter, 2010).

The powerful role of Brazil in the region

The following section provides an incomplete mention of the importance of Brazil among the four countries sharing the aquifer. Among these four countries, Brazil is the most powerful. Brazil is clearly the largest and most powerful country in South America, largely due to its natural resources, economic growth, military power, and economic-political alliances (Kelly, 2010: 48). Relations between Brazil and Uruguay are solid, the trade relations are strong, and their border is also known as the "peaceful frontier" (interview 1).[3] There are close relations between Brazil and Uruguay in several sectors, including trade, local commissions for cooperation on sanitation, and special agreements. Relations have been consolidated in the past years because of the periods of ruling governments with similar ideological values. Uruguay is clearly less powerful than Argentina and Brazil, and has always played the role of the 'buffer' between Brazil and Argentina. Despite Uruguay's small power and size, it performs better than its larger neighbours in terms of social concerns, corruption, and stability (Buquet and Piñeiro, 2014). Uruguay has good bilateral relations with both of its larger neighbours (Kelly, 2010). Paraguay is the least powerful of the four countries, and its "relative weakness and small size distinguish its regional standing" (Kelly, 2010: 63). Paraguay is rich of hydropower, and this supports the regional economic integration with its neighbouring countries. However, its landlocked position "encourages the country's subordinate status with regard to Brazil and Argentina, which provide Paraguay sea access" (Kelly, 2010: 63). "The country enjoys neither protection nor autonomy from Brazil […] rather, it endures persistent outside interference. Its primary wealth, from agriculture and hydroelectric power, is […] increasingly dominated by Brazil, in particular […]. Apparently, Paraguay's diplomatic balancing of its two large neighbours, so long utilized for security, has become less effective because of Brazil's recent surge to Southern Cone supremacy and its promotion of regional integration" (Kelly, 2010: 64). Brazilian farmers are increasingly buying and owning extensive Paraguayan farmed territory – especially since the 1960s in the Eastern region of Paraguay (Nickson, 1981) - and Paraguay is increasingly influenced by Brazilian politics (Galeano, 2012). Paraguay is also a close ally of the United States, and allows the US to realize military trainings in Paraguayan bases temporarily ceded to host US operations, in particular over the recharge area of the aquifer (Kelly, 2010).[4] Finally,

[3] Interview with an academic in social sciences in Uruguay that took place on the 27th of February 2016

[4] These operations have intensified in 2005 and 2006 by joint US and Paraguayan troops. These operations were based at Mariscal Estigarribia, at Paraguayan north province of Boquerón.

Argentina lost power in the region in the past decade due to the economic crisis and its economic protectionist policies. Nevertheless, it remains the most powerful geopolitical actor in the region after Brazil (Nolte and Wehner, 2015; Kelly, 2010) (interview 1). Hence, Brazil emerges as the most powerful country in the region for its economic, military, and political power.

The 2010 Guarani Aquifer System Agreement

This article uses the GAS as a case study to examine the extent to which a hydropolitical analysis can explain cooperation over the transboundary groundwater resources. For this reason, this section examines the 2010 GAS agreement. As noted by several scholars, the agreement follows principles of IWL (Villar, 2016; Sindico and Hawkins, 2015; Patole, 2015). As highlighted by Villar and Ribeiro (2014), the agreement incorporates the principles of the Draft Aquifer Articles: sovereignty, the equitable and reasonable use of water resources, the obligation not to cause significant harm, cooperation, and the exchange of data and information. The agreement aims at reducing asymmetric information on the GAS (Cassuto and Sampaio, 2013: 31), envisions a regional commission with set functions and powers (Villar and Ribeiro, 2011). In essence the agreement, once ratified, would allow a better operationalization of the commission and its structures and functions, making transboundary groundwater cooperation effective at a regional level.

As noted by Sindico and Hawkins (2015: 324), the GAS 2010 agreement is "a flexible framework for cooperation," "very general," and "a starting point." These qualities ensure that state sovereignty is not challenged. Villar (2016: 17) also emphasises that according to the 2010 agreement, "it is up to the States to deepen cooperation and to create proper arrangements and institutions to transboundary aquifers." For example, this aspect emerges when it comes to dispute settlements mechanisms. That is, the agreement has no clear measures, but it defers this decision to the commission that will be created by the agreement. Nevertheless, in the 2005 draft agreement, a provision defining the dispute settlement mechanism and an annex existed detailing how arbitration would function, but it was deleted in the 2010 final agreement (Sindico and Hawkins, 2015: 325). With the deletion of this clause and annex, the four governments reached consensus on the 2010 draft of the agreement, which was signed (ibid.).

Nevertheless, the GAS agreement has not yet entered into force, as only the Argentinian and Uruguayan governments have ratified it.[5] From a technical perspective, the agreement has been approved; what is missing is the political approval from Brazil and Paraguay through their ratification of the agreement. Concerning Brazil, it could be argued that the Brazilian government perceives that the agreement might undermine the status quo, current uses, and Brazilian sovereignty on the GAS that is within Brazilian territory, and therefore is not ratifying the agreement. Concerning the status quo, the Brazilian state of São Paulo – the most populous state in the country - and the city of Riberão Preto heavily rely on the GAS for municipal and domestic water supply (Dettoni, 2013).[6] The high reliance on the GAS especially for São Paulo and "a desire to secure more favourable terms than those outlined in the current version of the agreement" may be the main reason why Brazil has not ratified the agreement yet (Kruskal, 2016: 1). In addition, the two-year drought that impacted[7] Brazil in 2014-2016, resulting in water supply restrictions in the state of São Paulo, further reinforced Brazil's position of trying to secure more favourable terms of the agreement (Stauffer, 2016). In fact, more than 70% of the aquifer is located beneath Brazil, and 94% of the GAS extractions take place in Brazil (Kruskal, 2016). Nevertheless, the GAS occupies less than 10% of Brazil's territory, while 25% of the Uruguayan territory is above the GAS, and Uruguay consumes less than 5% of Brazil's consumption of the GAS (ibid.). It emerges therefore why Uruguay had an interest in promoting the agreement, while Brazil is wavier in moving forward with it as it does not have an interest in changing the status quo, its heavy reliance on the GAS, aiming at preserving its "unfettered access to the shared resource" (Kruskal, 2016: 1). Instead, Paraguay rejected the agreement for fears of undermining its national sovereignty (Arsenault, 2016), while it could be argued that the interest of Paraguay is its plan to exploit the GAS to promote economic growth, especially given its poor

[5] From a legal perspective, as noted by Withanachchi (2012), one major challenge in the transboundary water governance of the GAS has been the different power structures within the countries responsible and involved in regional governance mechanisms. Foster et al. (2009) noted that in Paraguay and Uruguay, water resources are completely within the national government jurisdiction. Therefore, in the cases of Paraguay and Uruguay, the national governments are responsible for policies and management concerning the GAS (Foster et al., 2009). Instead, in the case of Argentina and Brazil, competency for water resources relies within the local authorities, meaning provinces and federal states. Foster et al. (2009) noted that in Argentina and Brazil, the decentralisation of responsibilities concerning water resources represents an issue of governance when it comes to management of the shared water resources. In the case of Brazil, Cassuto and Sampaio (2013) emphasize the Brazilian legal system's complexity when it comes to the hierarchy of competencies on groundwater resources (Cassuto and Sampaio, 2013). Brzezinski and Navarro (2010) highlighted that it is in line with Federal Law that the National Water Resources Management System defines criteria of utilization as belonging to multiple uses and users, meaning local communities, government, and stakeholders.

[6] More technical studies to understand the long-term implications of these uses on the quality and quantity of the GAS would be needed.

[7] Droughts may impact the height of the aquifers; in fact, if an aquifer is upmped faster than its recharge – by precipitation or other groundwater flow – then the water levels may be lowered (Alsharifa et al., 2018).

economic growth compared to the other three countries in terms of GDP (Kruskal, 2016: 1). It could be argued that Brazil and Paraguay could have simply decided not to sign the agreement in 2010 if they were against it. The fact that Brazil and Paraguay have signed the agreement, even though they have not yet ratified it, could be interpreted in two ways. The first is that they preferred to be at the table in negotiations in order to negotiate a favourable agreement, resulting in a general and flexible agreement, rather than the alternative of being denied the opportunity to steer the negotiations on their terms. At the same time, after negotiating and signing the agreement, they could be using strategies to delay its implementation by not ratifying it or delaying its ratification, as Egypt did in the case of the Nile Cooperative Framework Agreement. The other possibility is that Brazil decided to sign the agreement, but has not yet managed to ratify the agreement, as it is not a priority for the political agenda of the Brazilian parliament and government. Nevertheless, officially, the issue of sovereignty was also the main reason for the rejection of the agreement in 2012 by the lower house of the Paraguayan legislature (Dettoni, 2013; Arsenault, 2016). Similarly in the Nile Basin, Egypt, which was the hydro-hegemon and has historically been the largest user of the water resources of the basin, has opposed a Nile Cooperative Framework Agreement as it was felt it could undermine Egypt's existing and historical uses and rights on the Nile River (Mekonnen, 2010).

Nevertheless, as noted by Villar (2016), although the agreement has not been ratified, positive outcomes so far have included the creation of the Regional Centre for Groundwater Management for Latin American and the Caribbean (CeReGAS) in Montevideo, Uruguay, in partnership with UNESCO-IHP, which aims to promote cooperation over transboundary groundwater resources in the region (OAS, 2009).

Discussion

The FHH is useful for understanding the dynamics surrounding the GAS case as it captures the power asymmetries at play during the signing of the GAS agreement. It emerges that Brazil, the most powerful state in the region, has played an important role in increasing formal cooperative relations over the shared aquifer. In fact, the agreement was signed after renegotiation and the decision to remove the clause concerning disputes settlements mechanisms, which Brazil strongly opposed (Sindico and Hawkins, 2015)(interview 1). In this instance, the Brazilian government deployed bargaining power in order to reach a more

favourable outcome that would not undermine Brazilian sovereignty. In case of disagreement on the implementation of the agreement, it is the non-powerful countries or non-hydro-hegemon that would likely seek support and benefit from dispute settlements mechanisms and arbitration details. In absence of such details, the powerful country or hydro-hegemon, Brazil, would be the state that would benefit the most, as power asymmetries would often determine the outcome of the resolution of the dispute. The same applies to the existence or lack of an agreement. If there is no agreement on shared water resources, then the status quo usually reflects allocations in line with power asymmetries in the region, benefiting the powerful and hydro-hegemon states. For this reason, it is unsurprising that Brazil pushed for the clause on dispute settlements to be removed, and is now delaying the introduction of the agreement into force by postponing its ratification. Thus, the FHH reveals power asymmetries to be a key factor regarding the current arrangements and dynamics around the dispute settlement clause. That is, Brazil deployed bargaining power through tactics and strategies to delay negotiations, pushing for a general and flexible agreement which preserves the status quo and current power relations. Nevertheless, it has to be noted that Brazil is a vast country, water scarcity is not perceived nationally as an urgent threat, and therefore the GAS is highly present but not high profile in the political agenda. Therefore, it could be argued that this was the reason why the agreement has not yet been ratified. In this context, it is actually notable that the four countries – including Brazil – decided to sit down and engage in dialogue, building a common vision and strategy on the future management of the GAS in the absence of water conflict or water scarcity (Villar and Ribeiro, 2014).

In other transboundary water resource systems, the hydro-hegemon used bargaining power to either delete clauses during negotiations for a regional and basin wide agreement, or to push for dispute settlements mechanisms not involving third parties. By eliminating dispute settlement provisions, the result is advantageous for the most powerful country in the basin. In the case of the Nile Basin Cooperative Framework Agreement, a similar situation emerged during the negotiations when the former hydro-hegemonic riparian country (Sandstrom, Jagerskog and Oestigaard, 2016) – Egypt – deployed bargaining power to try to delete Article 14(b) concerning water security (Mekonnen, 2010). In the case of the Yarmouk River Basin, a 1987 renegotiation of the existing 1953 Jordanian-Syrian agreement changed the dispute resolution approach to inter-governmental that is not subjected to third-party arbitration as it was in the 1953 agreement. This worked to Syria's advantage – Syria being the hydro-hegemon (Hussein, 2016; Hussein and Grandi, 2015; 2017; Hussein, 2017c; 2018).

The GAS case shows also that the exploitation potential pillar in the FHH emerges to be important when considering deep aquifers. As Farnum, Hawkins and Tamarin (2017: 308) note, exploitation potential over transboundary aquifers is a strong determining factor for a country's hegemonic position showing that there are "material power differences that arise between various catchment types". In the case of the GAS, which reaches a depth of over 1,000 meters in regions like Salto/Concordia, having the possibility to identify the groundwater resources, dig a well, and pump the groundwater in order to exploit it, is central to explaining outcomes of water allocation. In fact, in the area of the city of Riberão Preto in Brazil, the aquifer is shallow and therefore Brazil has the capabilities to extract groundwater resources (Walter, 2010). Instead, in the cities of Salto and Concordia, in Uruguay and Argentina, the aquifer is in average more than 200 meters depth. For this reason, in the latter case it is more complex to extract and use the groundwater resources, as perforation techniques can be expensive and unavailable (Walter, 2010). In this context, the country that has the capabilities for exploiting the aquifer and that is the most powerful one is the one that would benefit from the status quo and therefore from a weak agreement or from not having an agreement. This aspect of the FHH is particularly interesting when it comes to groundwater resources, as exploitation potential also requires information and data, for instance on the depth of the aquifer in the different areas. When it comes to surface water, exploitation potential hinges more on the size of the population and the engineering capabilities of a state of developing and using the water resources, for which data are easily obtainable. Therefore, the requirement of obtaining data on the aquifer as well as having the technological capabilities for extracting the water resources is unique to groundwater resources, and is a theoretical contribution to the FHH.

Also, this article and the case of the GAS contribute towards developing the FHH by considering local scales when it comes to transboundary aquifers. In fact, another important finding is that, when it comes to transboundary aquifers - compared to transboundary surface water governance – the local scale is to some extent, more important than the national scale. As seen in the GAS case, water is mainly consumed at the local level, especially at the community and municipality levels through decentralised frameworks. Hence, cooperation between the four countries is particularly active through these local municipalities, and less by the central states. In fact, this emerges by the four pilot studies envisioned as part of the GAS project. Kettelhut (2013: 114) explains that these four pilot projects were strongly supported

by all stakeholders from these municipalities and there was large social participation in supporting and developing the projects. The goal of the four pilot projects – promoted through GEF-Project Local Facilitaros, was at identifying local agreements and actions on local priorities and problems linked to the GAS management and its protection. Two of the four projects were transboundary and relating to current and projected uses – Concordia (Argentina) / Salto (Uruguay) and Rivera (Uruguay) / Santana do Livramento (Brazil) –, the third, Encarnación – Cuidad del Este – Caaguazú (Paraguay), was about acquiring data and further information about the aquifer, and the fourth, and Ribeirão Preto (Brazil), focused on a heavily urbanised area (OAS, 2009; Villar and Ribeiro, 2011). In this city, in a municipality of about 650,000 residents, all the domestic water supply comes from the GAS. In addition, the Ribeirão Preto area is one of major agricultural production, producing mainly sugarcane for alcohol distillation, coffee and oranges (for fruit juice production). In addition, Ribeirão Preto has important industries of fuel-alcohol distilling, agro-industrial products and services, and manufacturing enterprises. Uncertainty on the abstractions from the GAS have pushed the local municipality to support the project, given the importance of the GAS for the whole community. In addition, side effects of the over-abstraction have resulted in the past decades in: "increases in operational water-supply costs, due to falling water level and decreasing well efficiency with loss of upper well-screen sections; loss of groundwater confinement in some boreholes; previously effluent watercourses becoming influent and increasing groundwater pollution risks" (Foster et al., 2006: 11). Hence, a stronger support from boh the general public, the industrial and agricultural sector, to the GAS project initiative. For instance, local initiatives supporting the pilot project included the Comitê da Bacia Hidrográfica do Pardo (CBHP), which is promoting action to constrain water demand in the urban population; and the Instituto Geologico de Sao Paulo (IGSP), which has conducted aquifer vulnerability mapping, groundwater pollution risk assessment and source protection zone definition (ibid: 12). The over-abstraction of the GAS in this area – while only a few kilometres away there is availability of surface water resources – shows the necessity, according to Kettelhut (2013: 114), of further integrated water resources management. Nevertheless, given the importance of the GAS for the residents of Ribeirão Preto, the whole municipality, including the private sector, the local municipal council and assembly, and environmental associations, were supportive in the different stages of the pilot project (ibid). The case of the towns of Rivera and Santana do Livramento have been experiencing transboundary cooperation in different sectors, for instance they have a single continuous urban area with common electricity supply system, emergency services and freedom of movement. Agriculture and forestry are key

sectors for these communities. In order to promote the pilot project, a Comisión Transfronteriza del Acuífero Guaraní (COTRAGUA) has been established, and it includes representatives of 5 local stakeholder organizations on each side. These stakeholders include the local government offices, the corresponding water utilities (OSE and DAE), water well drillers, NGOs, agricultural, hydrological and public health organizations. The aims of this commission are to: "assist in the collation of relevant technical, economic and legal materials, and in the dissemination of information to the community; focal point for required social surveys and promotion of community participation in groundwater global water partnership associate program management decision-making, including denouncing illegal well construction and polluting discharges; coordinate local efforts for capacity building amongst stakeholders" (Foster et al., 2006: 15). The Salto/Concordia case, briefly seen above, focuses on the thermal spas and the thermal tourism in the two cities. The "spas do not have adequate water demand and use management, and there is a communal need to develop and disseminate more efficient geothermal water-use practices, including water recycling for the cultivation of exotic gardens, space-heating of hotel installations and greenhouses, and fish farming, with safe discharge of effluents (especially if their salinity is elevated), and to combine this resource as appropriate with shallow groundwater for 'non-spa uses'" (Foster et al., 2006: 17). To support the pilot project, a local committee was established, the Comité Local de Apoyo al SAG – Proyecto Piloto Concordia/Salto, including representatives from the two sides from local government and municipalities, provincial and federal water agencies, universities and geothermal water users associations. The aims of this committee were to: "assist in the collation of relevant technical, economic and legal materials, and in the dissemination of information to the community; focal point for required social surveys and promotion of community participation in groundwater management decision-making, including denouncing illegal well construction; coordinate local efforts for capacity building amongst stakeholders" (Foster et al., 2006: 17). Finally, the Itapua case in Paraguay, had as its main focus land-use planning, agricultural production, and management of water resources at the regional level. The goals of this case study were to: "review the socio-economic and agricultural evolution of the area since 1960, including the mapping of the changes in land-use and agricultural cropping; […] classify the more heavily applied pesticides on the basis of their water solubility and soil mobility; […] establish a network of relatively shallow groundwater monitoring piezometers and wells; […] establish the hydrogeologic and socio-economic potential of the [GAS] to support supplementary agricultural irrigation as an insurance against crop yield reductions associated with droughts even of short duration, especially in the soya-

bean cultivation cycle; a critical evaluation of the procedures used to develop and protect groundwater sources used for public water-supply and the design and operation of sanitation systems in small rural towns" (Foster et al., 2006: 18-19; OAS, 2009).

Hence, local forms of cooperation are more likely to happen between these municipalities or local communities, even in an informal setting, rather than state-to-state formal cooperation. In fact, these communities were eager to be involved and to support the pilot projects. This also emerges in the fact that some of these commissions decided to continue informal cooperation and meetings even after the completion of the pilot project, such as in the Concordia/Salto case. This support from local communities and stakeholders to local forms of cooperation is largely due to the fact that groundwater governance is a high priority at the local level and less so for the national governments in the absence of a national water crisis. The localised nature of groundwater use may in part explain why only four agreements on transboundary aquifers have been signed and ratified worldwide in contrast to the 600 identified transboundary aquifers in existence (Hawkins and Martin-Nagle, In Press). An example can be shown through the case of the Disi aquifer case, a resource shared by Jordan and Saudi Arabia. Here, an agreement was signed in 2015[8] when water in Jordan became an issue of national security. While the Disi aquifer is used locally, it is also utilized as a national supply source, whereby its waters are pumped 300 km north to the main cities of the country. Hence, the national government had a strong interest in concluding a treaty on the Disi aquifer. It could therefore be said that cooperation at the national level on transboundary aquifers is more likely to occur when the water of the aquifer is used not only locally, but also to serve big urban areas or influential territories of the country.

Formal cooperation can be difficult to establish among all aquifer-sharing states. Nevertheless, informal cooperation - especially at the local scale and thus not affecting the interests of the most powerful country - is possible and more feasible. It can also be successful for data collection and exchange, as well as for monitoring. As noted by Sindico (2016), cooperative arrangements, both informal and formal, can be established either bilaterally or at the municipality scale. At the local scale, it is easier to establish institutions and cooperative measures for monitoring of the aquifer and projects of water conservation through educational programmes on raising awareness (Sindico, 2016; Maganda, 2005). In fact, at the local scale,

[8] Agreement between the Government of the Hashemite Kingdom of Jordan and the Government of the Kingdom of Saudi Arabia for the Management and Utilization of the Ground Waters in the Al-Sag/ Al-Disi Layer 30 April 2015

the leadership and vision of local individuals is often more important than state interests (Martin-Nagle, 2016). This has also happened at the municipal level along the Jordan River Basin, but as shown in this conflict defined case, it does not necessary result in overcoming power asymmetries and conflicting relations at the state level. Nevertheless, as showed by the Guarani Salto-Concordia Binational Commission, it can have results especially on water conservation and data exchange. In fact, especially concerning water conservation and water awareness raising, even national governments are generally supportive of similar initiatives, which are perceived to be not political but rather technical, and do not challenge the status quo of water uses and allocations. The Guarani Salto-Concordia Binational Commission shows that cooperation at the local level is defined and supported by personalities and the vision of individuals that drive cooperation. While cooperation can be formalised, it can also continue even after official cooperation ends if there is willingness, trust, and drive from the individuals involved in the process. Cooperation at the local level is easier and less complicated to achieve rather than at the national or regional levels since municipalities and communities at the local level are more aware of the challenges and implications of not cooperating. Moreover, they are more likely to understand the relevance of cooperating to solve common issues impacting local communities than the governmental personnel residing in the capitals, which may be far away from the relevant territories where the shared water resources are. This issue of local cooperation – formal or informal – as more relevant and likely to happen in the case of transboundary aquifers is a key contribution of this research. Hence, the FHH needs to go beyond its state-centred approach and, especially in the case of transboundary aquifers, consider the role of local communities and municipalities.

Conclusion

This article applies the FHH to transboundary aquifers, and uses the case study to explain the current arrangements on the GAS. This has built upon on the FHH, highlighting elements that are more relevant when applying this analysis to groundwater rather than surface water resources. This article found that there are several levels of cooperation on the GAS: the formal cooperation among states within the GAS project and the 2010 agreement; and the informal cooperation among the epistemic community and the local communities and cities. This study shows that perhaps a FHH analysis can explain outcomes at the highest level in relation to the international agreement, but other factors can explain local level and informal cooperation, which is also important. In fact, while Brazil played a role in delaying the

agreement, informal cooperation at the local level continues and has not been stopped by Brazil's lack of commitment to the international agreement.

The article also found that in the case of transboundary aquifers, geographical position has a more complex role compared to when the framework is applied to surface water resources. In fact, this is because the elements of the geographical position that need to be considered in the analysis of aquifers are: extension of the aquifer, where the recharge and discharge areas are, quality of the aquifer in the different parts of the GAS, and the depths in the different areas of the aquifer. Power asymmetries are relevant for both surface and groundwater resources. In the case of groundwater resources, availability of data and information about the groundwater resources is key, and is more relevant than in the case of surface water resources as it is more difficult to collect data in the case of groundwater resources. States can use the information they have in order to negotiate more favourable deals and agreements, especially if their counter-part has limited knowledge and data on the shared groundwater resource. Exploitation potential, which is often overlooked in the analysis of surface water resources, is also important in the case of deep aquifers. In terms of groundwater resources, exploitation potential is: the pumping ability, which includes both the economic and the technological capabilities of pumping the water; and the capabilities of making that water usable through any required filtering system that may be required; availability of engineering and engineering systems for building pumping facilities and filtering mechanisms; and population size in order to be able to exploit the extracted water. In particular, technology and economic resources are necessary in order to identify and exploit groundwater resources from deep aquifers, and the resources in order to make the water "usable" need to be considered, and especially in terms of water quality. In fact, if the aquifer's water quality is adequate, the resources needed would be mainly pumping and filtration, while if water quality is poor, exploitation potential in terms of technology and financial resources would be needed to apply more sophisticated processes of water treatment, which are generally much more expensive. Finally, the author argues that an important difference between the nature of surface water and groundwater resources is the local nature of groundwater use in general. Groundwater is often used more by individuals or local service providers than with large state sponsored infrastructure that is usually used with surface water management, making of groundwater resources more of a democratic resource.

Finally, this article also found that transboundary aquifers are more likely to be a priority for cooperation for local communities, as usually they are used at the municipal level. Instead, it is easier to have state-to-state level cooperation when the water is used nationally and in particular to serve the needs of big urban areas or influential regions. In addition, informal cooperation, especially at the local level, is driven through the visions and personal relations of individuals, and it is not usually perceived by the governments as undermining or challenging the national sovereignty. For this reason, as in the case of the GAS, informal cooperation at the local level after the termination of the pilot projects in 2009 initiated with the GAS project. It also revealed the important role that was played by non-state actors, in this case local councils and international organisations, in pushing for transboundary groundwater cooperation and governance. In fact, local councils, academics, and the Global Environmental Facility were the drivers of transboundary cooperation, making the issue of the management of the GAS a matter to be included in national political agendas. Hence, this article has shown that while states determine international cooperation and agreements, informal cooperation at the local level follows a different logic to than put forward in the FHH. However, future research should further investigate the drivers of informal cooperation at the local level.

Overall, this article deployed the FHH to analyse the formal cooperation on the GAS, showing the necessity of including a hydropolitical analysis of the GAS. However, this article has also noted that the GAS agreement has not been ratified by Brazil and Paraguay since it was perceived as undermining their sovereignty. For this reason, how the GAS agreement is perceived by the governments and parliaments of Brazil and Paraguay is important because it determines the agreement's ratification, and accordingly which solutions are opened and institutionalised in the national legal and policy architecture. Future research should build on the latest research on ideational power and discourses (Hussein, 2017a), and should unpack the ideational power dimension of the FHH, in order to identify the discourses and framings of the issue that are informing people's perceptions about the GAS. Future research should focus on how the GAS and GAS agreement are represented by media at the national level in the four countries, and also follow the latest research in critical hydropolitics on how the issue of water is framed by the educational system and textbooks in the four countries (Hussein, 2017b). What are the discourses constructed and reproduced about the GAS agreement, especially in Brazil and Paraguay? How did these discourses develop, by whom, and why? Comparatively, what were the discourses in Argentina and Uruguay, and how did they drive towards the ratification of the GAS agreement? By answering these questions, it will be

possible to better understand the role of discursive power in shaping transboundary water governance in the case of the GAS.

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