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Articles

Hard, Soft & Uncertain: The Guarani Aquifer and the Challenges of Transboundary Groundwater

David N. Cassuto* & Romulo S.R. Sampaio⁺

ABSTRACT

This Article begins with an overview of the ecology of the Guarani Aquifer region before turning to the legal and ecological problems it faces. Because the majority of the Guarani Aquifer underlies Brazil (with the rest residing below Argentina, Paraguay, and Uruguay), the laws and policies of Brazil have a significant managerial impact. Consequently, the Brazilian legal regime forms the focus of the first Part of the Article. The Article then analyzes the international transboundary framework before turning to the recently enacted Agreement on the Guarani Aquifer. This Agreement, signed but not yet ratified by four countries, represents a major step forward in transnational cooperation. However, its language is so broad that it elides some of the principal management challenges facing this and all transboundary aquifers. The Article then looks at the legal and policy issues that local environmental problems and climate change present for the management of the aquifer and recommends a management and dispute resolution strategy based on the notion of “equitable apportionment.”

The complexity and environmental importance of the region, as well as the looming threats presented by climate change, make the need for accurate and detailed scientific and technical information urgent and

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crucial. Yet, relying on such information to manage such a complex natural resource also presents risks. Too often, the role of uncertainty in risk assessment and in legal and managerial decisions gets reduced or ignored.

Lessening uncertainty requires reducing asymmetric information. The recent international agreement regarding the Guarani represents a significant (albeit preliminary) step forward in this regard. Increasing knowledge over the regulated resource demands categorizing “hard” and “soft” uncertainties. In addition, the regulatory framework must acknowledge the unitary nature of the aquifer while yet remaining sensitive to differing national and local priorities. This Article reviews the endogenous and exogenous challenges facing the Guarani Aquifer System. It looks particularly at those within and arising from Brazil. It then offers an international dispute resolution framework, drawn from the United States’ doctrine of equitable apportionment, and offers some proposed amendments to the multilateral agreement for managing the Guarani.

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I. INTRODUCTION

The Guarani Aquifer System (“GAS” or “Guarani”) is a recently discovered, unfathomably large underground water system underlying Brazil, Paraguay, Uruguay, and Argentina.¹ Its proper management, particularly in the coming era of climate change and concomitant water shortages, looms increasingly vital, both to the oversitting nations and to the world at large.² Nevertheless, transboundary groundwater management has received relatively little attention in international law until recently.³ Furthermore, despite the recent publication of Draft Articles on the Management of Transboundary Aquifers by the International Law Committee of the United Nations,⁴ transboundary groundwater law remains very much in flux. In addition, the recently signed agreement (“Acordo”) between the four countries that overlie the Guarani⁵ offers progress but no real solutions to the aquifer’s management dilemmas.

This Article situates the managerial challenges facing the GAS within the larger challenges arising from multilateral and multifarious use regimes as well as by an unstable and rapidly changing environment.

1. The GAS is estimated to contain 37,000 km³ of freshwater. OFFICE FOR SUSTAINABLE DEV. AND ENV’T OF THE ORG. OF AM. STATES, WATER PROJECT SER. NO. 77, GUARANI AQUIFER SYSTEM: ENVIRONMENTAL PROTECTION AND SUSTAINABLE DEVELOPMENT OF THE GUARANI AQUIFER SYSTEM (Oct. 2005), *available at* www.oas.org/dsd/Events/english/Documents/OSDE_7Guarani.pdf. There is about 37,600,000 km³ of freshwater on Earth. *How much water is there on, in, and above Earth?*, U.S. GEOLOGICAL SURV., <http://ga.water.usgs.gov/edu/earthhowmuch.html> (last visited Oct. 19, 2012).

2. David N. Cassuto & Romulo S.R. Sampaio, *Keeping It Legal: Transboundary Management Challenges Facing Brazil and the Guarani*, 36 WATER INT’L 661 (2011) (building upon many ideas first laid out in this piece, which was written for a special issue of Water International treating transboundary groundwater).

3. See Rep. of the Int’l Law Comm’n, 66th sess, *Draft Articles on the Law of Transboundary Aquifers*, U.N. Doc. A/63/10; U.N. GAOR, 63d Sess., Supp. No. 10, (2008) [hereinafter *Draft Articles*]; Gabriel Eckstein & Yoram Eckstein, *A Hydrogeological Approach to Transboundary Ground Water Resources and International Law*, 19 AM. U. INT’L L. REV. 201, 222 (2003); Owen McIntyre, *Fragmentation in International Water Resources Law: Reconciling the International Law Commission’s 2008 Draft Articles on Transboundary Aquifers with the 1997 UN Watercourses Convention*, in PROCEEDINGS OF THE ISARM2010 INTERNATIONAL CONFERENCE: TRANSBOUNDARY AQUIFERS: CHALLENGES AND NEW DIRECTIONS (Dec. 6–8, 2010).

4. *Draft Articles*, *supra* note 3.

5. *Acordo sobre o Aquífero Garani* [Agreement on the Guarani Aquifer], Aug. 2, 2010, Arg.-Braz.-Para.-Uru., Ministério Das Relações Exteriores [Brazilian Ministry of Foreign Affairs] [hereinafter *Acordo*].

It argues that no multilateral agreement can succeed (for the Guarani or any other transboundary groundwater resource) until domestic laws are harmonized both among themselves and with ecological realities. The Article categorizes domestic and multilateral policy challenges in light of various endogenous and exogenous threats and proposes a management and conflict resolution strategy. That proposed strategy builds on an international methodology already in existence⁶ that is itself based on the U.S. experience of equitable apportionment. The approach offered herein suggests a framework that will provide increased jurisdictional heft and enforceability to the Acordo. However, the strategy proffered here is not specific to the GAS. It is adaptable to other transboundary aquifer regimes with multilateral management agreements as well. Unfortunately, only two such agreements currently exist (including the Acordo) despite the fact that there are at least 270 known transboundary aquifers.⁷

Part II of this Article describes the regional ecology of the GAS and the endogenous and exogenous challenges it faces. It explains how these dilemmas arise from the inability of regulatory regimes to adjust to the cycle of hard and soft uncertainties. Part III looks at the Brazilian legal system as it relates to groundwater. Brazil overlies eighty percent of the GAS and is consequently the most influential of the four overlying nations. Yet, Brazil has a basic conflict within its water laws that impedes transboundary groundwater management.

In Part IV, the international legal challenges presented by transboundary groundwater are examined in light of how they relate to the GAS. Part IV examines the Acordo, a multilateral agreement signed (but not yet ratified) by the four overlying countries and argues that, while the Acordo represents laudable progress, it is not yet sufficient to the task at hand. In addition to the aforementioned problems of domestic disharmony (which make effective multilateral management impossible), the Acordo lacks an effective enforcement mechanism and dispute resolution procedure. Part V proposes language to amend the Acordo to incorporate principles of equitable apportionment (drawn from U.S.

6. See Stephen C. McCaffrey, *Sovereignty and Cooperative Management of Shared Water Resources in a Time of Shrinking Availability: The Role of International Law* at 114, in PROCEEDINGS OF THE ISARM2010 INTERNATIONAL CONFERENCE: TRANSBOUNDARY AQUIFERS: CHALLENGES AND NEW DIRECTIONS (Dec. 6–8, 2010).

7. Gabriel Eckstein, *Hydraulic Harmony or Water Whimsy? Guarani Aquifer Countries Sign Agreement*, INT'L WATER L. PROJECT BLOG (Aug. 5, 2010, 11:08 PM), <http://www.internationalwaterlaw.org/blog/2010/08/05/hydraulic-harmony-or-water-whimsy-guarani-aquifer-countries-sign-agreement/> (suggesting that there are only two such agreements currently in existence).

water law) and to grant jurisdiction to the International Court of Justice (“ICJ”) to resolve disputes that arise among the signatory countries.

II. OVERVIEW OF REGIONAL ECOLOGY AND ENDOGENOUS AND EXOGENOUS CHALLENGES FACING THE GAS

A. A Brief Overview of the GAS

The GAS—the world’s largest aquifer—underlies Brazil, Paraguay, Uruguay, and Argentina, constituting a continuous geological formation shared by the four countries.⁸ It was discovered just recently, in 1996,⁹ and is named after the indigenous nation that carries the same name and has inhabited the region for centuries. The Guarani contains 30 trillion cubic meters of water, 1.2 million square kilometers, and comprises one of the most important eco-regions in the world.¹⁰ It is integrally connected through overland rivers (the Parana and the Paraguay) with the Pantanal, the largest wetland in the world, which is located in Bolivia, Paraguay, and Brazil.¹¹ The GAS recharge zones are primarily located in Brazil and Paraguay, and the discharge zones are in Argentina and Uruguay.¹² The aquifer’s annual recharge rate is estimated at forty-five to fifty-five cubic kilometers of water, which represents less than 0.2 percent of the freshwater storage.¹³ The health of the GAS and the issues created by its transboundary overlap present a complex management

8. Maria Lúcia Navarro Lins Brzezinski, *Regulating Transboundary Groundwater: Big Challenges for Brazil*, at 1, in PROCEEDINGS OF THE ISARM2010 INTERNATIONAL CONFERENCE: TRANSBOUNDARY AQUIFERS: CHALLENGES AND NEW DIRECTIONS (DEC. 6–8, 2010).

9. *Id.*

10. INSTITUTO SOCIOAMBIENTAL, ALMANAQUE BRASIL SOCIOAMBIENTAL [BRAZIL SOCIO-ENVIRONMENTAL ALAMANC] (Beto Ricardo & Maura Campanili eds., 2008).

11. *Id.* at 297.

12. See EDUARDO USUNOFF, WEB-BASED INFORMATION FOR INTEGRATED WATER RESOURCES MANAGEMENT, OF A MULTI-NATIONAL AQUIFER: THE GLOBAL ENVIRONMENT FACILITY PROJECT ON THE GUARANI AQUIFER, available at http://s162n22.fau.edu/wis3/presentations/30_Usunoff_paper.pdf.

13. Gerhard Schmidt & Fernando Larroza, *Pedro Juan Caballero — Ponta Porã: A Groundwater Transboundary Situation between Paraguay and Brasil*, at 1, in PROCEEDINGS OF THE ISARM2010 INTERNATIONAL CONFERENCE: TRANSBOUNDARY AQUIFERS: CHALLENGES AND NEW DIRECTIONS (Dec. 6–8, 2010).

dilemma, particularly in light of the absence of precise technical and scientific information related to underground water.

Annual extraction levels of the Guarani currently hover around 1.04 billion cubic meters per year, well within recharge levels of the aquifer as a whole and approximately 0.003 percent of the estimated 30 trillion cubic meters of water contained within it.¹⁴ At current levels of exploitation, the GAS could offer its four overlying nations fresh water for over 2,000 years.¹⁵ Although impressive at first glance, this statistic should not undermine the importance of integrated management policies among the overlying nations, especially in light of the exponential increase in pressure on groundwater resources worldwide.¹⁶

Economics play a significant role in determining how the Guarani will be utilized. Since there are sufficient alternative surface water sources at present, it is generally not cost-effective to use water from the aquifer for irrigation or other heavily consumptive uses. However, as climate change shifts the amount and availability of other water, those economics could and likely will change.¹⁷

14. WORLD BANK, REP. NO. ICR00001198, IMPLEMENTATION COMPLETION AND RESULTS REPORT ON A GRANT TO ARGENTINA, BRAZIL, PARAGUAY AND URUGUAY FOR THE ENVIRONMENTAL PROTECTION AND SUSTAINABLE DEVELOPMENT OF THE GUARANI AQUIFER SYSTEM PROJECT (July 31, 2009), *available at* <http://documents.worldbank.org/curated/en/2009/07/10952015/latin-america-caribbean-region-environmental-protection-sustainable-development-guarani-aquifer-system-project>.

15. L. Amore & U. Tröger, *Transboundary Guarani Aquifer System and Groundwater Management Mechanisms*, at 2, in PROCEEDINGS OF THE ISARM2010 INTERNATIONAL CONFERENCE: TRANSBOUNDARY AQUIFERS: CHALLENGES AND NEW DIRECTIONS (Dec. 6–8, 2010) (“The static water reserves were calculated as higher than 29,551 km³ (4,000 km³ ±), but the deep recharge in 1.4 km³/ano, indicating the occurrence of mining water in confined areas. The exploitable volumes were calculated in 2,014 km³ (± 270 km³), or 6% of SAG reserves, considering the maximum drawdown of water levels by pumping as 400 m. If current exploitation was maintained at 1.04 km³/ano, through the 1,800 wells that reach the SAG (a total of 8,000 known wells in the region), available reserves could be exploited by more than 2,000 years at current patterns of consumption.”).

16. UNESCO, WATER: A SHARED RESPONSIBILITY: THE UNITED NATIONS WORLD WATER DEVELOPMENT REPORT 2 (2006), *available at* <http://unesdoc.unesco.org/images/0014/001454/145405E.pdf>.

17. There are already signs of stress on surface water supplies. For example, Merin Lake, which is bordered by both Uruguay and Brazil, supplies water for much of Uruguay’s rice production. Brazil withdraws significant amounts for irrigation as well. See MVOTMA, *Segunda Comunicacioun Nacional al Conferencia de las Partes en la Convencion Marco de las Naciones Unidas sobre el Cambio Climatico, Unidad del Cambio Climatico* 226–27 (2004), *available at* http://www.cambioclimatico.gub.uy/index.php?option=com_search&Itemid=5

Uses of the Guarani's waters vary by region. The majority goes into public water supplies, but significant amounts also go toward agricultural and industrial use and to recreation (primarily thermal tourism).¹⁸ Among the four overlying nations, Brazil relies most heavily on the Guarani. This is due to the country's size and demographics and to the fact that it overlies the majority of the aquifer. Brazil's extraction accounts for eighty-seven percent of the water withdrawn from the aquifer,¹⁹ with the state of São Paulo exerting the greatest pressure.²⁰

The regional ecology, as well as the complex socioeconomic framework, presents an array of managerial challenges. Social and economic pressures are influenced and, in some circumstances, fueled by regional and local zoning policies. From national zoning policies to local land-use choices, social needs and economic demands need to be factored into the GAS's governance. In addition, the transboundary nature of the Guarani adds another layer of complexity. Figure 1 below illustrates the geographical reach of the GAS and offers an indication of some of the socioeconomic pressures and management dilemmas that it faces. For example, the portion of Brazil that overlies the aquifer includes the most industrialized and agriculturally intense areas of the country.

&searchword=Segunda+comunicacion&searchphrase=any&ordering=newest (suggesting that as a result, demands for water from the lake are stressing the regional ecosystem, the most likely candidate for an alternative source is the Guarani).

18. Amore & Tröger, *supra* note 15, at 3 ("In general, the main use of the waters of GAS is for public supply (66%). The industrial use (refrigerators, sugar/alcohol plants, etc.) reaches 16%, while in the countryside it is only 5%. Recreational uses in thermal areas have reached 13%, and 100% of the water in Argentina are intended for tourist use. In Paraguay and Uruguay more than 90% of GAS water is used to supply urban areas.").

19. *Id.*

20. Schmidt & Larroza, *supra* note 13, at 2 ("Both in terms of population and groundwater production Brasil has a dominating role in the SAG [Guarani Aquifer System – *Sistema Acuífero Guarani*] region: 87% of the SAG population of 92 million inhabitants live on the Brazilian territory, and about 93% of the recent groundwater production (1040 million m³ in 2007) happens in Brasil, mainly in the federal state of São Paulo."). Along with the state of São Paulo, another seven Brazilian states overlie the Guarani Aquifer: Rio Grande do Sul, Santa Catarina, Paraná, Mato Grosso, Mato Grosso do Sul, Goiás and Minas Gerais.

Figure 1. Map of the Guarani Aquifer²¹

In the Parts to follow, we explore the regional ecology and regional legal instruments applicable to the GAS. We begin, however, with an analysis of the Brazilian legal framework.

B. Endogenous and Exogenous Challenges Facing Policy Makers

We identify two types of challenges facing sound policymaking for the Guarani: endogenous and exogenous challenges.

1. Endogenous Challenges

Endogenous challenges are those inherent to the hydrology of the aquifer. Hydrology is by nature a complex science. When dealing with an aquifer as large and varied as the Guarani, as well as a dearth of

21. Aquífero Guarani, WIKIPEDIA, http://pt.wikipedia.org/wiki/Aqu%C3%ADfero_Guarani (last visited Nov. 18, 2012).

precise and consolidated scientific information regarding groundwater resources,²² hydrology becomes more complicated still. That complexity, coupled with the enormous geographical scale of the GAS, raises problems of soft uncertainty. Soft uncertainty arises “where [a] precise outcome cannot be predicted but a probability distribution can be specified”²³ For example, the hydrology of the region, while not completely mapped, is a knowable unknown. The obstacles are, for the most part, knowable and their potential impacts and benefits calculable. That soft uncertainty has implications not only for instrumental managerial policies like the jurisdictional debate highlighted below,²⁴ but also for groundwater policies that aim to balance development pressures with the ecological health of the region.²⁵ Naturally, as the science of hydrology advances, more information will become available and the concomitant uncertainty will abate.

Ironically, as more is learned about the GAS, new uncertainties replace those just resolved. It is a never-ending cycle. Thus, neither endogenous challenges nor soft uncertainties will ever disappear. A sound management policy acknowledges and allows for this reality.

2. Exogenous Challenges

The other types of challenges facing the Guarani are exogenous. Exogenous challenges derive from external phenomena. The uncertainties generated by exogenous forces are often “hard.” Hard uncertainty occurs “where one does not even know the parameters of the outcomes.”²⁶ Indeed, it is not even possible to know the nature of the

22. P.C. Villar, *Moving Toward Managing the Guarani Aquifer: The Brazilian Case*, at 1, in PROCEEDINGS OF THE ISARM2010 INTERNATIONAL CONFERENCE: TRANSBOUNDARY AQUIFERS: CHALLENGES AND NEW DIRECTIONS (Dec. 6–8, 2010) (noting that the complexity of the GAS “increases as groundwater depends on science to reveal its characteristics and the risks it runs. Such characteristic hinders its political and social appeal, since its importance and the emergency of the impacts are not perceivable to laymen. If on one hand the lack of technical information hinders the creation of a policy for this resource, on the other, the lack of social understanding of the theme makes the practical legitimation of a possible aquifer legislation more difficult.”).

23. Aaron Wildavsky, *The Political Economy of Efficiency: Cost-Benefit Analysis, Systems Analysis, and Program Budgeting*, 26 PUB. ADMIN. REV. 292, 296 (1966).

24. See *infra* Part III.A, note 51 and accompanying text.

25. See Amore & Tröger, *supra* note 15, at 3 (highlighting some of the risks imposed by development pressures: “In general, main concentrated threats on water quality of the SAG are related to risk of manmade contamination in the outcrop zones. Regarding water availability greater risks are interference between wells and mining waters from areas under intensive use.”); see also Cassuto & Sampaio, *supra* note 2.

26. Wildavsky, *supra* note 23, at 296.

risk. For example, climate change presents a problem of hard uncertainty.²⁷ The dimensions of the threat are not yet measurable and the impacts remain mostly unknown.²⁸ Therefore, the character of these “unknown unknowns” prevents policy makers from determining the scope of the risks and makes it impossible to formulate precise managerial strategies. A precautionary approach is therefore both prudent and necessary, although it too creates uncertainties and managerial challenges.²⁹ As a practical matter, soft uncertainty lends itself to cost-benefit analysis and other risk assessment methods. Hard

27. Eric A. Posner & Cass R. Sunstein, *Climate Change Justice*, 96 GEO. L.J. 1565, 1590 (2008).

28. See Magdalena A.K. Muir, *Managing Transboundary Aquifers for Climate Change: Challenges and Opportunities*, in PROCEEDINGS OF THE ISARM2010 INTERNATIONAL CONFERENCE: TRANSBOUNDARY AQUIFERS: CHALLENGES AND NEW DIRECTIONS (Dec. 6–8, 2010) (“Some key climate impacts for water quantity and quality are saline intrusion and contamination of aquifers. Changes in seasonal and annual precipitation, flooding, temperature and extreme weather events also affect the recharge and discharge of aquifers, and could lead to contamination of aquifers even where there is no water scarcity. Last, climate impacts for aquifers may be greater for coastal aquifers, or in arid and semi-arid regions, such as the Mediterranean, Middle East and northern Africa.”).

29. See David Magnus, *Risk Management Versus the Precautionary Principle: Agnotology as a Strategy in the Debate over Genetically Engineered Organisms*, in AGNOTOLOGY: THE MAKING AND UNMAKING OF IGNORANCE 251–53 (Robert N. Proctor & Londa Schiebinger eds. 2008); Cass Sunstein critiques the Precautionary Principle by arguing that it leads to regulatory paralysis:

The precautionary principle might seem to call for stringent regulation of genetic engineering on the theory that this technology contains at least some risk of causing ecological harm. But such regulation would also create risks of adverse effects, simply because genetic engineering holds out a prospect of producing ecological and health benefits. The precautionary principle would seem both to require and to forbid stringent regulation of genetic engineering. The same can be said for many activities . . . such as nuclear power and non-therapeutic cloning, simply because risks are on all sides of the situation.

Cass R. Sunstein, *Probability Neglect: Emotions, Worst Cases, and Law*, 11 YALE L.J. 61, 93 (2002).

However, environmentalist opposition to things like GMOs finds support in a statistical risk distribution methodology called a “power law,” which is used to measure risk in complex systems (i.e. systems made up of multiple interactive systems). Under a power law analysis, freak outcomes weigh heavily in the analysis as for example, when one is measuring the likelihood of floods. So, for example, if one is graphing the average birth weight of a puppy, one would not expect gross deviations from the mean. On the other hand, if one were tracking hurricanes, there is the potential for radical deviation. Extreme events are more likely in complex systems. For a useful discussion of power laws, see MANFRED SCHROEDER, *FRACTALS, CHAOS, POWER LAWS: MINUTES FROM AN INFINITE PARADISE* 103–119 (1991).

uncertainty, by contrast, cannot be quantified and thus cannot be contrasted or its risks accurately described.³⁰

Managing for hard uncertainty involves acknowledging that much of what is not known is unknown. This means that the regulatory state must be able to adapt to emergent challenges. The goal would be to bring the unknown unknowns of hard uncertainty into the realm of the known unknowns (soft uncertainty). From there, it becomes possible to shift uses and policies to address and to adapt to the new information. In this way, hard uncertainty converts to soft uncertainty, which then can move into the realm of the known. So, the desired progression is from unknown unknown to known unknown to known known. Once complete, the cycle begins anew.

III. BRAZILIAN LAWS AND POLICIES REGARDING THE GAS

This Part focuses on Brazilian laws and policies regarding the GAS for several reasons. First, as noted *supra*, the largest portion of the aquifer underlies Brazilian territory (61.65 percent of the total area of the aquifer versus 20.98 percent under Argentina, 8.05 percent under Paraguay and 3.32 percent under Uruguay),³¹ thus making Brazilian management practices potentially more influential. In addition, of the 92 million people living in the Guarani Aquifer region, 80 million of them live in Brazil—forty-three percent of that country's population. Furthermore, the GAS spans eight Brazilian states (Rio Grande do Sul, Santa Catarina, Paraná, São Paulo, Mato Grosso, Mato Grosso do Sul, Goiás and Minas Gerais) and more than 500 municipalities.

As discussed below, Brazilian law is not clear on the managerial hierarchy concerning transboundary groundwater even among and amidst the various Brazilian states. This uncertainty will have a significant impact on the implementation of the recently signed (but not yet ratified) international agreement, the Acordo.³² This impact is due in part to the fact that the Acordo acknowledges the authority of each overlying nation to manage that portion of the aquifer over which it sits.³³ As a result, Brazil's management practices will have a

30. Soft uncertainty arises "where [a] precise outcome cannot be predicted but a probability distribution can be specified." Hard uncertainty occurs "where one does not even know the parameters of the outcomes." Wildavsky, *supra* note 23, at 296.

31. Brzezinski, *supra* note 8, at 2.

32. See Acordo, *supra* note 5.

33. See *id.* art. II.

proportionally larger impact on the aquifer's health and resilience. Consequently, Brazil's responsibility to implement sound water management practices is proportionally larger as well.³⁴

Second, the scope of Brazil's activities requires different, yet integrated management strategies. Even within one single activity, water needs and impacts can vary as it does in agribusiness, where intense crop use can lead to considerable drawdown in one region, whereas industrial livestock production in another region might lead to groundwater contamination.³⁵ The GAS is thus vulnerable to a wide range of activities and policies, some of which do not even necessarily implicate the aquifer directly.³⁶ For example, an indirect but highly significant impact on the GAS comes from land-use law. Brazilian municipalities enjoy significant legal and managerial authority over zoning. These local land-use choices, all of which affect drawdown, recharge, and contamination, pose their own set of challenges for groundwater management.³⁷

Third, from a practical perspective, the background and expertise of the authors³⁸ permits us far more insight into the international and Brazilian legal frameworks for transboundary groundwater management. Nonetheless, we acknowledge that a truly comprehensive analysis of the GAS must include a similar treatment of Paraguay, Uruguay, and Argentina. Our hope is that this Article can contribute to this important endeavor.

34. Villar, *supra* note 22 (highlighting Brazilian responsibility regarding the Guarani Aquifer in light of the fact "the biggest part of the aquifer is located in Brazilian soil").

35. See Amore & Tröger, *supra* note 15 (referring to some of the threats faced by the Guarani Aquifer).

36. WORLD BANK, *supra* note 14.

37. H.S.V. Totin et. al., *Climate and Land Use Change Impacts on Groundwater Quality in the Beninese Coastal Basin of the Transboundary Aquifer System Benin-Nigeria-Togo*, in PROCEEDINGS OF THE ISARM2010 INTERNATIONAL CONFERENCE: TRANSBOUNDARY AQUIFERS: CHALLENGES AND NEW DIRECTIONS (Dec. 6–8, 2010) (stressing that "land use and land cover (LULC) changes are one of the main human induced activities altering the groundwater system").

38. See Staff, *Brazil-American Institute for Law and Environment*, PACE LAW, <http://www.pace.edu/school-of-law/centers-and-special-programs/institutes/brazil-american-institute-law-and-environment-baile/staff-3> (last visited Dec. 27, 2012).

A. Brazilian Legal Approaches to Endogenous Issues

Brazilian environmental law is well-developed and highly complex. It includes a constitutional provision dedicated to the environment³⁹ and many other federal, state, and municipal statutes and regulations, all of which intertwine to form a holistic legal regime. This Subpart examines existing laws and policies in order to identify likely sources of endogenous and exogenous challenges for the GAS.

Historically, Brazilian legislators have paid very little attention to groundwater.⁴⁰ Consequently, the legal framework for dealing with groundwater issues is of comparatively recent vintage. However, growing pressure over access to and protection of this scarce resource is now forcing policy makers to address the regulatory gaps and inconsistencies between surface and groundwater management.⁴¹

The 1988 Federal Constitution and the 1997 National Water Policy Act established a new paradigm in Brazilian water law. Prior to 1988, private ownership over water resources was permissible.⁴² The 1988 Constitution declared that the environment is an asset of common use and essential to a healthy quality of life. This principle includes water.⁴³ Following from this idea of the environment as a public good, under Brazilian law, no one owns water and all have equal and unfettered access to it.⁴⁴ Codifying statutes on the nature of water as a public good soon followed. For example, Article 99 of the 2002 Brazilian Civil Code states that rivers and oceans are public assets and Article 1 of the National Water Policy Act declares that water lies within the public domain.⁴⁵ This constitutional and statutory combination places water firmly within the legal category of public assets of common use.

39. CONSTITUIÇÃO FEDERAL [C.F.] [CONSTITUTION] art. 225 (Braz.).

40. Antonio H. Benjamin & Cláudia L. Marques, *The Water Giant Awakes: An Overview of Water Law in Brazil*, 83 TEX. L. REV. 2185, 2205–06 (2005).

41. *See id.*

42. CID TOMANIK POMPEU, DIREITO DE ÁGUAS NO BRASIL 41–45 (2006).

43. VLADIMIR PASSOS, DE FREITAS ÁGUAS: ASPECTOS JURÍDICOS E AMBIENTAIS 17–18 (JURUÁ, CURITIBA 2002).

44. Brazilian law construes equal access according to the principle of isonomy, which allows for differing capacities, needs, and uses to dictate water management and allocation policies. *See* National Water Management Policy Act, Lei No. 9.433, de 8 janeiro de 1997, DIÁRIO OFICIAL DA UNIÃO [D.O.U.] de 09.01.1997 (Braz.), *available at* [http://www.oas.org/usde/environmentlaw/waterlaw/documents/Brazil-Law_No_9,433_\(1997\).pdf](http://www.oas.org/usde/environmentlaw/waterlaw/documents/Brazil-Law_No_9,433_(1997).pdf).

45. *See* CÓDIGO CIVIL [C.C.] art. 99 (2002) (Braz.); *see also* National Water Management Policy Act, Lei No. 9.433, de 8 janeiro de 1997, art. 1, DIÁRIO OFICIAL DA UNIÃO [D.O.U.] de 09.01.1997 (Braz.), *available at*

However, the aforementioned statutory shift from private to public ownership of water focused primarily on surface water. The discussion of groundwater in the 1988 Constitution confined itself to jurisdictional issues regarding the scope and nature of the respective managerial authority of the federal and state governments. This division of authority has generated considerable confusion and conflicting interpretations. Article 20, Section III of the 1988 Constitution tasks the federal government with managing lakes, rivers, and watercourses on lands within its domain that wash more than one state and that serve as boundaries with other countries.⁴⁶ It also extends jurisdiction over beaches and the territorial sea.⁴⁷ It does not, however, confer any explicit authority over groundwater. By contrast, Article 26 entrusts states with managing groundwater.⁴⁸ This bifurcated authority creates a serious problem for aquifers such as the Guarani that underlie multiple states and extend beyond national jurisdiction.⁴⁹ Since groundwater resources (i.e. the Guarani) can be transboundary, it is not clear whether transboundary groundwater would fall under state or federal control.

To settle this problem, several lawmakers proposed a constitutional amendment. The amendment seeks to resolve the inherent conflict arising from designating transboundary resources as the province of the federal government while placing control over groundwater resources within state control. The amendment explicitly grants federal jurisdiction over transboundary water, regardless of whether it is surface or ground.⁵⁰ Federal control seems the proper and logical solution because of the need for a central authority and unifying regulatory regime. As things currently stand, it is not clear that the Brazilian federal government has the authority to manage the Guarani nor the ability to bind individual states to commitments made under the 2010 Acordo between the four countries.⁵¹

[http://www.oas.org/usde/environmentlaw/waterlaw/documents/Brazil-Law_No_9,433_\(1997\).pdf](http://www.oas.org/usde/environmentlaw/waterlaw/documents/Brazil-Law_No_9,433_(1997).pdf).

46. CONSTITUIÇÃO FEDERAL [C.F.] [CONSTITUTION] art. 20, § III (Braz.).

47. *Id.*

48. *Id.* art. 26.

49. This is not an uncommon problem. The U.S. often has separate regimes for groundwater and surface water, leading to considerable confusion and legal disarray.

50. See S. Rep. No. 1.283, DE 2010 (Aug. 4, 2010) (Braz.), available at <http://www.senado.gov.br/atividade/materia/getPDF.asp?t=82128&tp=1> [hereinafter Brazilian Senate Report].

51. Villar, *supra* note 22, at 3 (“Presently, the legal groundwater guardianship is performed almost exclusively by the states and with extremely different implementation levels, even when the same aquifer is shared.”).

The alternative—entrusting individual states, each with differing priorities and management strategies, with controlling a shared resource of multilateral and international significance—creates irreconcilable federalist tension and jeopardizes international agreements and treaties. Rather than amend the Constitution, some judges and scholars argue that the concept of watercourses in Article 20 should be broadly construed to include groundwater that serves as boundaries with other countries and/or wash more than one state.⁵² However, this interpretation does not enjoy widespread acceptance not least because it seems to flout the plain language of the Constitution.

The existing text of Article 20 of the Brazilian Constitution states as follows:

The following are property of the Union: 3. the lakes, rivers and any watercourses in lands within its domain or that wash more than one state, that serve as boundaries with other countries or that extend into foreign territory or proceed therefrom, as well as bank lands and river beaches;⁵³

Article 26, which deals with assets falling under state jurisdiction, states:

The property of the states includes: 1. surface or subterranean waters, flowing, emerging or in deposit, with the exception, in this case, of those resulting from work carried out by the Union, as provided by law . . .⁵⁴

Read together, the plain language of the two articles makes clear that surface water and groundwater have distinct management regimes and that groundwater pertains to the states. However, neither provision directly addresses the issue of transboundary groundwater. From this language and accompanying lack of guidance arises the jurisdictional conflict over groundwater management.

52. CONSTITUIÇÃO FEDERAL [C.F.] [CONSTITUTION] art. 20 (Braz.). CID TOMANIK POMPEU, *supra* note 42, at 55-58 (presenting the conflicting views about State jurisdiction over groundwater that serves as boundaries with other countries and/or wash more than one state in arts. 20 and 26 and of the Brazilian Constitution).

53. For an unofficial English version of the 1988 Brazilian Constitution, see *República Federativa de Brasil/ Federative Republic of Brazil Constitución Política de 1988, con reformas de 1996, em inglês 1988 Constitution, with 1996 reforms in english*, POLITICAL DATABASE OF THE AMERICAS, GEORGETOWN UNIV., <http://pdba.georgetown.edu/Constitutions/Brazil/english96.html#mozTocId30141> (last visited May 3, 2011).

54. *Id.*

The proposed amendment would change Article 26 to read:

The following are property of the Union: 3. the lakes, surface and groundwater, including those in aquifers, rivers and any watercourses in lands within its domain or that wash more than one state, that serve as boundaries with other countries or that extend into foreign territory or proceed therefrom, as well as bank lands and river beaches;⁵⁵

As amended, the Constitution would confer jurisdiction over the groundwater resources shared by more than one state to the federal government.

Unfortunately, the proposed amendment stands little chance of success. The sponsoring Senator had argued that the ambiguity over state and federal jurisdiction arose from a drafting error, which the proposed amendment would remedy.⁵⁶ Ten years after the amendment was proposed, however, another report maintained that there was no error.⁵⁷ The report's author, Senator Kátia Abreu, maintained that control over groundwater was intentionally left with the individual states because the legislature had intended to create a decentralized management structure similar to the 1997 Water Policy Act.⁵⁸ Under this view, allocating control over groundwater to the federal government would violate both the statute and the intended meaning of the Constitution.

However, the logic of Senator Abreu's report does not withstand serious scrutiny. A decentralized management approach only makes sense when the resource in question is not shared multinationally. It would be impossible for the federal government to conduct a coherent foreign policy if transboundary negotiations were carried on by various states whose interests may not align and which might take different positions with respect to the management of the resource. In addition, the Constitution does not propound a decentralized approach for every situation, as demonstrated by the provision allocating control over transboundary surface waters to the federal government.

Clearly, there is no philosophical issue at stake here. Rather, this is an instance of conflicting provisions and only one logical resolution. Multistate control over transboundary resources cannot possibly succeed. A centralized regulatory regime is the only alternative. Nevertheless, despite the urgency of the issue and the clear path to resolution, the

55. See Brazilian Senate Report, *supra* note 50.

56. See *id.*

57. See *id.*

58. See *id.*

proposed amendment was tabled in August 2010 with no further action currently contemplated.⁵⁹

Meanwhile, the legislature has enacted a different set of regulations to close the gap between the groundwater and surface water management regimes. In 2001, the National Water Resources Council ("CNRH") enacted a series of resolutions aimed at integrating ground and surface water management.⁶⁰ They include Resolutions 9/2000, 15/2001, 22/2002, 48/2005, 76/2007, 91/2008, 107/2010, and 126/2011.⁶¹

Resolution 9/2000 created a Committee tasked with integrating groundwater into the 1997 Water Policy Act and resolving compatibility issues between surface and groundwater laws and policies.⁶² Resolution 15/2001 acknowledges those jurisdictional challenges and some of the exogenous threats facing underground water and creates a general regulatory framework that takes into account the peculiarities of groundwater.⁶³ Resolution 22/2002 deals specifically with the need to rely on scientific information about the hydrology of aquifers and requires that National Resource Plans contain such information.⁶⁴ It constitutes an important regulatory step forward to address endogenous and exogenous challenges facing groundwater in Brazil. Resolution 48/2005 regulates the costs for the use of the water embedded in the 1997 Water Policy Act.⁶⁵ Resolution 76/2007 further strengthens the groundwater regulatory apparatus by creating a general framework covering extraction of mineral and thermal waters found in underground water deposits.⁶⁶ Resolution 91/2008 extends the different categories created by the 1997 Water Act based on preponderant use of the resources to cover groundwater.⁶⁷ Prior to Resolution 91/2008, those categories existed only for surface water. Groundwater had been subject

59. For an updated status of the proposed constitutional amendment, see *PROPOSTA DE EMENDA À CONSTITUIÇÃO, Nº 43 de 2000* [*Proposed Constitutional Amendment no. 43 of 2000*], SENADO FEDERAL [BRAZILIAN SENATE], http://www.senado.gov.br/atividade/materia/detalhes.asp?p_cod_mate=45833 (last visited Sept. 24, 2012).

60. Benjamín & Marques, *supra* note 40, at 2213.

61. See *Resoluções* [Resolutions], CONSELHO NACIONAL DE RECURSOS HÍDRICOS [BRAZILIAN NATIONAL WATER RESOURCES COUNCIL], http://www.cnrh.gov.br/sitio/index.php?option=com_content&view=article&id=14 (last visited Sept. 24, 2012).

62. Resolução No. 9, de 21 de Junho de 2000 (Braz.).

63. Resolução No. 15, de 11 de Janeiro de 2001 (Braz.).

64. Resolução No. 22, de 24 de Maio de 2002 (Braz.).

65. Resolução No. 48, de 21 de Março de 2005 (Braz.).

66. Resolução No. 76, de 16 de Outubro de 2007 (Braz.).

67. Resolução No. 91, de 5 de Novembro de 2008 (Braz.).

to a specific plan, called the National Groundwater Plan, which was then integrated into the National Water Plan, approved by Resolution 99/2009. Resolution 107/2010 instituted criteria to be adopted for the planning, implementation, and operation of the Groundwater Integrated Qualitative and Quantitative Monitoring National Network.⁶⁸ Finally, Resolution 126/2011 creates a national registry of surface and groundwater users. It is an important step toward inventorying the demands over water resources and for providing reliable data for an efficient management policy.⁶⁹

In addition to the aforementioned regulation from the CNRH, the National Environmental Council (“CONAMA”)⁷⁰ also promulgated water quality standards in 2005 (Resolution 357/2005)⁷¹ and groundwater quality standards in 2008 (Resolution 396/2008).⁷²

This extensive list of resolutions forms a useful framework for groundwater regulation. However, it does not correct the ongoing inability to integrate water policies with land use, climate change, and other environmental policies with direct impact on water management strategies. A more robust legal framework—one that relies less on regulation and more on statutes—is needed, particularly in light of the jurisdictional conflicts highlighted above.

The need for integration has become particularly urgent as a result of ballooning demand for water by agribusiness. Yet, Senator Abreu (author of the report criticizing the proposed amendment) is one of the strongest congressional voices on behalf of agribusiness. She also serves as the President of the Brazilian National Agriculture Confederation, an

68. Resolução No. 99, de 26 de Março de 2009 (Braz.); Resolução No. 107, de 13 de Abril de 2010 (Braz.).

69. Resolução No. 126, de 29 de Junho de 2011 (Braz.).

70. See generally Luiz Fernando Henry Sant’Anna, *General Overview of Brazilian Environmental Law*, 15-SPG INT’L L. PRACTICUM 22, 22 (Spring 2002) (“The main objective of CONAMA, which is the National Council for the Environment, is to deliberate, within the scope of its competence, about rules and standards that are essential to public health and safety and that are compatible with an ecologically balanced environment, and to support, study, and propose to the Ministry of the Environment . . . governmental policy relating to the environment and natural resources.”).

71. Resolução Conama No. 357, de 17 de Março de 2005, DIÁRIO OFICIAL DA UNIÃO [D.O.U.] de 18.3.2005 (Braz.), available at <http://www.mma.gov.br/port/conama/legiabre.cfm?codlegi=459>.

72. Resolução Conama No. 396, de 3 de Abril de 2008, DIÁRIO OFICIAL DA UNIÃO [D.O.U.] de 3.4.2008 (Braz.), available at <http://www.mma.gov.br/port/conama/legiabre.cfm?codlegi=562>.

entity representing the interests of agribusiness.⁷³ While the stated reasons for opposing the amendment defy logic, one might reasonably assume that agribusiness views state regulators as potentially friendlier and more receptive to their needs and objectives, and thus more likely to create a more business-friendly regulatory regime. After all, state regulators work in the respective state capitals, while federal regulators tend to be farther away—both physically and philosophically. Thus, it is not surprising that attempts to allocate more control over groundwater to the federal government have met with fierce resistance from well-funded interest groups.

Amidst this constitutional uncertainty over groundwater jurisdiction, states overlying the Guarani have been attempting to control access and promote conservation.⁷⁴ For instance, the state of São Paulo, the main consumer of water from the Guarani, created the State Water Resources Council (“CERH-SP”) to regulate and protect the State’s water resources.⁷⁵ It established restricted zones for the perforation of tubular wells in the city of Ribeirão Preto, one of the major consumers within São Paulo, in order to shield the Guarani from contamination.⁷⁶ São Paulo also enacted a set of groundwater policies aimed at dealing with the socioeconomic pressures arising from the region’s high level of urbanization and industrial and agricultural activities.⁷⁷ Given the importance of São Paulo—both economically and socially—a regulatory framework addressing groundwater (São Paulo’s groundwater comes mainly from the GAS) is somewhat reassuring. Nevertheless, as

73. See *Sobre o Sistema CAN*, NAT’L AGRIC. CONFEDERATION, <http://www.canaldoprodutor.com.br/sobre-sistema-cna/quem-e-quem> (last visited Sept. 24, 2012).

74. See generally Villar, *supra* note 22 (“The absence of a specific federal law on groundwater, the state domain of the aquifers regardless of their geographic limits, and the municipal competency to manage the use and occupation of the soil generated a great lack of articulation and freedom between the three levels of power: Union, States and Municipalities.”).

75. See *São Paulo State Water Resources Council*, SIGRH, http://www.sigrh.sp.gov.br/cgibin/sigrh_carrega.exe?f=/index/index.html&lwactw=616.6685986030287 (last visited Sept. 24, 2012).

76. See São Paulo State Water Resources Council, Deliberation n. 65 (Sept. 4, 2006), *available at* http://www.sigrh.sp.gov.br/cgibin/sigrh_home_colegiado.exe?COLEGIADO=CRH&TMA=DELIBERACAO&lwactw=503582.

77. Lei No. 6.134, de 2 de Junho de 1988 (Braz.), *available at* http://www.cetesb.sp.gov.br/licenciamento/legislacao/estadual/leis/1988_Lei_Est_6134.pdf; São Paulo State Decree n. 32,955 (June 2, 1988), *available at* <http://www.al.sp.gov.br/repositorio/legislacao/decreto/1991/decreto%20n.32.955,%20de%2007.02.1991.htm>.

previously noted, a state regulatory regime cannot possibly manage a transboundary groundwater resource effectively. Consequently, the GAS remains imperiled.

Another example of a brewing conflict stemming from the use of the aquifer lies in the state of Mato Grosso do Sul, where the passage of Resolution 8 in July 2009 empowers the state's Environmental Authority to require permits for property owners seeking to operate wells on their land.⁷⁸ However, as the agency begins rationing permits to prevent groundwater overdraft, property owners whose title predates the 1988 Constitution could potentially file takings claims.⁷⁹ Their argument would be that they owned the water prior to 1988 and the state took it without offering compensation. The argument against compensating those whose water rights were expropriated arises from Article 8 of the Water Code.⁸⁰ Article 8 states that water can be privately held but that ownership is conditioned on the waters not being declared assets of common use. Because the 1988 Constitution, Article 99 of the 2002 Civil Code,⁸¹ and the 1997 Water Policy Act⁸² all declare water to fall under the category of common use, any claims for compensation seem dubious.⁸³

In addition to the already troublesome jurisdictional problem over groundwater resources, power over land-use policies is divided among federal, state, and municipal authorities, with the majority of power going to municipalities. Article 30, Sections I and II of the Brazilian Constitution empower municipalities to legislate over matters of local

78. Resolução Semac No. 08, de 6 de Julho de 2009, arts. 1 & 2, DIÁRIO OFICIAL DO ESTADO DE MATO GROSSO DO SUL de 7.7.2009 (Braz.), available at <http://www.imasul.ms.gov.br/control/ShowFile.php?id=111055>.

79. For a more detailed discussion regarding groundwater and the issue of takings in Brazil, see generally David N. Cassuto & Rômulo S. R. Sampaio, *Water Law in the United States and Brazil — Climate Change & Two Approaches to Emerging Water Poverty*, 35 WM. ENVTL. L. & POL'Y REV. 371, 397–400 (2011).

80. See Decreto No. 24.643, de 10 Julho de 1934, arts. 139-144, DIÁRIO OFICIAL DA UNIÃO [D.O.U.] de 10.7.1934 (Braz.), available at http://www.planalto.gov.br/ccivil_03/decreto/D24643.htm.

81. See Lei No. 10.406, de 10 de Janeiro de 2002, arts. 98, 99, DIÁRIO OFICIAL DA UNIÃO [D.O.U.] de 1.11.2002 (Braz.), available at http://www.planalto.gov.br/ccivil_03/Leis/2002/L10406.htm.

82. National Water Management Policy Act, Lei No. 9.433, de 8 janeiro de 1997, art. 1, DIÁRIO OFICIAL DA UNIÃO [D.O.U.] de 09.1.1997 (Braz.), available at http://www.planalto.gov.br/ccivil_03/Leis/L9433.htm.

83. See Cassuto & Sampaio, *supra* note 79, at 399; see also CONSTITUIÇÃO FEDERAL [C.F.] [CONSTITUTION] art. 225 (Braz.).

impact.⁸⁴ The above-stated example of the city of Ribeirão Preto is one such instance. Land-use policies must take into account the potential negative impacts on overall management policies for the conservation and sustainable use of the GAS.⁸⁵

Absent a centralized regulatory regime, however, local water and land-use management initiatives, well-intentioned though they may be, cannot succeed. They can cause interstate and intrastate conflicts, and their resolution may then generate new conflicts with other state or local management policies. Meanwhile, there exists no congruity with the national position with respect to international cooperation. Not only does this impede cooperative federalism and international diplomacy, it makes it all but impossible to ascertain best practices for maintaining and sustaining the resource while safeguarding the health and preservation of local inhabitants and ecosystems.

It bears stressing that a centralized management system for transboundary groundwater does not foreclose individual states from participating in the regulatory process.⁸⁶ Local input regarding proper use and management is crucial to any effective management regime. In addition, subterranean hydrology is becoming increasingly sophisticated. Some experts suggest that the impacts of certain uses of transboundary groundwater resources can be entirely localized.⁸⁷ For example, if a portion of the Guarani is all but entirely bounded by impermeable rock such that local drawdowns or contamination do not impact the larger aquifer, it makes little sense to allocate the management of that portion of the aquifer to federal control. In such circumstances, state and local authorities should retain managerial authority in cooperation with the federal regime. This synergistic approach is particularly important given the abundance of soft and hard uncertainty presented by groundwater

84. See CONSTITUIÇÃO FEDERAL [C.F.] [CONSTITUTION] (Braz.).

85. See Amore & Tröger, *supra* note 15, at 3 (“[T]he combination of increased water use, lack of adequate sanitation and amendment of land use can lead to a rapid modification of the current situation and the emergence of new critical areas.”).

86. See *id.* (noting that “users and local communities must be engaged on rational use, as well as national governments, state and local authorities should strengthen the management and protection measures of groundwater in order to prevent emerging conflicts”).

87. See *id.* (discussing a study of the Guarani Aquifer System which demonstrated that “[i]nternally, each area presents special characteristics of flows, naturally slow through the rock pores and fissures. In the transition between the northern and southern areas, the groundwater flow is limited by the occurrence of deep tectonic movement . . .”).

management.⁸⁸ The next Subpart looks at the exogenous challenges presented by climate change.

B. The Brazilian Legal Approach to Exogenous Issues

Exogenous issues are, by definition, unknown. However, the causes are sometimes identifiable. Climate change offers an example of an identifiable source of exogenous challenges of particular relevance to groundwater management and water availability in general. Long periods of drought are becoming more frequent, even in humid states in the south of the country such as Paraná and Rio Grande do Sul.⁸⁹ A major project aimed at diverting water from the San Francisco River to the arid northeast region of Brazil offers another example of how water management policies in a country known for its water abundance must now focus on avoiding water shortages.⁹⁰ In addition, the ongoing controversy over the construction of the Belo Monte Dam in the state of Pará is fueled in part by the fact that the increasing and worsening cycles of drought in the Amazon make hydropower increasingly unfeasible.⁹¹

According to the Intergovernmental Panel on Climate Change, there is “*high confidence*” that northeastern Brazil “will suffer a decrease in water resources due to climate change.”⁹² The report projects significant adverse impacts on agriculture, water supply, energy production, and health. While dry regions will become drier, there will also be changes in rainfall patterns and runoff in traditionally humid zones. This will impact water availability and quality and present challenges to infrastructure.⁹³ According to a World Bank report, climate changes are expected to cause higher levels of evapotranspiration in the Guarani Aquifer region that will affect both aquifer use levels and recharge rates.⁹⁴ The long-term

88. As we have argued elsewhere, this synergistic approach is vital to any functional water law regime. See Cassuto & Sampaio, *supra* note 79, at 376–78.

89. See, e.g., Carlos Caminada & Carla Simoes, *Brazil Drought Threatens 10 Million Tons of Corn, Soy*, BLOOMBERG (Jan. 7, 2009), <http://www.bloomberg.com/apps/news?pid=21070001&sid=a7Ks4iGegt8o>.

90. See generally Cassuto & Sampaio, *supra* note 79, at 405 (providing a general assessment of the overall impacts of climate change in Brazil).

91. See David N. Cassuto, *Belo Monte: The Legal Waters Continue to Roil*, JURIST (Dec. 9, 2011), <http://jurist.org/forum/2011/12/david-cassuto-brazil-dam.php>.

92. INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2007: IMPACTS, ADAPTATION AND VULNERABILITY 175 (2008) (emphasis added).

93. Noah D. Hall et al., *Climate Change and Freshwater Resources*, WTR NAT. RESOURCES & ENVIRONMENT 30, 34–35 (2008).

94. See WORLD BANK, *supra* note 14; see also COOLEY ET AL., PACIFIC INSTITUTE & UNEP, UNDERSTANDING AND REDUCING THE RISKS OF CLIMATE CHANGE FOR

implications of this and other climatic shifts are likely to be significant and ongoing even as their full dimensions are unknown.

Brazil implemented a national climate change policy, the National Climate Change Policy Act (“NCCPA”), at the end of 2009 that highlights the need to manage natural resources in light of the risks posed by climate change.⁹⁵ However, the policy offers guidelines rather than any clear plan of action. Specific regulatory measures were left to the executive branch to enact and were also delegated to states and municipalities. In 2010, the first step on regulating the NCCPA was conceived. Decree n. 7,390 of 9 December 2010 was enacted with the purpose of regulating the NCCPA.⁹⁶ While the Decree provided more specific guidance on the implementation aspects of the NCCPA, it remains quite broad and lacks concrete enforceable rules.⁹⁷

Incorporating the guidelines of the NCCPA and regulations into existing water law presents significant challenges. The principles embedded in the 1997 National Water Policy Act demonstrate an emerging awareness that water management must adapt to modern environmental realities, including climate change.⁹⁸ Together with the 2009 NCCPA, principles such as the precautionary approach, intergenerational equity, multiple use, and risk assessment now infuse the Brazilian water regime. However, enforcement remains a significant issue for Brazil as well as for the other three countries overlying the GAS.⁹⁹ In addition, there is an inherent challenge to managing for unknown threats, especially when it involves acting counter to public opinion and/or powerful political and business interests.

It is hard to imagine a politician easily convincing her constituents to support her vote to oppose a program that will bring immediate and identifiable benefits because she believes it will increase vulnerability to

TRANSBOUNDARY WATERS 13 (Dec. 2009), *available at* http://www.pacinst.org/reports/transboundary_waters/transboundary_water_and_climate_report.pdf.

95. *See* Lei No. 12.187, de 29 de Dezembro de 2009, arts. 4, 5, DIÁRIO OFICIAL DA UNIÃO [D.O.U.] de 30.12.2009 (Braz.), *available at* http://www.planalto.gov.br/ccivil_03/_Ato2007-2010/2009/Lei/L12187.htm.

96. Decreto No. 7,343 de 9 de Dezembro de 2010, art. 1 (Braz.), *available at* http://www.planalto.gov.br/ccivil_03/_Ato2007-2010/2010/Decreto/D7390.htm.

97. *See id.*

98. Hall et al., *supra* note 93, at 34; *see also* Cassuto & Sampaio, *supra* note 79, at 410.

99. LESLEY MCALLISTER, MAKING LAW MATTER: ENVIRONMENTAL PROTECTION AND LEGAL INSTITUTIONS IN BRAZIL 178–85 (2008); Cassuto & Sampaio, *supra* note 79, at 411.

an as yet unidentified threat that may manifest at some unknown time. Clearly, too much caution can cause societal paralysis. However, too little caution leaves a society unprepared and unable to respond to emergent challenges.¹⁰⁰ The ideal regulatory state offers sufficient predictability to enable regulated entities to understand the parameters under which they must operate while retaining the flexibility to adapt to new and unanticipated challenges arising from a dynamic environment.¹⁰¹

The task now facing Brazil involves fashioning an independent regulatory apparatus that can withstand campaigns to manipulate public opinion and undermine sound policymaking. Sound water policymaking in a world in the midst of climate change requires implementing the principles and guidelines already in place despite the pressures created by large-scale development projects that continue to fail to account for the new water-scarce reality. It also involves constructing a regulatory state capable of adjusting to unanticipated shifts in the status quo.

IV. INTERNATIONAL GROUNDWATER LAW AS APPLIED TO THE GAS

Further complicating the challenges discussed above is the international dimension of managing the GAS. There exists a general legal framework for managing transboundary groundwater resources. Moreover, there is a set of multilateral agreements of particular relevance to the GAS. They serve as model international law for issues involving shared water resources. This framework, however, lacks the means through which to manage the endogenous and exogenous challenges facing the aquifer. This Part analyzes that framework and explains why it is inadequate to the task at hand.

100. For more information on the pros and cons of the precautionary principle, see Noah M. Sachs, *Rescuing the Strong Precautionary Principle from Its Critics*, U. ILL. L. REV. 1285, 1325 (2011); David A. Dana, *A Behavioral Economic Defense to the Precautionary Principle*, 97 NW. U. L. REV. 1315, 1317–18 (2003); Frank B. Cross, *Paradoxical Perils of the Precautionary Principle*, 53 WASH. & LEE L. REV. 851, 851 (1996).

101. See David N. Cassuto, *The Law of Words: Standing, Environment & Other Contested Terms*, 28 HARV. ENV'T'L L. REV. 79 (2004) [hereinafter Cassuto, *The Law of Words*] (“As the [social] system adapts, it gains complexity, enabling it to better cope with future perturbations. A static environment/system relationship would mean that communication as well as systemic evolution would stagnate. Stability depends on the system’s ability to reproduce and function both despite and because of ongoing environmental disturbance.”).

The international legal framework for groundwater is constantly evolving. In general, international laws regarding groundwater build on existing rules for surface water. They include the 1966 Helsinki Rules on the Uses of the Waters of International Rivers,¹⁰² which were adopted by the International Law Association and laid out foundational principles for transboundary water issues.¹⁰³ This agreement was followed by the 1997 United Nations Convention on Nonnavigational Uses of Watercourses,¹⁰⁴ which led to the 2004 Berlin Rules on Water Resources.¹⁰⁵

International groundwater law also encompasses the 1986 Seoul Rules on International Groundwaters¹⁰⁶ and the 1994 United Nations International Law Commission Resolution on Confined Transboundary Groundwater.¹⁰⁷ Further, in 2008, the United Nations General Assembly agreed upon a resolution of principles specifically for transboundary aquifers.¹⁰⁸

International agreements specifically dealing with the Guarani Aquifer include the 1969 Treaty on the La Plata Basin.¹⁰⁹ This treaty provides the foundation upon which the Guarani Aquifer Environmental Protection and Sustainable Development Project¹¹⁰ was construed. All the aforementioned multilateral agreements laid the foundation for the Acordo.¹¹¹

102. Int'l Law Assoc., Fifty-Second Conference, Helsinki, Finland, *Helsinki Rules on the Uses of Waters of International Rivers* (1966).

103. Benjamín & Marques, *supra* note 40, at 2220–21.

104. U.N. Convention on the Law of the Non-Navigational Uses of International Watercourses, May 21, 1997, 36 I.L.M. 700 (1997).

105. The Berlin Rules on Water Resources, Aug. 21, 2004, 71 I.L.A. 337, 385 (2004).

106. Int'l Law Assoc., Sixty-Second Conference, Seoul, S. Korea, *Seoul Rules on International Groundwaters* (1986).

107. U.N. Rep. of the Int'l Law Comm'n, 46th Sess., May 2–July 22, 1994, U.N. Doc. A/49/10 (1994), *reprinted in* 2 Y.B. Int'l L. Comm'n 135 (1994).

108. G.A. Res. 63/124, U.N. Doc. A/RES/63/124 (Jan. 15, 2009).

109. Benjamín & Marques, *supra* note 40, at 2228–31.

110. ORG. OF AM. STATES OFFICE FOR SUSTAINABLE DEV. & ENV'T, GUARANI AQUIFER SYSTEM (Oct. 2005), *available at* http://www.oas.org/dsd/Events/english/Documents/OSDE_7Guarani.pdf.

111. Acordo, *supra* note 5 (citing the Treaty of La Plata River Basin and the Environmental Protection and Sustainable Development Project as consideration for the agreement).

A. *Agreement on the Guarani Aquifer (Acordo)*

The Acordo outlines basic principles adopted by the four signatory countries and, if ratified, will represent a step forward for the aquifer's multilateral management while still respecting domestic autonomy. It adopts many of the principles enumerated in the United Nations International Law Commission ("ILC") Draft Articles on the Law of Transboundary Aquifers.¹¹² Even as it emphasizes national sovereignty,¹¹³ the Acordo also obliges signatories to manage the aquifer in accordance with governing principles of international law.¹¹⁴ This includes the obligation to not cause harm to another party or to the environment.¹¹⁵ It also imposes multilateral obligations, including protecting and conserving the aquifer in a manner ensuring multiple, rational, sustainable, and equitable uses.¹¹⁶

Though imperfect, the Acordo represents a significant achievement in the field of international water law. To date, only a handful of international groundwater management agreements exist despite the existence of at least 270 transboundary aquifers, which provide water to millions of people.¹¹⁷ Because the Guarani, like all transboundary water resources, falls under multiple national jurisdictions and because the policies of the respective nations concerning overdraft and pollution impact the rest of the aquifer, the management strategies of the four countries overlying the GAS must be harmonized in order to function effectively. That strategy can derive from principles of reasonable and equitable use¹¹⁸ for allocation policies, as well as principles of no

112. *Draft Articles*, *supra* note 3 (precepts embraced by the Acordo include: no significant harm, sovereignty of the aquifer state, cooperation, and the regular exchange of information); *see also* Bryan A. Green, *The Guarani Aquifer & International Groundwater Law: Advancing Towards a Legal Framework for the Management of a Transboundary Aquifer*, 13 U. DENV. WATER L. REV. 361, 384–85 (2010).

113. Acordo, *supra* note 5, art. 2; *see also* *Draft Articles*, *supra* note 3, art. 3 (declaring that each overlying state has sovereignty over the part of the portion of the transboundary aquifer located in its territory).

114. Acordo, *supra* note 5, art. 2.

115. *Id.* art. 3.

116. *Id.* art. 4. It is worth noting that the aforementioned objectives are aligned with the ones found in the 1997 Brazilian National Water Management Policy Act. *See* National Water Management Policy Act, Lei No. 9.433, art. 1, de 8 janeiro de 1997, DIÁRIO OFICIAL DA UNIÃO [D.O.U.] de 09.01.1997 (Braz.), *available at* [http://www.oas.org/usde/environmentlaw/waterlaw/documents/Brazil-Law_No_9433_\(1997\).pdf](http://www.oas.org/usde/environmentlaw/waterlaw/documents/Brazil-Law_No_9433_(1997).pdf).

117. Benjamín & Marques, *supra* note 40, at 2211–12.

118. Acordo, *supra* note 5, arts. 3–4.

significant harm for issues arising from contamination.¹¹⁹ Even as the Acordo recognizes these key precepts, its enforcement mechanisms remain underdeveloped. This lack of a shared approach to enforcement is understandable in light of the different national interests involved. However, its absence could hinder future efforts to manage the resource multilaterally.

The Acordo adopts a number of important procedural principles. For example, the four nations agree to share information as well as to inform their fellow signatories of any domestic initiatives that may cause transboundary impact.¹²⁰ Furthermore, Article 4 acknowledges the importance of protecting and conserving the aquifer as well as the need to identify areas requiring special attention, especially those near the borders.¹²¹ Nonetheless, as is often the case in multiparty agreements, the language of the Acordo is broad and may simply be papering over disputed issues.¹²²

Similarly, Article 15, which creates a multilateral commission to oversee and manage cooperation between the parties, does not set out any specific duties or authority for the Commission. Instead, it states that the Commission will propound its operating regulations at a later date. This leaves the nascent Commission without a clear mandate or the means to enforce it. That mandate is urgently needed to provide the means to resolve the complex dilemmas that accompany the management of interstate and international transboundary groundwater resources.

However, the threshold question that must precede any other managerial guidance involves determining the correct methodology for equitably allocating the aquifer's waters. While the sheer size of the Guarani could lead one to presume that allocation is not the most urgent managerial issue, that premise is flawed for several reasons.

First, until the waters are allocated, it will be difficult, if not impossible, to codify the principles of sovereignty that the Acordo

119. *Id.* arts. 3, 6–7.

120. *Id.* arts. 8–9. This approach is congruent with existing international law, as articulated in The United Nations Conference on Environment and Development Rio Declaration of 1992 (“States shall provide prior and timely notification and relevant information to potentially affected States on activities that may have a significant adverse transboundary environmental effect and shall consult with those states at an early stage and in good faith.”). *See also* Noah D. Hall, *Political Externalities, Federalism, and a Proposal for an Interstate Environmental Impact Assessment Policy*, 32 HARV. ENVTL. L. REV. 49, 74 (2008).

121. Acordo, *supra* note 5, art. 4.

122. Benjamín & Marques, *supra* note 40, at 2197.

purports to embrace.¹²³ Since sovereignty over transboundary resources is problematic by definition, if the overlying nations do not have the means through which to quantify their control over the resource, irresolvable conflicts become inevitable. Furthermore, the exogenous factors discussed above will likely destabilize cooperation and generate disagreement. The overlying nations could avoid much of that disharmony by equitably allocating the water and creating the means through which to adjudicate disputes arising from current and future use pressures.

Concerns over the nature and scope of the sovereignty guaranteed to the signatory nations in Article 2 are already the subject of vigorous debate.¹²⁴ Indeed, some argue that the mere fact that such language exists within a modern transboundary water agreement reflects the enormous difficulty that continues to bedevil international ground and surface water management.¹²⁵ This debate over the extent and understanding of sovereignty is likely to remain unresolved for the foreseeable future. In the interim, a practical solution would involve recognizing that states can and must collaborate based on a shared vision of existing principles of domestic and international environmental laws, as well as instrumental principles of equitable apportionment. The following two Subparts elaborate on the grounds (1) for the application of existing principles of domestic and international environmental laws and (2) for a more specific management guideline that incorporates the equitable apportionment doctrine, which, in turn, also serves to guide adjudication processes.

123. See Acordo, *supra* note 5. The Acordo notes the principles of sovereignty expressed in Declaration of the United Nations Conference on the Human Environment and Resolution 1803 (XVII). United Nations Conference on the Human Environment, Stockholm, Swed., June 5–16, 1972, U.N. Doc. A/CONF.48/14/Rev.1 (1973); Permanent Sovereignty over Natural Resources, G.A. Res. 1803(XVII), 17 U.N. GAOR Supp. No. 15, U.N. Doc. A/5217, at 15 (1962).

124. See McCaffrey, *supra* note 6; see also Owen McIntyre, *Fragmentation in International Water Resources Law: Reconciling the International Law Commission's 2008 Draft Articles on Transboundary Aquifers with the 1997 U.N. Watercourses Convention*, at 2, in PROCEEDINGS OF THE ISARM2010 INTERNATIONAL CONFERENCE: TRANSBOUNDARY AQUIFERS: CHALLENGES AND NEW DIRECTIONS (Dec. 6–8, 2010).

125. Gabriel Eckstein, *Hydraulic Harmony or Water Whimsy? Guarani Aquifer Countries Sign Agreement*, INT'L WATER L. PROJECT BLOG (Aug. 5, 2010, 11:08 PM), <http://www.internationalwaterlaw.org/blog/2010/08/05/hydraulic-harmony-or-water-whimsy-guarani-aquifer-countries-sign-agreement/>.

B. Managing for Uncertainty Under the Current Legal Regime

1. Using Existing Laws to Manage for Uncertainty

International laws and agreements regarding the GAS offer some guidelines through which the involved countries can assess and manage the myriad eco-systemic and political variables presented by such a vast and multifarious resource. Inventorying uncertainties is a necessary precondition to providing for the needs of the overlying countries.¹²⁶ It is also a requirement for a second important initiative: reducing asymmetric information. That reduction in asymmetry requires qualified public participation at all levels of policymaking.

Nevertheless, cooperation without clearly codified guidelines cannot resolve contentious disputes between sovereign nations. As exogenous and endogenous events create and compound uncertainties (both hard and soft), signatory nations will face pressures that are both as old as human civilization and as new as current events. For example, development pressures and conservation goals offer fertile ground for conflicting interests within the overlying countries. These conflicts can lead to a tragedy of the commons (at both the domestic and transnational levels) if not properly managed.¹²⁷

On the other hand, overregulation can diminish efficiency and impair development. Optimizing regulation presents an ongoing challenge, but the obstacles grow larger when the commons is as complex as the GAS. The complexity and environmental importance of the region, as well as the looming threats presented by climate change, make the need for accurate and detailed scientific and technical information urgent and crucial.¹²⁸ Yet, relying on such information to manage such a complex natural resource creates risks as well.¹²⁹

126. See Cass Sunstein, *Cost-Benefit Analysis and the Environment* (Univ. of Chicago, Olin Law & Econ. Program, Working Paper No. 227.5).

127. See generally Garrett Hardin, *Tragedy of the Commons*, 162 *SCI.* 1243 (1968) (The phenomenon of tragedy of the commons was first described in 1968 by Garrett Hardin. The dilemma occurs when multiple individuals, sharing the same resource act in their own self-interest in using the resource causing the resource to become depleted from overuse.).

128. See Hall et al., *supra* note 93.

129. See generally ULRICH BECK, *RISK SOCIETY: TOWARD A NEW MODERNITY* (Mark Ritter trans., 1986).

Environmental uncertainty can never be eliminated; at best, it can be quantified and reduced.¹³⁰ Too often, however, the role of uncertainty in risk assessment and in legal and managerial decisions gets reduced or ignored.¹³¹ Understanding the role of uncertainty and how to best manage it is necessary to achieve a stable regulatory framework—not just for the Guarani region, but for all transboundary water regimes.

2. *Reducing Asymmetric Information*

Shared information is an often overlooked management tool. Decreasing uncertainty requires reducing asymmetric information. This will require policy makers to bridge the gaps among scientists coming from different areas of knowledge as a first attempt to mitigate the impacts of the socioeconomic burdens born by the regulated sectors.¹³² Local and traditional knowledge, particularly for a resource as vast as the GAS, must also be considered. Capacity building is crucial. Users must have access to state of the art scientific information written in language accessible to nonspecialists. The less asymmetric the information, the lower the degree of uncertainty, and consequently, the more likely the regulatory decision will be beneficial.¹³³ In this context, beneficial means both more legitimate and more procedurally efficient, taking into account the competing uses and needs of different regions within Brazil and within the four overlying nations.¹³⁴

With regard to the GAS, recent developments reveal a laudable collaboration aimed at reducing asymmetric information at all levels: international, regional, and local. However, public participation must also play a key role. Vital information resides within traditional and local knowledge.¹³⁵ Another crucial component of a successful multilateral management strategy (including both multistate and multinational resource management) lies in coordinating actions and plans.

For known unknowns that create endogenous challenges, cost-benefit analysis (accounting for externalities as well as noneconomic factors) can serve a useful function at all levels, from international to

130. See generally Christopher H. Schroeder, *Rights Against Risks*, 86 COLUM. L. REV. 495 (1986).

131. Wildavsky, *supra* note 23.

132. See generally James E. Krier, *Risk and Design*, 19 J. LEGAL STUD. 781 (1990).

133. Gene Rowe & Lynn J. Frewer, *Evaluating Public-Participation Exercises: A Research Agenda*, 29 SCI., TECH., & HUM. VALUES 512, 520 (2004).

134. See generally JEAN-JACQUES LAFFONT, *INCENTIVES AND POLITICAL ECONOMY* (2000).

135. Benjamín & Marques, *supra* note 40, at 2232–42.

local. For exogenous threats, a precautionary approach, tempered by pragmatism and relying heavily on public participation, should govern.¹³⁶ Incorporating the precautionary principle requires understanding and managing for the catastrophic potential of low probability events with high impacts. This involves constructing mitigation policies that navigate dangers presented by unknown and unpredictable events, while remaining nonexclusionary and not unduly burdening regulated sectors.¹³⁷

Incorporating these management tools into the Acordo Commission's mandate will require some tough sledding, but is necessary to the enactment of balanced, responsive policies. In sum, the Commission's mandate must include a transparent and timely procedure to convey scientific information to the general public, enable public participation within the decision-making process, and enable rapid response to environmental and societal shifts. It must also include an effective method for allocating managerial responsibility and enabling dispute resolution among the four nations. Those latter requirements can best be accomplished through a procedure based on principles articulated in the U.S. water law doctrine of equitable apportionment.

136. Article 12 of the *Draft Articles* requires that states overlying transboundary aquifers "take a precautionary approach in view of the uncertainty about the nature and extent of a transboundary aquifer or aquifer system and of its vulnerability to pollution." *Draft Articles*, *supra* note 3, art. 12; Eckstein & Eckstein, *supra* note 3, at 222. However, Article 12 is concerned solely with pollution, not with general management practices. Furthermore, as Professor McCaffrey notes, the precautionary principle is generally relevant to situations where there is scientific uncertainty while there is "[l]ittle . . . uncertainty . . . about the harm pollution would cause to an aquifer." He goes on to argue that it would have been more appropriate for Article 12 to have "enjoined states to exercise a high degree of caution, perhaps even to take precautionary measures, so as to prevent pollution of shared aquifers, rather than to have invoked a principle or approach designed to deal with uncertainty." Stephen C. McCaffrey, *The International Law Commission Adopts Draft Articles on Transboundary Aquifers*, 103 AM. J. INT'L L. 272, 278 (2009).

137. See generally Thomas C. Schelling, *Some Economics of Global Warming*, 82 AM. ECON. REV. 1 (1992).

V. INCORPORATING THE EQUITABLE APPORTIONMENT DOCTRINE INTO THE ACORDO AND CREATING A SOUND MANAGEMENT STRATEGY FOR THE GAS

International groundwater law has already moved towards incorporating principles of equitable apportionment into what the ILC Draft Articles call “equitable and reasonable utilization.”¹³⁸ However, as the name implies, both it and the U.S. doctrine of equitable apportionment are primarily concerned with allocating water rights among interested parties.¹³⁹ The focus of this Part is more on managerial authority and dispute resolution. In order to contextualize the international legal guidelines as well as our recommendations for the GAS, it is instructive to briefly review the U.S. doctrine of equitable apportionment.

A. *The Equitable Apportionment Doctrine*

“Equitable apportionment” is used in U.S. law to allocate surface water between quasi-sovereign states and thereby adjudicate interstate disputes. It is well-suited to adjudicate transboundary groundwater disputes as well. The American system of federalism among quasi-sovereign states resembles, in many key respects, the relations between sovereign nations. As Justice Holmes wrote in *Georgia v. Tennessee Copper* in 1907, a state “has an interest . . . in all the earth and air within its domain. It has the last word as to whether its mountains shall be stripped of their forests and its inhabitants shall breathe pure air.”¹⁴⁰ In 1982, the Court expanded its discussion of the sovereignty of states, noting that they possess at least two relevant sovereign interests: “First . . . the power to create and enforce a legal code, both civil and criminal; second, the demand for recognition from other sovereigns—most frequently this involves the maintenance and recognition of borders.”¹⁴¹

138. As Professor McCaffrey notes, the doctrine was first introduced into international water law in the International Law Association’s 1966 Helsinki Rules and was embraced by the International Court of Justice in its 1997 decision in the *Case Concerning the Gabčíkovo-Nagymoros Project (Hungary/Slovakia)*. STEPHEN C. MCCAFFREY, *THE LAW OF INTERNATIONAL WATERCOURSES* 384–85 (2d ed. 2007).

139. *Id.*

140. *Georgia v. Tenn. Copper Co.*, 206 U.S. 230, 237 (1907).

141. *Alfred L. Snapp & Sons, Inc. v. Puerto Rico ex rel. Barez*, 458 U.S. 592, 601 (1982). The quasi-sovereign nature of states and their consequent right to seek judicial redress for damage to their territory also played a pivotal role in *Massachusetts v. Environmental Protection Agency*, 549 U.S. 497, 519–20 (2007).

This similarity between the right of U.S. states to seek domestic redress for sovereignty violations and the right of sovereign nations to do likewise in international disputes is already recognized by international law outside of the water law context.¹⁴² For example, the *Trail Smelter* adjudication of the dispute between the United States and Canada acknowledged the responsibility of sovereign states for transboundary pollution while also recognizing the value and applicability of U.S. methods for resolving interstate conflicts to international dispute resolution.¹⁴³

In U.S. jurisprudence, equitable apportionment guides the U.S. Supreme Court when exercising its original jurisdiction over interstate disputes over surface water allocation. In other words, when there exists a conflict between two states with differing laws, the Supreme Court resolves the dispute by applying equitable principles tailored to adjudicate interstate water disputes. The Court's involvement in interstate water allocation is more than a century old, and its foundational principles have evolved over time. In *Kansas v. Colorado*, a 1907 case, the Court rejected Colorado's claim that the principles of sovereignty gave Colorado the right to appropriate the entire flow of the Arkansas River.¹⁴⁴ The Court held that "[e]quality of right" is the governing principle for resolving interstate water disputes¹⁴⁵ and that states stand on equal footing "in point of power and right" with respect to interstate water bodies.¹⁴⁶

In 1983, in *Idaho v. Oregon*,¹⁴⁷ the Court articulated a set of applied guidelines for its interstate water jurisprudence:

- States may not preserve the natural resources within their borders solely for their own inhabitants.

142. See MCCAFFREY, *supra* note 138, at 386–99 (describing equitable apportionment and its analogues in international water law).

143. See *Trail Smelter (U.S. v. Can.)* 3 R.I.A.A. 1907, 1965 (1941); see also Cassuto, *The Law of Words*, *supra* note 101, at 109 ("In effect, the decision introduced the Roman concept of *sic utere ut alienum non laedas* (one should use one's own property in such a manner as not to injure that of another) to modern international environmental law."); Brian R. Popiel, Comment, *From Customary Law to Environmental Impact Assessment: A New Approach to Avoiding Transboundary Environmental Damage Between Canada and the United States*, 22 B.C. ENVTL. AFF. L. REV. 447, 451 (1995); Martin D. Gelfand, Note, *Practical Application of International Environmental Law: Does It Work Atoll?* 29 CASE W. RES. J. INT'L L. 73, 77 (1997).

144. *Kansas v. Colorado*, 206 U.S. 46, 97–98 (1907).

145. *Id.* at 97.

146. *Wyoming v. Colorado*, 259 U.S. 419, 465 (1922).

147. *Idaho ex rel. Evans v. Oregon*, 462 U.S. 1017, 1020–27 (1983).

- No state has inherent priority over another state with respect to the waters of interstate streams.
- For its claim to interstate water to have any chance at success, the complaining state must show that it took affirmative steps to conserve water as well as to augment supply.¹⁴⁸

It bears noting that, in addition to the above principles, the Court set a high bar for those states claiming injury over allocations of an interstate water body.¹⁴⁹ The complaining state must show substantial injury to its interests as a result of the actions of the defendant state.¹⁵⁰ Furthermore, the evidentiary standard for proving that injury is “clear and convincing evidence.”¹⁵¹ Both the substantial injury bar and the clear and convincing evidence threshold make it likely that states will exhaust all other options available before resorting to a court challenge.

When interstate disputes do land before the Supreme Court, in addition to the guidelines described above, the Court applies a mix of fundamental principles of equity and basic rules of water management without “quibbling over formulas.”¹⁵² As articulated in *Nebraska v. Wyoming*,¹⁵³ those principles include (but are not limited to) considering the:

- Physical and climatic conditions
- Rates and patterns of consumption
- Existing rights under state law
- Nature and rate of return flows
- Effect of wasteful uses on downstream areas
- Extent and economics of existing uses
- Damage to upstream areas as compared to benefits to downstream areas if upstream uses are restricted

The foregoing guidelines offer a broad framework for dispute resolution while allowing the Court to integrate whatever other factors it deems useful in any given situation. In other words, as J.B. Ruhl points

148. See J.B. Ruhl, *Equitable Apportionment of Ecosystem Services: New Water Law for a New Water Age*, 19 J. LAND USE & ENVTL L. 47, 50–51 (2003).

149. *Idaho*, 462 U.S. at 1027.

150. *Id.*

151. *Id.*

152. *New Jersey v. New York*, 283 U.S. 336, 343 (1931).

153. See *Nebraska v. Wyoming*, 325 U.S. 589, 618 (1945).

out, "equitable apportionment encompasses whatever seems relevant to a fair division of the resource between the states."¹⁵⁴ This flexibility means that it can incorporate new developments in hydrology or ecology and new information about demands and uses and also adapt to situations requiring new or revised principles of law.

The applicability of this regime to international interstate disputes seems clear. As an initial matter, it makes the bar for demonstrating injury sufficiently high so as to discourage litigation and encourage multiple uses. It also places a considerable evidentiary burden on complaining states (the clear and convincing evidence standard) to support the injury claimed. This high evidentiary bar will demand extensive due diligence and thereby encourage alternative dispute resolution. Both of these approaches would work well in an international context.

With respect to the GAS, the size and hydrological variations in the aquifer mean that different states (and the various regions within the different states) will necessarily have different use patterns. Those varying uses will impact the aquifer in differing ways. Consequently, any dispute resolution approach must be flexible and adaptable to these regional variations, similar to the flexibility that is required to respond to exogenous and endogenous managerial challenges.¹⁵⁵ Because it arose to address just such situations, equitable apportionment is highly adaptable to such circumstances. The doctrine offers broad guidelines based on equity and existing legal doctrines in the respective states while allowing consideration of other relevant factors. No one set of legal principles is dispositive, although all are instructive. Equitable apportionment also allows for uncertainty (e.g. variations in climatic conditions, changes in flows and use patterns, etc.) to play a role in dispute resolution practices.

*B. A Viable Dispute Resolution Mechanism: The ICJ is
the Proper Site for Adjudicating Disputes in the GAS*

In addition to a well-articulated dispute resolution process whose authority all parties recognize, the process must be implemented by a body that commands the respect and allegiance of all the parties, and its decisions must have the force of binding international law. Based on its

154. Ruhl, *supra* note 148, at 52.

155. *See supra* notes 22–30 and accompanying text.

track record of effectively adjudicating transboundary disputes,¹⁵⁶ ICJ seems the appropriate forum for settling disputes over the GAS.

In order for ICJ jurisdiction to occur, the ICJ's charter requires that its jurisdiction be spelled out in the agreement between nations. Consequently, for the ICJ to have jurisdiction over the signatories to the Acordo, that jurisdiction must be actually inserted into the agreement. The ICJ has already articulated the need for environmental impact assessments as a requirement for actions with the potential for significant transboundary impact.¹⁵⁷ The equitable apportionment principles articulated by the Acordo Commission should meld nicely with those existing principles to guide the ICJ's adjudication of disputes over allocation. One of the principal benefits of the equitable apportionment allocation and dispute resolution methodology proposed here is that it can operate in the absence of a resolution to the contentious issue of sovereignty over transboundary resources. In this sense alone, it is a significant improvement over the current language of the agreement.

The existing framework is inadequate because it lacks both a philosophical and methodological heuristic for mediating disagreements between the sovereign nations that overlie the resource. Simple calls for cooperation cannot suffice because of the competing allegiances of the disputants. Furthermore, limiting the Acordo Commission's mandate to simply issuing a recommendation for resolving a multilateral disagreement is also insufficient.¹⁵⁸ The irresolvable nature of such disputes leads to overly rigid readings of the sovereignty principle,¹⁵⁹ as well as overly hopeful expectations of multilateral cooperation.¹⁶⁰ By contrast, when applied judiciously in the proper forum, equitable apportionment principles successfully negotiate a middle ground between these two unworkable options.

156. See generally Dr. Jorge E. Vinuales, *The Contribution of the International Court of Justice to the Development of International Law: A Contemporary Assessment*, 32 *FORDHAM INT'L L.J.* 232 (2008).

157. The court noted that it is "a requirement under general international law to undertake an environmental impact assessment where there is a risk that the proposed industrial activity may have a significant adverse impact in a transboundary context, in particular, on a shared resource. . . ." *Pulp Mills on the River Uruguay (Arg. v. Uru.)*, 2010 I.C.J. 14, 83 (April 20).

158. Acordo, *supra* note 5, art. 17.

159. See McCaffrey, *supra* note 6, at 289 (discussing the ill-conceived and poorly received Harmon Doctrine of the United States).

160. See generally *id.* (laying out the flaws in the ILC Draft Articles).

C. Proposed Amendments to the Acordo

Given the foregoing, we propose several clauses for adoption into the Acordo. The first is an amendment to Article 16, the second is an amendment to Article 17, and the last is an additional paragraph to Article 17. This additional paragraph to Article 17 is inspired by the Judicial Settlement of Dispute Clause in the 1975 Statute of the River Uruguay between Uruguay and Argentina. That clause forms the source of the ICJ jurisdiction in the recent case between the two countries regarding pulp mills on the Uruguay River. The proposed clauses are as follows:

We propose the following language for Article 16:

Direct negotiations among the Parties over the interpretation of the application of the Acordo must take into account existing general principles of international water law, and the rules derived from the equitable apportionment doctrine set forth in Article ___ herein.

When called upon to draft recommendations over disputes concerning the interpretation of application of the Acordo, the Commission must be bound by existing general principles of international water law, and by the rules derived from the equitable apportionment doctrine set forth in Article ___ herein.

We propose the following amendment to Article 17:

Any dispute concerning the interpretation or application of the Acordo which cannot be settled by direct negotiations or via recommendations issued by the Commission may be submitted by any the Parties to the International Court of Justice [or the Arbitral Tribunal].

We propose an additional paragraph to Article 17, with the following language:

In hearing cases arising from the dispute resolution clause, the ICJ [or the Arbitral Tribunal] should be bound by generally accepted principles of international law, as well as by the principles of equitable apportionment highlighted (but not limited to those) below:

- Physical and climatic conditions
- Rates and patterns of consumption
- Existing rights under national laws
- Nature and rate of return flows
- Effect of wasteful uses and their transboundary impacts of the GAS
- Extent and the social and economic aspects of existing uses

- Damage to one (or more) neighboring countries as compared to benefits to one (or more) neighboring countries if the prior uses are restricted

It bears noting that adjudication before the ICJ or an Arbitral Tribunal would only become an option after exhausting the mandatory mediation processes imposing direct negotiation and then recommendations issued by the Acordo Commission. In both cases, the mediation procedure would be guided by existing principles of international and domestic law regarding groundwater, and more substantively, by the rules derived from an adapted equitable apportionment doctrine. If mediation cannot resolve a given dispute, the adjudication clause would then apply. The adjudication clause institutes ICJ's jurisdiction.¹⁶¹

A second best approach presupposes that the arbitral clause in Article 19 of the Acordo remains unchanged. The second part then creates the framework through which to implement equitable apportionment of the GAS via the mandate for the ICJ or to the Commission as is currently articulated in Article 15 of the Acordo. This approach would indicate a set of rules accepted by the parties that would guide the ICJ's ruling in accordance with Article 38 of the Statute of the

161. Annex to U.N. Charter, Statute of the International Court of Justice, art. 36, available at <http://www.icj-cij.org/documents/index.php?p1=4&p2=2&p3=0> (last visited Sept. 24, 2012) ("1. The jurisdiction of the Court comprises all cases which the parties refer to it and all matters specially provided for in the Charter of the United Nations or in treaties and conventions in force. 2. The states parties to the present Statute may at any time declare that they recognize as compulsory ipso facto and without special agreement, in relation to any other state accepting the same obligation, the jurisdiction of the Court in all legal disputes concerning: a. the interpretation of a treaty; b. any question of international law; c. the existence of any fact which, if established, would constitute a breach of an international obligation; d. the nature or extent of the reparation to be made for the breach of an international obligation. 3. The declarations referred to above may be made unconditionally or on condition of reciprocity on the part of several or certain states, or for a certain time. 4. Such declarations shall be deposited with the Secretary-General of the United Nations, who shall transmit copies thereof to the parties to the Statute and to the Registrar of the Court. 5. Declarations made under Article 36 of the Statute of the Permanent Court of International Justice and which are still in force shall be deemed, as between the parties to the present Statute, to be acceptances of the compulsory jurisdiction of the International Court of Justice for the period which they still have to run and in accordance with their terms. 6. In the event of a dispute as to whether the Court has jurisdiction, the matter shall be settled by the decision of the Court.").

ICJ.¹⁶² The same authority allows for the formation of an Arbitral Tribunal.

VI. CONCLUSION

In sum, the legal framework for the Guarani represents progress but also highlights the challenges and risks ahead. Brazil's constitutional predicament with respect to transboundary groundwater, as well as other domestic legal hurdles, complicates an already difficult multilateral management process. Overcoming these challenges and effectively managing the Guarani will require both domestic legal reform, as well as increased attention to hard and soft uncertainty questions. Once categorized, policy makers must allow for public participation through the promotion of awareness, capacity building, community involvement, and traditional knowledge. In addition, the regulatory framework must acknowledge the unitary nature of the aquifer while still remaining sensitive to differing national and local priorities. This challenge, faced by every transnational water negotiation, looms particularly large with the GAS because of the size and importance of the resource and because of its impact on other sensitive and protected regions.

The Acordo is a strong beginning to the creation of a multilateral management regime, but it cannot yet function effectively. Significant changes in both the domestic hydro-legal regimes of the overlying countries remain necessary, as is the emendation of the Acordo itself. While this Article confines itself to the domestic groundwater regime of Brazil, similar attention must be paid to the regimes of Argentina, Uruguay, and Paraguay. Nevertheless, given Brazil's size and dominance of the aquifer region, if and when it harmonizes its groundwater laws and brings transboundary groundwater under federal jurisdiction, that concordance will constitute a significant step toward effective multilateral management.

Finally, the Acordo itself must be strengthened to include a mandate for the Commission it creates, and to create an effective dispute

162. *Id.* art. 38 (“1. The Court, whose function is to decide in accordance with international law such disputes as are submitted to it, shall apply: a. international conventions, whether general or particular, establishing rules expressly recognized by the contesting states; b. international custom, as evidence of a general practice accepted as law; c. the general principles of law recognized by civilized nations; d. subject to the provisions of Article 59, judicial decisions and the teachings of the most highly qualified publicists of the various nations, as subsidiary means for the determination of rules of law. 2. This provision shall not prejudice the power of the Court to decide a case *ex aequo et bono*, if the parties agree thereto.”).

resolution process. We have proposed a process that draws on existing principles of international groundwater law (equitable and reasonable utilization) while hearkening back more strongly to the predicates of that doctrine, which lie within the principle of equitable apportionment. We argue that the Acordo should be amended to create jurisdiction for the ICJ over multilateral disputes in the GAS and that those disputes be resolved according to principles laid out in the jurisprudence of equitable apportionment.

Justice Holmes wrote that “a river is more than an amenity, [sic] it is a treasure.”¹⁶³ The same is true—perhaps even truer—of the Guarani Aquifer. The proposals offered here represent part of an ongoing process to safeguard this treasure against the pressures and challenges of a changing world and climate while allowing its sustainable use in perpetuity. There are uncertain days ahead for the GAS and for the four countries that manage it. But uncertainty has always been with us and will never disappear. The goal is not to eradicate uncertainty but rather to formulate an effective strategy for managing it.

163. *New Jersey v. New York*, 283 U.S. 336, 342 (1931).