

Identifying International Legal Trends for Managing Transboundary Groundwater and Aquifers

Gabriel Eckstein

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Transboundary Groundwater
and Aquifers*

The Groundwater Project

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*The Groundwater Project
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The Groundwater Project Foreword

The United Nations (UN) Water Summit on Groundwater, held from 7 to 8 December 2022 at the UNESCO headquarters in Paris, France, concluded with a call for governments and other stakeholders to scale up their efforts to better manage groundwater. The intent of the call to action was to inform relevant discussions at the UN 2023 Water Conference held from 22 to 24 March 2023 at the UN headquarters in New York City. One of the required actions is *strengthening human and institutional capacity*, for which groundwater education is fundamental.

The 2024 World Water Day theme is *Water for Peace*, which focuses on the critical role water plays in the stability and prosperity of the world. The [UN-Water website](#)[↗] states that *more than three billion people worldwide depend on water that crosses national borders*. There are 468 transboundary aquifers, yet most countries do not have an intergovernmental cooperation agreement in place for sharing and managing the aquifer. Moreover, while groundwater plays a key role in global stability and prosperity, it also makes up 99 percent of all liquid freshwater—accordingly, groundwater is at the heart of the freshwater crisis. *Groundwater is an invaluable resource.*

The Groundwater Project (GW-Project), a registered Canadian charity founded in 2018 is committed to advancement of groundwater education as a means to accelerate action related to our essential groundwater resources. We are committed to *making groundwater understandable* and, thus, enable *building the human capacity for sustainable development and management of groundwater*. To that end, the GW-Project creates and publishes high-quality books about *all-things-groundwater*, for all who want to learn about groundwater. Our books are unique. They synthesize knowledge, are rigorously peer reviewed and translated into many languages, and are free of charge. An important tenet of GW-Project books is a strong emphasis on visualization: Clear illustrations stimulate spatial and critical thinking. The GW-Project started publishing books in August 2020; by the end of 2023, we had published 44 original books and 58 translations. The books can be downloaded at gw-project.org[↗].

The GW-Project embodies a new type of global educational endeavor made possible by the contributions of a dedicated international group of volunteer professionals from a broad range of disciplines. Academics, practitioners, and retirees contribute by writing and/or reviewing books aimed at diverse levels of readers including children, teenagers, undergraduate and graduate students, professionals in groundwater fields, and the general public. More than 1,000 dedicated volunteers from 70 countries and six continents are involved—and participation is growing. Revised editions of the books are published from time to time. Readers are invited to propose revisions.

We thank our sponsors for their ongoing financial support. Please consider donating to the GW-Project so we can continue to publish books free of charge.

The GW-Project Board of Directors, January 2024

Foreword

This book, “Identifying International Legal Trends for Managing Transboundary Groundwater” is a sequel to the book: “Cross-Border Impacts Related to Transboundary Aquifers: Characterizing Legal Responsibility and Liability,” which was published by the Groundwater Project in 2023. There are 468 aquifers and aquifer systems in the world that are identified as *transboundary*. This designation means that water in an aquifer underlying one nation flows to areas beneath a neighboring country, either naturally or induced by groundwater withdrawals in the neighboring country. Just as a river that flows from one country to another can pose international issues (e.g., when the action of one country negatively impacts the river water in another country), transboundary groundwater can be the subject of disputes. For example, when groundwater withdrawal causes diminishment of the groundwater resource in a neighboring country, there is potential for a transboundary water issue, as there can be if contaminated groundwater migrates beneath another country.

Although the number of aquifers identified as transboundary involve more than a hundred countries, the international legal regime applicable to transboundary groundwater is in an early stage of development. The first book in this pair described various hydrogeologic circumstances that can result in cross-border impacts on groundwater. This second book uses the few existing, international, formal agreements and informal arrangements applicable to transboundary groundwater to introduce the reader to the legal thought processes and trends relevant to the status of these transboundary water resources under international law. As the occurrence of drought expands while food for the global population remains tied to irrigation, use of groundwater is increasingly the last resort. Hence, the need for attention to the interface between law and hydrogeology is mounting.

The author of this book, Gabriel Eckstein is a professor of law at Texas A&M University. He holds two law degrees, a degree in geology, and a degree in international relations. In addition, he gained insights about groundwater from professional collaborations with his father, Dr. Yoram Eckstein (deceased), who was a hydrogeology professor and practitioner. He has three decades of experience in international law and policy for cross-border freshwater resources and has worked on numerous water law and policy initiatives, including the UNESCO-led advisory group established for the UN International Law Commission that crafted the UN Draft Articles on the Law of Transboundary Aquifers.

John Cherry, The Groundwater Project Leader
Guelph, Ontario, Canada, Month 2024

Preface

Groundwater respects no political borders. It flows where the forces of nature take it. When artificial boundaries demarcate territory, jurisdiction, and sovereignty, it simply ignores those maps. Apart from most island-nations, groundwater resources traverse the international frontiers of every country on the planet.

While this reality makes clear sense to water scientists and engineers, it is not always apparent or palatable for policymakers, politicians, or even the average person. Communities and nations all-too-often seek to tame groundwater and force it to conform with humanity's political designs to determine who owns the precious liquid, and who has the right to exploit it.

This is not to say that we should not have rules for sharing this transboundary resource. On the contrary, this book is an appeal for more thoughtful and science-based approaches to the governance of transboundary groundwater and aquifers. Whether or not we like the current international political order, it is unlikely to change anytime soon. Hence, we need to craft international law in ways that both fit within the existing political system and make scientific sense. We have a chance to do just that with the management of international, cross-border groundwater resources.

Although many other natural resources have been subjected to rules governing their cross-border administration and use, the international legal regime applicable to transboundary groundwater and aquifers is still in a nascent stage of development. Until now, few nations have engaged with their neighbors over these resources. Thus, there was no need for such law. But with growing challenges posed by expanding economies and increasing demand, pollution of existing water supplies, climate change, and water scarcity, many countries have begun to intensify their interest in these subsurface, cross-border waters.

Having little international experience to draw from, these nations are moving slowly to identify and develop rules for transboundary subsurface waters. They are also testing and borrowing concepts and norms from other transboundary regimes, such as those applied to cross-border rivers and lakes. As these principles and norms are implemented, it will be useful to identify trends in their evolutionary process in order to challenge their logic, application, and suitability in light of both political and scientific reality. This book is an early effort in that direction.

Reviewing all of the formal agreements and informal arrangements applicable to transboundary groundwater and aquifers that have ever been crafted, this book explores the current international legal status of these resources. It identifies trends and gaps in the emerging international regime, and highlights some of the legal practices and approaches that various nations are currently employing to administer their transboundary groundwater and aquifers.

Upon completion of this book, the reader will:

1. Recognize some of the sources of international law, including formal agreements and informal arrangements, that can serve as the basis for the international legal trends for transboundary groundwater and aquifer governance.
2. Identify and have a general understanding of the trends developing in the evolution of international law for transboundary groundwater and aquifers.
3. Have a better sense of the challenges of harmonizing international politics and law with the science of groundwater resources.

What legal principles and norms will ultimately inure among the global community for the governance of transboundary groundwater and aquifers remains unclear. However, by tracking the progress, sharing experiences, and engaging in thoughtful analysis, the hope is that the regime that emerges is reasonable and sound, both politically and scientifically.

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- ❖ Laura Movilla, Lecturer, University of Vigo, Vigo, Spain;
- ❖ Dave Owens, Professor of Law and Associate Dean for Research at University of California, Berkeley, USA; and
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Citations are provided to acknowledge the sources of material presented in figures and tables. Where no citation appears, the figure or table material is original to this book.

1 Introduction

As global demand for freshwater resources continues to grow, groundwater resources that traverse international boundaries have become increasingly important. This is due, in large part, to the realization that apart from most island nations, there is scarcely a country in the world not linked hydrologically to a neighboring sovereign nation (Teclaff & Teclaff, 1979; Almásy & Busás, 1999).

An international transboundary aquifer is a groundwater-bearing formation that spans across (and below) an international border of two or more nations, as illustrated in Figure 1. The setting for such aquifers can be complex with aquifer recharge and discharge occurring in different or multiple nations, and across river basins. A key feature of such aquifers is hydrological connectivity, meaning that actions in one part of the aquifer (like extraction or pollution) can impact water availability and quality across the boundary. Moreover, because they cross international political jurisdictions, their management and usage often raise complex legal and political considerations that require negotiation and cooperation to ensure their sustainable use, as well as to prevent conflicts over scarce water resources.

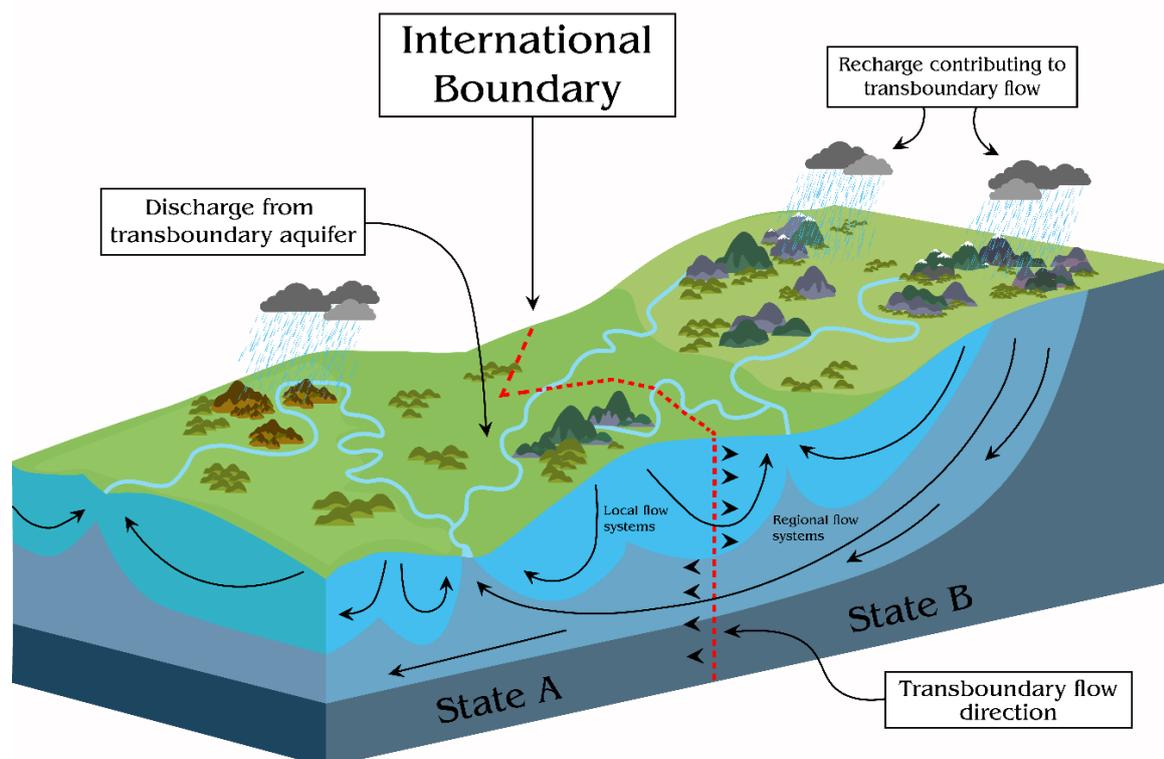


Figure 1 - An international transboundary aquifer is one that traverses an international border. While cross-border groundwater flow is often a key feature of transboundary aquifers, fossil aquifers, which can have little to no actual flow, also can be transboundary and underlie political boundaries.

To date, 468 aquifers have been identified as traversing an international frontier (International Groundwater Resources Assessment Centre (IGRAC), 2021)¹, including 106 in Africa (Figure 2); 130 in Asia, Oceania, (Figure 3) and the Middle East (Figure 7); 52 in Central and South America (Figure 4); 83 in North America (Figure 5); and 97 in Europe (Figure 6). These numbers, however, are expected to grow as additional data and information are developed.

¹ In its 2015 map, IGRAC identified 592 “transboundary aquifers and groundwater bodies.” In its 2021 edition, IGRAC decided not to include transboundary groundwater bodies “in order to more accurately reflect the true number of transboundary aquifers globally.” IGRAC explained that “[t]ransboundary groundwater bodies are not necessarily complete hydrological units, but rather management units. In many cases, aquifers are subdivided into groundwater bodies while occasionally groundwater bodies may contain multiple aquifers. This causes confusion when describing the number and extent of transboundary aquifers and aquifer systems across Europe” (IGRAC, 2021).



Figure 2 - Transboundary aquifers of Africa (adapted from IGRAC, 2022a).

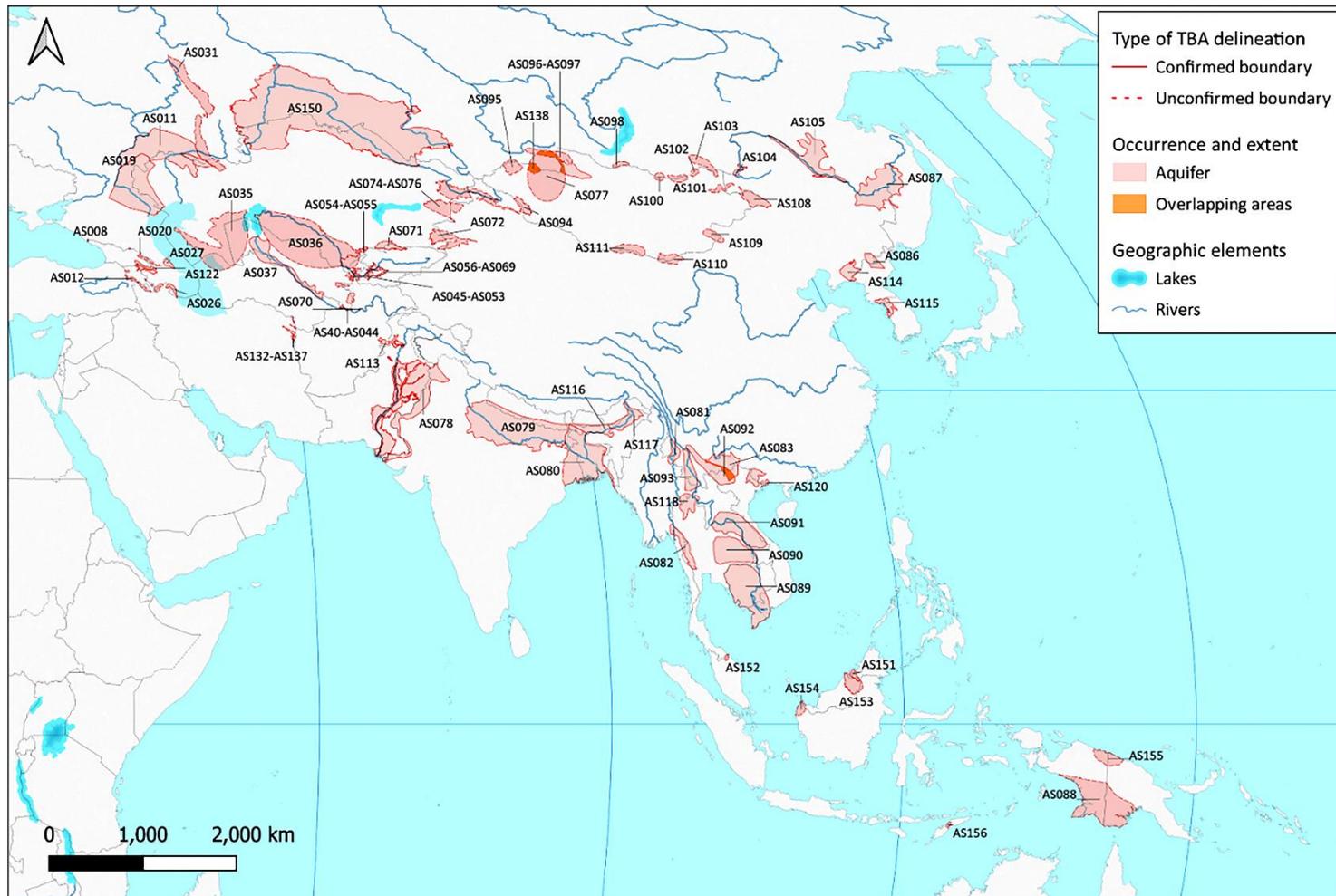


Figure 3 - Transboundary aquifers in Asia and Oceania (IGRAC, 2022b).



Figure 4 - Transboundary aquifers of Central and South America (adapted from IGRAC, 2022c).

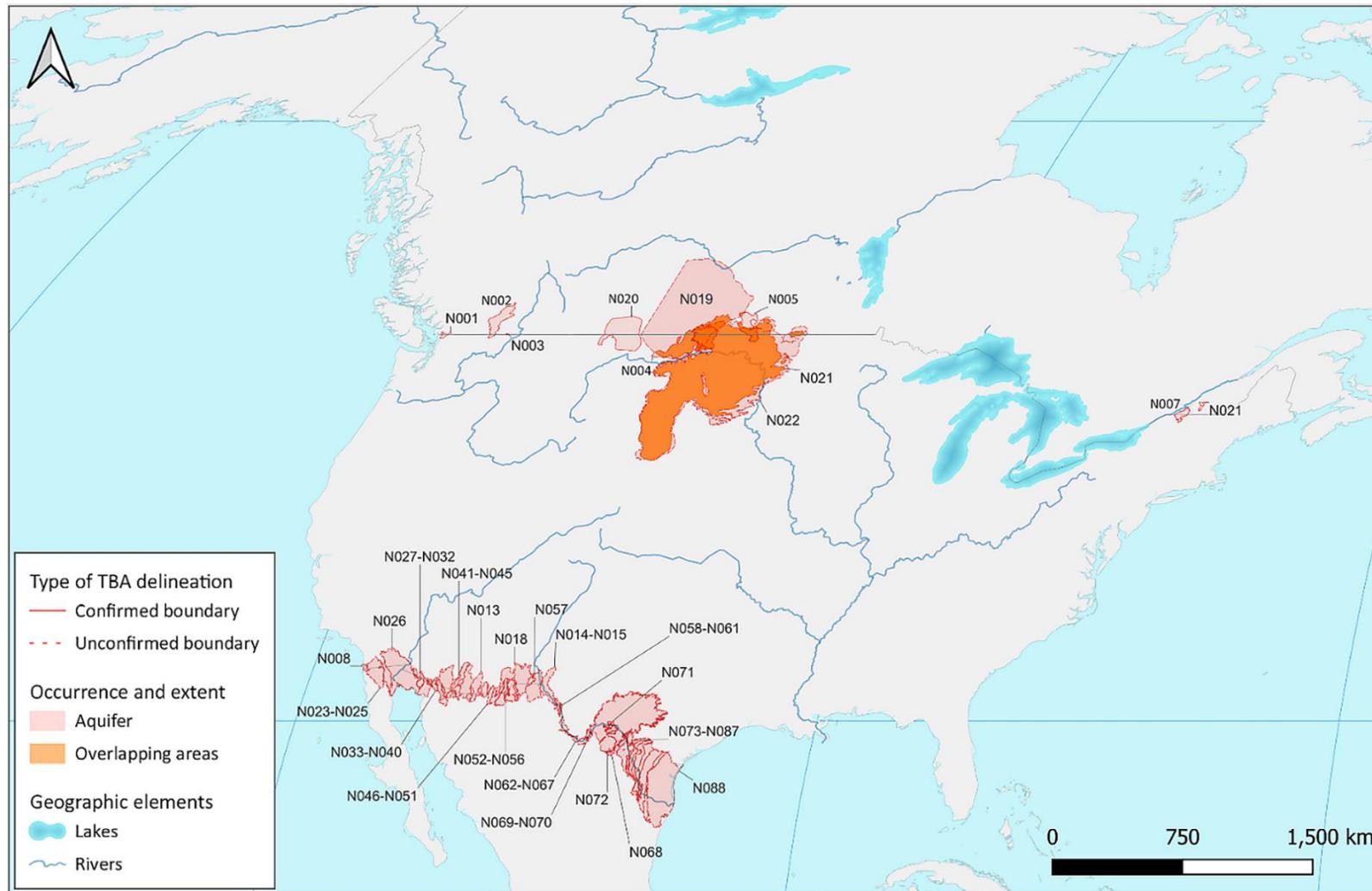


Figure 5 - Transboundary aquifers of North America (adapted from IGRAC, 2022f).

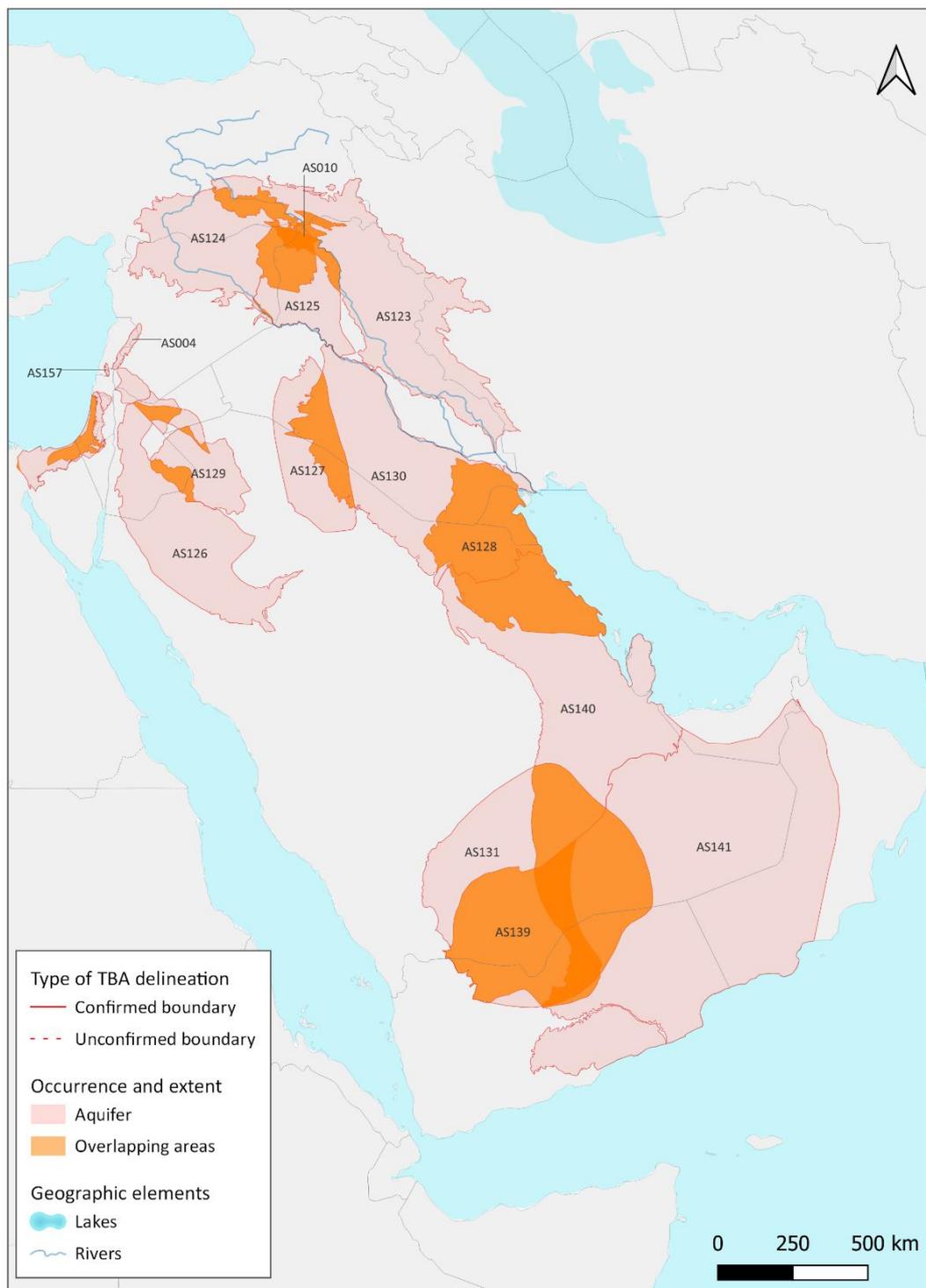


Figure 7 - Transboundary aquifers of the Middle East (adapted from IGRAC 2022e).

Currently, knowledge about transboundary aquifers remains incomplete for many regions of the world such as parts of Africa and Central and South Asia. While the precise global human, environmental, and economic significance of these shared resources has escaped quantification, extrapolations suggest that it is far from insignificant. Groundwater today is the most extracted natural resource on Earth with more than 1,000 km³ of groundwater being extracted every year worldwide to meet agricultural, industrial, and human needs (Famiglietti, 2014). That is more than 170 times the total volume of oil extracted annually around the world.² Around 40 percent of the world's production of irrigated crops is dependent on groundwater; 45 percent of humanity's freshwater needs for everyday domestic uses, such as cooking and hygiene, come from groundwater (Margat & van der Gun, 2013); and more than half of all drinking water originates from freshwater aquifers (Mukherjee et al., 2021; Figure 8).



Figure 8 - Access to clean water can improve lives on many levels (photo credit: Rawles, 2024).

Moreover, and more specific to the focus of this book, transboundary aquifers and groundwater resources are critical to a significant proportion of the world's population. We know, for example, that more than 40 percent of the world's population resides in transboundary river basins (UN Environmental Programme, 2002) and that most rivers—including transboundary rivers—are hydraulically connected to alluvial or other aquifers. While aquifers do not always underlie the entirety of river basins, it is logical to infer that a comparable if not larger number of people reside in the basins of aquifers that either are directly transboundary or otherwise connected to transboundary watercourses.

² According to [statista.com](https://www.statista.com), in 2014 (and again 2021), global oil production amounted to 4.2 billion metric tons. That is equivalent to 5.833 km³ of oil annually, which is approximately 170th of the total volume of groundwater extracted in 2014 (Statistica, n.d.).

In addition, some large transboundary aquifers extend beyond the geographic boundaries of transboundary river basins, and numerous communities and nations around the world rely on cross-border fossil aquifers as their primary source of freshwater. Accordingly, it is evident that a significant proportion of the global population is dependent on aquifers and groundwater bodies that traverse international political boundaries.

Despite this intense global dependency, until rather recently, politics and law had scarcely considered these subsurface resources in an international transboundary context. Only a handful of treaties address transboundary aquifers, and there are few concrete international legal rules governing relations over cross-border groundwater resources. One of the challenges has been the conflation of groundwater and aquifers within political and legal circles, even though these are distinct concepts with specific meanings.

Groundwater refers to the water found in the saturated portion of an aquifer, while an aquifer is a permeable geologic formation that has the capacity to store and transmit water (Rivera, 2021). Thus, groundwater is the liquid that fills an aquifer, and the two terms are not interchangeable. This has raised the question of whether international regulatory mechanisms should focus on groundwater, on aquifers, or both. As a general matter, this debate has yet to be resolved. Thus, for the purpose of his book, I refer to *groundwater* when referring to the liquid, and to *aquifers* when referring to the formation. Where appropriate, I refer to both intentionally.

Notwithstanding, nations and intergovernmental organizations are now beginning to discuss and explore possible legal regimes and mechanisms for the exploitation and management of transboundary groundwater and aquifers. Moreover, several countries overlying specific transboundary aquifers have begun to experiment and implement various approaches to address rights and obligations pertaining to these shared subsurface resources. While the legal status of transboundary groundwater and aquifers under international law is still at a very early stage of development, several emerging trends and priorities can be distinguished.

This book identifies the few available formal agreements and informal arrangements that exist between nations over specific shared aquifers. It also highlights several global instruments that are relevant to the topic and evaluates all of them as possible sources for customary international law for the management of transboundary groundwater resources and aquifers. The presumption adopted here is that the principles of state conduct emerging from these instruments can be viewed as representative of state practice in the management of these resources for the purposes of identifying customary international law. Based on this analysis, the book identifies and characterizes the main trends, practices, and priorities that emerge from these instruments for the assessment, use, allocation, and protection of cross-border groundwater and aquifers. Lastly, the book highlights various gaps and shortcomings in the emerging international legal regime and offers recommendations for the further development of the law.

It is noteworthy that the analysis presented here does not address state conduct and practice that have not been memorialized in formal or informal instruments; nor does it consider treaties and other instruments that apply to river basins and purport to encompass adjacent or hydrologically connected transboundary aquifers within their regime. While undoubtedly relevant to the present discussion, these examples require more extensive investigations and the collection of data and information that are beyond the scope of this book. These additional sources of customary state practices, however, should be addressed in subsequent research and supplemented to the present work.

Notwithstanding these shortcomings, the current research is critical to better understand how cross-border groundwater resources and aquifers can and should be sustainably managed to ensure adequate freshwater for people and the environment. Moreover, in the face of ever-increasing pressures from economic and population growth, climatic changes, and dwindling supplies, cooperation over all transboundary freshwater resources, including groundwater, must be a global priority. Ultimately, the purpose of this book is to facilitate international cooperation among nations sharing transboundary groundwater and aquifers.

2 Understanding International Law

Before embarking on a discussion of the emerging international law for transboundary groundwater and aquifers, it is important to clarify what is international law and what it is not. In addition, it is imperative to understand how international law is formed and created, and how it differs from the domestic legal regimes found around the world.

When speaking of international law, scholars and practitioners usually refer to what is known as public international law to differentiate it from private international law (Figure 9). The latter can be set aside for purposes of this book as it pertains to the law governing private transactions across borders—transactions between private actors (individuals and companies), as well as between private actors and national governments, for the exchange of goods and services—which is governed by international trade and contracts law. In contrast, public international law, which is directly relevant to the subject matter of this book, constitutes the set of norms, rules, and standards that apply to the conduct of nations as they relate to each other. This is the law that applies when nations engage with each other over cross-border resources like freshwater.

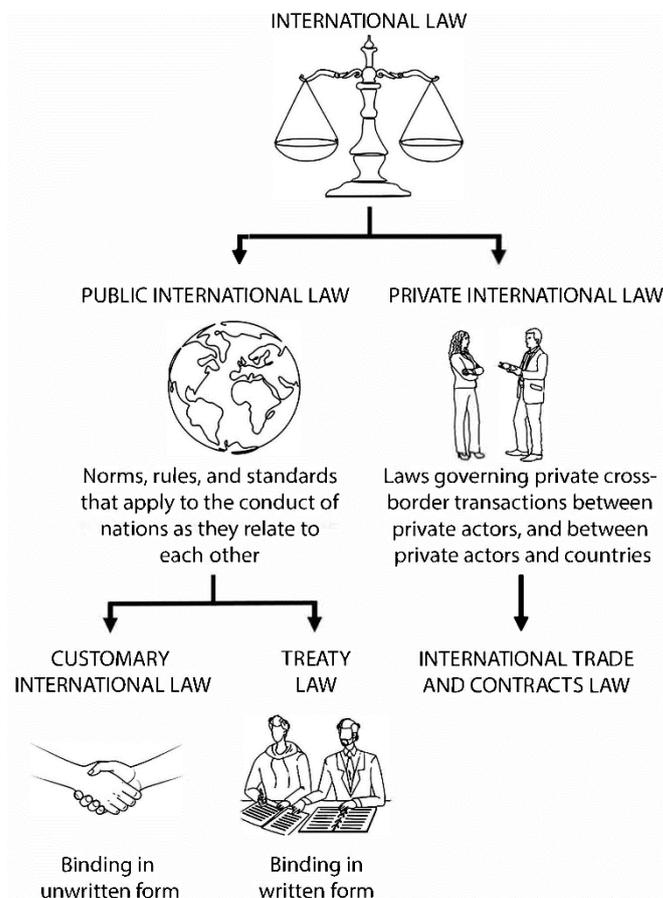


Figure 9 - International law is composed of public international law, which encompasses international water law and relations among nations over shared freshwater resources, and private international law, which applies to commercial and other private cross-border transactions between private actors, as well as between a private actor and a state.

When assessing public international law, two inter-related points are particularly important for understanding how the system works, and how it is different from state-based legal regimes. The first is that public international law primarily applies to countries and not to individuals. This means that there are only approximately 200 actors globally who are subject to international law. With few exceptions—such as those related to human rights and the laws of war—people and corporations are governed exclusively through the domestic laws of nations (Crawford, 2012).

Second, public international law is not a system in which law is established and enforced through a parliamentary or administrative process. There is no legislative body authorized to craft binding international laws and norms. While the General Assembly of the United Nations (UN) can formulate global treaties, it has no authority to impose them on, or enforce them against, any nations. Rather, the international legal system operates predominantly through the consent of the members of the international community. States effectively must agree to be bound by specific rules and principles for them to be binding.

In the case of a new treaty, each state must affirmatively ratify or accede to that instrument before it can be made obligatory for that state. This approach to the development of law is due to the absence of a political and legal hierarchy or an authoritative global government operating in the international arena. Moreover, it reflects the reality that public international law is really a function of international politics and diplomacy. No sovereign nation can be legally forced to submit to a rule or norm with which it disagrees, even those that it wishes to ignore; compliance by nations with international law can only be achieved through compromise and diplomacy. Even where an international tribunal concludes that a violation of law has occurred, a remedy can usually be achieved only with the acquiescence of the rule-breaking nation (Crawford, 2012).

Public international law is largely derived from two principal sources: formally codified instruments like treaties and conventions (collectively *treaty* or *treaties*) and customary practices of nations that rise to the level of customary international law. Generally, a treaty is a formal, binding, and written agreement between sovereign nations; in simple terms, a treaty is a contract entered into by two or more countries. It creates international obligations, or treaty law, for those nations that have ratified the instrument and, thereby, consented to the regime, norms, and obligations found in the document.

By itself, however, a treaty does not bind any nation that does not ratify the instrument. Thus, for example, the *Treaty on the Utilization of Waters of the Colorado and Tijuana Rivers and of the Rio Grande* entered into by the United States and Mexico in 1944 only obligates the United States and Mexico and has no impact on any other nation. Likewise, the *UN Convention on the Non-navigational Uses of International Watercourses* (1997), which has been ratified by 37 State Parties, is binding only on those 37 states. To obligate nations who might not otherwise endorse or join a treaty, something else is needed. This is known as customary international law (Shaw, 2012).

Customary international law refers to law that develops because of customarily accepted practices of states that are not necessarily codified or written in a treaty. It is the outcome of two interrelated notions:

- an objective element that consists of broad and consistent conduct of states in response to particular issues or situations, and
- a subjective element whereby the states abiding by the particular conduct do so under the belief that it is both legally appropriate and obligatory (Shaw, 2012).

The first element is described as *state practice* and reflects a need to show that a considerable number of nations consistently follow the specified conduct over some extended period (Figure 10). The second component, often expressed by the Latin phrase *opinio juris sive necessitatis*—literally, *an opinion of law or necessity*—requires that the conduct be pursued out of a sense of legal obligation rather than moral responsibility or threat of reprisal (Shaw, 2012).

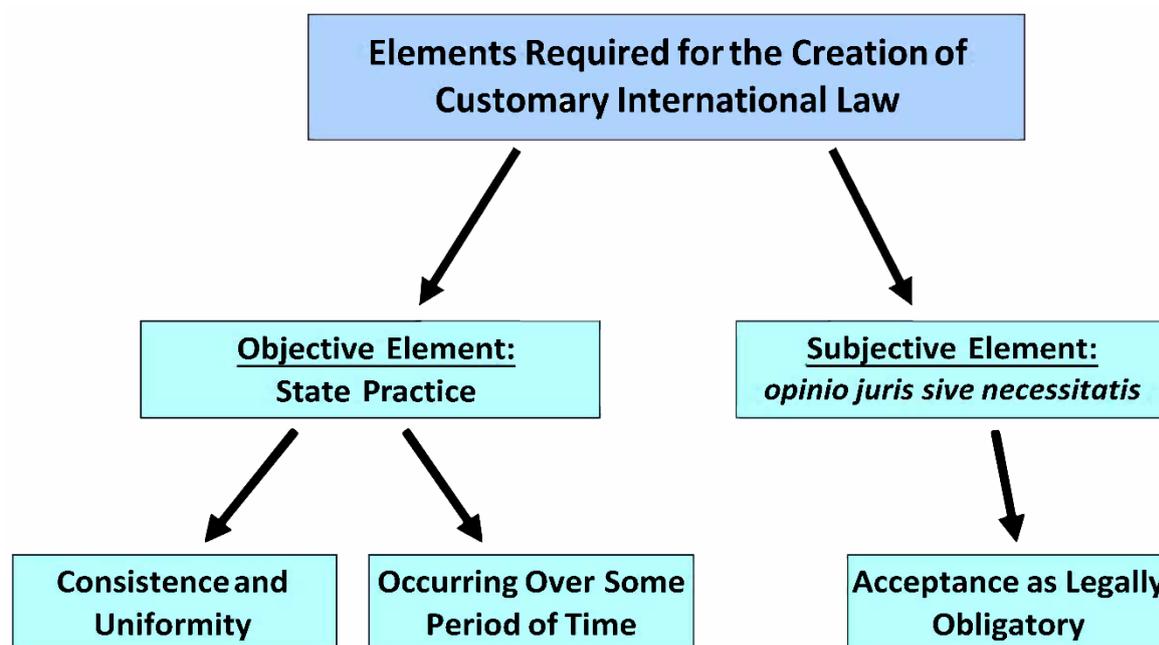


Figure 10 - Elements of customary international law.

Thus, for example, the obligation to cooperate over transboundary waters “on the basis of sovereign equality, territorial integrity, mutual benefit and good faith,” as articulated in Article 8 of the UN Watercourses Convention (1997), is well-recognized as having already been incorporated into customary international water law (McCaffrey, 2019). The state practice element is evidenced by the hundreds of examples in which nations around the world have engaged with their riparian neighbors to cooperatively address various freshwater-related challenges. Moreover, the *opinio juris* [abbrev. for *opinio juris sive necessitatis*] component is demonstrated not only by the unwavering recurrence of such cooperation—suggesting that the conduct is obligatory; it is also confirmed by the fact that countries on five continents on hundreds of transboundary watercourses have entered into hundreds of treaties that incorporated the obligation (McCaffrey, 2019).

Generally speaking, customary international law is binding on all nations. Thus, the obligation to cooperate over transboundary waters as described in this book is obligatory for all the world's nations. An exception to this rule arises when a state formally and persistently objects to a specific customary international legal norm from the time that the custom was formed and also adopts a contrary practice. Where such an objection is persistently asserted, the state raising the objection is excused from complying with the specific norm it is protesting.

If a state formally and persistently objects to a customary norm that has already been established, its objections do not necessarily impact the particular customary international legal norm unless other states also agree to the deviation. While one or two such protestors will not have a significant impact on the status of a particular customary international law norm, where multiple states persistently object to the same customary practice, the normative value of that practice may begin to wane (Crawford, 2012). Thus, for example, as nations began to object to the relevance and applicability of the principles of absolute territorial sovereignty and absolute territorial integrity in the context of transboundary watercourses during the 1800s and 1900s, their acceptance as part of customary international water law have significantly diminished to the point of irrelevance. Today, both principles—which proponents assert to claim a right to use the entirety of all freshwater within their national boundaries irrespective of any impact on other countries sharing a particular freshwater resource—are considered by most of the world's nations as untenable relics of the law that have been superseded by the notion of limited territorial sovereignty (McCaffrey, 2019).

Customary international law differs from treaty law in the sense that the former exists and is binding in its unwritten form. With some exceptions, it also differs from treaty law by being binding on all nations (except persistent objectors) since there is no need for formal ratification by each individual nation. This is not to say that the two sources of law are mutually exclusive. Articulations of customary international law are often found in bilateral and multilateral treaties and other international instruments, which can serve as further evidence for the existence of a customary norm.

Likewise, a legal standard that previously had not been widely practiced by states, but which is codified in international agreements, can evolve into a customary international legal norm if a significant number of nations ratify the relevant instruments and conform their conduct to the specific norm (Crawford, 2012). While it is a significant overgeneralization, it may be helpful to conceptualize treaty law, especially multilateral treaties, as a top-down approach to the creation of international law resulting from formally negotiated agreements, while customary international law is a bottom-up approach based on the consistent practice, conduct, and action of states in response to particular issues or situations.

For purposes of this book, the analysis explores a series of formal agreements and informal arrangements that specifically address the assessment, use, allocation, and protection of cross-border groundwater resources and aquifers. The objective of this

investigation is to identify and describe emerging customary international legal norms based on obligations and responsibilities found in those instruments. The book presumes that state conduct grounded in these written obligations represents state practice for the purpose of customary international law.

One final point that is important for understanding the evolving international law of transboundary groundwater resources is the distinction between formal agreements and informal arrangements. While certainly an oversimplification of how such instruments are perceived and treated, for purposes of this book, among the international legal community an *agreement is considered to be* an instrument that creates a formal relationship between sovereign nations that is entered into by national representatives under the banner of international law, and is ratified by a nation in conformity with that nation's domestic legal authorization procedures. Thus, the 1969 Vienna Convention on the Law of Treaties defines the term *treaty* to mean "*an international agreement concluded between States in written form and governed by international law.*" Like a contract between private parties, such an instrument:

- creates obligations to take or refrain from taking certain action;
- is considered lawfully binding between the ratifying parties to the instrument;
- and,
- at least in theory, can be taken to an international tribunal to enforce commitments and address violations.

In contrast, an *informal arrangement* is an unofficial instrument that creates a non-binding, aspirational relationship between the parties, and is entered into without the official imprimatur of any national authority (Movilla Pateiro, 2016). Informal arrangements can be entered into by national governments or by subnational units (e.g., municipalities, cantons and provinces, state agencies, and so on). For example, two subnational units located across an international border may enter into a cross-border pact or understanding that is not formally sanctioned, yet not prohibited, by their respective national governments. As a matter of law, such informal arrangements usually have no binding force in either the domestic legal systems of the two neighboring countries or under international law, and cannot be used as a basis for mandating action or sanctions in response to alleged violations.

Thus, for example, the *Treaty on the Utilization of Waters of the Colorado and Tijuana Rivers and of the Rio Grande* entered into by the United States and Mexico in 1944 is a full-fledged, official, and binding treaty. It created a formal relationship between the two countries for the management and allocation of the three cross-border rivers named in the instrument's title and obligated them to create the binational commission known as the International Boundary and Water Commission. The treaty was negotiated and signed by officially designated representatives of the two nations; it was then ratified by both Mexico and the United States in conformity with each of their domestic legal authorization procedures.

In contrast, when the Junta Municipal de Agua y Saneamiento de Juarez, Chihuahua, Mexico, entered into a Memorandum of Understanding with the El Paso Water Utilities Public Services Board of the City of El Paso, Texas, USA, for the exchange of information on and cooperation over the Rio Grande River and Hueco Bolson Aquifer that traverses their common border, the resulting instrument was an informal arrangement as it was entered into without the formal authorization of the respective federal governments. Thus, its contents are non-binding and unenforceable under the laws of either nation or under international law.

Nevertheless, both agreements and informal arrangements can be viewed as evidence of state practice for purposes of establishing customary international law. In the case of formal agreements, the conduct is official and sanctioned, and directly attributable to the nations that ratify the instrument; in the case of informal arrangements, while the conduct is unofficial, if it is not prohibited or otherwise rejected by the national governments of the countries involved in the pact, that conduct may be attributed to the two states for purposes of identifying state practice. Accordingly, both agreements and informal arrangements can serve as evidence of customary international legal practices.

3 Sources for Identifying International Law for Transboundary Groundwater and Aquifers

Despite the relevance of transboundary groundwater and aquifers to human existence, economic development, and environmental sustainability, domestic and international attention on these subsurface resources is a relatively recent phenomenon. This book identifies seven agreements and eight informal arrangements globally (Figure 11)—some of which are composed of a series of sub-instruments that collectively form the respective agreement or informal arrangement—that create a governance regime specific to a particular transboundary aquifer, aquifer system, or series of aquifers. The instruments that have been identified to date are provided in Table 1, Table 2, and Table 3.

Official Transboundary Groundwater Agreements	Informal Transboundary Groundwater Arrangements
2017 Carboniferous Limestone Aquifer Agreement (Belgium & France)	2019 Senegalo-Mauritanian Aquifer Basin
2015 Al-Sag/ Al-Disi Aquifer Agreement (Jordan & Saudi Arabia)	2017 Ocotepeque–Citalá Aquifer (El Salvador & Honduras)
2010 Guarani Aquifer Agreement (Argentina, Brazil, Paraguay & Uruguay)	2017 Stampriet Transboundary Aquifer System (Botswana, Namibia & South Africa)
2009 Series of documents for aquifers on the Mexico-USA border	2017 Concordia-Salto MoU on the Guarani Aquifer (Argentina & Uruguay)
2008 Genevese Aquifer Convention (France & Switzerland)	2016 Lithuania/Latvia Agreement no. 16-28
2002 Series of documents for the Northwestern Sahara Aquifer System (Algeria, Libya & Tunisia)	2014 Iullemeden, Taoudeni / Tanezrouft Aquifer System (Algeria, Benin, Burkina Faso, Mali, Mauritania, Niger, and Nigeria)*
1992/2000/2002 Series of documents for the Nubian Sandstone Aquifer (Chad, Egypt, Libya & Sudan)	1999 Juárez-El Paso MoU for the Hueco Bolson (Mexico & United States)
	1996 Washington State – British Columbia MoA (Abbotsford-Sumas Aquifer) (Canada & United States)

* Official agreement that is not in force and, thus, regarded as an unofficial arrangement

Figure 11 - Transboundary groundwater agreements and arrangements (official and informal).

Table 1 - Official agreements in force related to transboundary groundwater resources and aquifers.

Agreements	Parties	Aquifer(s)	Date signed
Convention de Mise à Disposition et D'échange de Données Relatives à la Gestion de Eaux Souterraines des Calcaires du Carbonifère (Convention for the Provision and Exchange of Data Relating to the Management of Groundwater from Carboniferous Limestones) (Carboniferous Limestone Aquifer Agreement)	Wallonne (Belgium), Flemish (Belgium), and French delegations to the International Scheldt Commission	Carboniferous Limestone Aquifer	14 December 2017
Agreement between the Government of the Hashemite Kingdom of Jordan and the Government of the Kingdom of Saudi Arabia for the Management and Utilization of the Ground Waters in the Al-Sag/Al-Disi Layer (Al-Sag/Al-Disi Agreement)	Hashemite Kingdom of Jordan, and Government of the Kingdom of Saudi Arabia	Al-Sag/Al-Disi Aquifer	30 April 2015
Acuerdo sobre el Acuífero Guarani (Guarani Aquifer Agreement)	Republic of Argentina, Federative Republic of Brazil, Republic of Paraguay, and Oriental Republic of Uruguay	Guarani Aquifer	2 August 2010
Series of documents constituting an agreement for aquifers traversing the Mexico–US border ³	Mexico and United States	All aquifers on the Mexico-US border	
- 2009 Joint Report of the Principal Engineers Regarding the Joint Cooperative Process—United States–Mexico for the Transboundary Aquifer Assessment Program (2009 Joint Report)			19 August 2009
- Letter from USA Commissioner C. W. Ruth to Mexican Commissioner Roberto F. Salmon Castelo approving the 2009 Joint Report of the Principal Engineers Regarding the Joint Cooperative Process—United States–Mexico for the Transboundary Aquifer Assessment Program			19 August 2009
- Letter from Mexican Commissioner Roberto F. Salmon Castelo to USA Commissioner C. W. Ruth approving the 2009 Joint Report of the Principal Engineers Regarding the Joint Cooperative Process—United States–Mexico for the Transboundary Aquifer Assessment Program			19 August 2009
Convention relative à la protection, à l'utilisation, à la réalimentation et au suivi de la Nappe Souterraine Franco-Suisse du Genevois (Convention on the Protection, Utilisation, Recharge and Monitoring of the Franco-Swiss-Genevese Aquifer) (Genevese Convention)	Community of the Annemassienne region, France; Community of the Genevois Rural Districts, France; Rural District of Viry, France; and The Republic and Canton of Geneva, Switzerland	Genevese Aquifer	18 December 2007

Continued Table 1 - Official agreements in force related to transboundary groundwater resources and aquifers.

³ These series of documents are regarded collectively as a formal *agreement* for purposes of this book because the two Commissioners of the International Boundary and Water Commission have authority from their respective governments to enter into official, binding agreements.

Agreements	Parties	Aquifer(s)	Date signed
Series of Instruments Constituting an Agreement for the Northwestern Sahara Aquifer System	Algeria, Libya, and Tunisia	Northwestern Sahara Aquifer System	
- Establishment of a Consultation Mechanism for the Northwestern Sahara Aquifer System (NWSAS)			20 December 2002
- Minutes of the Tripartite Regional Workshop, Establishment of a Consultation Mechanism for the Northwestern Sahara Aquifer System (SASS)			19-20 December 2002
- Declaration by the Ministers of Water Resources of the Countries Sharing the Northwestern Sahara Aquifer System			2006
Series of Agreements for the Nubian Sandstone Aquifer	Chad, Egypt, Libya, and Sudan	Nubian Sandstone Aquifer	
- 1992 Constitution of the Joint Authority for the Study and Development of the Nubian Sandstone Aquifer Waters			1992
- 2000 Programme for the Development of a Regional Strategy for the Utilisation of the Nubian Sandstone Aquifer System: Agreement No. 1 - Terms of Reference for the Monitoring and Exchange of Groundwater Information of the Nubian Sandstone Aquifer System, signed in Tripoli			5 October 2000
- 2000 Programme for the Development of a Regional Strategy for the Utilisation of the Nubian Sandstone Aquifer System: Agreement No. 2 - Terms of Reference for Monitoring and Data Sharing, signed in Tripoli			5 October 2000
- 2013 Regional Strategic Action Programme for the Nubian Aquifer System			18 September 2013

Table 2 - Official agreements not in force related to transboundary groundwater resources and aquifers.

Agreement	Parties	Aquifer(s)	Date signed
Memorandum of Understanding for the Establishment of a Consultation Mechanism for the Integrated Management of the Water Resources of the Iullemeden, Taoudeni/Tanezrouft Aquifer System (ITAS MoU) ⁴	Algeria, Benin, Burkina Faso, Mali, Mauritania, Niger, and Nigeria	Iullemeden, Taoudeni / Tanezrouft Aquifer System	28 March 2014

⁴ The ITAS MoU is treated here as an informal arrangement. While it contains language that would bind the parties to the terms of the instrument, and while it has been signed by Benin, Mali, Niger, and Nigeria, but not by Algeria, Burkina Faso, and Mauritania, it has yet to be formally ratified into any of the member states' domestic legal systems. Nevertheless, according to Article 18 of the 1969 Vienna Convention on the Law of Treaties, nations that have signed a treaty are obligated to refrain from acts that would defeat the object and purpose of that treaty even prior to its formal entry into force. This means that while the instrument remains formally non-binding, it obligates the signatory states to aspire to the terms of the instrument or, at least, not take any action that is contrary to those terms. Accordingly, the ITAS MoU is treated as an informal arrangement for the purposes of this study.

Table 3 - Informal arrangements related to transboundary groundwater resources and aquifers.

Informal Arrangements	Parties	Aquifer(s)	Date signed
Déclaration ministérielle sur le Bassin aquifère sénégal–mauritanien (Ministerial declaration on the Senegalo–Mauritanian aquifer basin) (Senegalo–Mauritanian Declaration)	Mauritania and Senegal	Senegalo–Mauritanian aquifer basin	29 September 2021
Carta de Intención Para la Gobernanza del Acuífero Ocotepeque–Citalá (Statement of Intent for the Governance of the Ocotepeque–Citalá Aquifer), El Salvador y Honduras (Ocotepeque–Citalá Sol)	Municipalities, water boards, national and regional institutions for the integrated governance of the Ocotepeque–Citalá Aquifer shared by El Salvador and Honduras in the Trifinio region	Ocotepeque–Citalá Aquifer	22 February 2019
Series of informal arrangements for the Stampriet Transboundary Aquifer System ⁵	Botswana, Namibia, and South Africa	Stampriet Aquifer System	
- ORASECOM Forum of the Parties Resolution endorsing the Council Resolution at their Ordinary Meeting			16 November 2017
- ORASECOM Resolution on Nesting the Stampriet Transboundary Aquifer System (STAS) Multi-Country Cooperation Mechanism (MCCM) in ORASECOM			17-18 August 2017
Acuerdo de Entendimiento Entre la Municipalidad de Concordia, Republica Argentina e Intendencia de Salto, Republica Oriental de Uruguay (Memorandum of Understanding Between the Authorities of Concordia, Republic of Argentina, and Salto, Republic of Uruguay) (Concordia–Salto MoU)	Cities of Concordia, Argentina, and Salto, Uruguay	Guarani Aquifer	23 March 2017
Agreement no. 16–28. On cooperation between the Lithuanian Geological Survey under the Ministry of Environment (LGT) and the Latvian Environment, Geology and Meteorology Centre (LVGMC) on cross-border groundwater monitoring (Lithuania/Latvia Informal Arrangement) ⁶	Lithuanian Geological Survey under the Ministry of Environment; Latvian Environment, Geology and Meteorology Centre	All aquifers on the Lithuanian–Latvian border	20 June 2016

⁵ The series of instruments for the Stampriet Transboundary Aquifer System (STAS) are categorized here collectively as an “informal arrangement” because the STAS documents listed in the table have not been made available publicly by ORASECOM, and only secondary sources that described those documents were obtained for review. As a result, the precise language used in the documents and the process by which they were adopted have not been substantiated by primary sources and are uncertain or unknown.

⁶ While titled as an *Agreement*, this instrument is regarded as an *informal arrangement* for purposes of this book because it is entered into by subnational units of the two governments without the formalities of a treaty or other formal agreement.

Continued Table 3 - Informal arrangements related to transboundary groundwater resources and aquifers.

Agreements	Parties	Aquifer(s)	Date signed
Memorandum of Understanding between the City of Juárez, Mexico, Utilities and the El Paso Water Utilities Public Services Board (PSP) of the City of El Paso, Texas (Juárez–El Paso MoU)	Junta Municipal de Agua y Saneamiento de Juarez, Mexico; and El Paso Water Utilities Public Service Board, United States	Hueco Bolson Aquifer	6 December 1999
Memorandum of Agreement Related to Referral of Water Right Applications (Abbotsford–Sumas MoA) [relevant to the Abbotsford–Sumas Aquifer]	State of Washington (US) Department of Ecology and the Province of British Columbia (Canada) Minister of Environment, Lands, and Parks	Abbotsford–Sumas Aquifer	12 April 1996

It is noteworthy to point out seven particular features of these instruments. First, most of these agreements and informal arrangements were preceded by a collaborative project to study and better understand the particular transboundary aquifer, aquifer system, or series of aquifers and their distinct characteristics (Movilla Pateiro, 2016). While this is not determinative, it strongly suggests that joint efforts related to developing data and information on transboundary aquifers can have positive results on international relations and cooperation related to the administration of cross-border groundwater resources and aquifers.

Second, the agreements and informal arrangements included in this book are only those that focus exclusively on transboundary groundwater and aquifers. They do not include instruments with broader scopes, such as treaties that address all frontier water resources—both surface and subsurface. For example, 14 percent of treaties for transboundary watercourses concluded between 1950 and 2014—and more than half concluded between 2000 and 2007—included some reference to groundwater (Giordano et al., 2014). While cross-border groundwater resources have historically been treated as secondary or even tertiary priorities in such instruments (Eckstein, 2017), that trend appears to be changing. Nevertheless, this book focuses exclusively on agreements and informal arrangements specifically designated for cross-border groundwater and aquifers.

Third, there is no discernable pattern in terms of the types of aquifers that have been made subject to the agreements and informal arrangements discussed in this book. They include both confined and unconfined aquifers, with some aquifers that include substantial areas of both confined and unconfined formations, as well as recharging and non-recharging—also known as *fossil*—aquifers.

Fourth, some of the agreements included in these lists are actually a series of interrelated instruments that must be read collectively. Their value as full-fledged official agreements arise from the integration of the individual provisions and authorities found in each of the constituent documents. Thus, for example, the 2009 Joint Report of the Principal Engineers Regarding the Joint Cooperative Process, United States–Mexico, for the Transboundary Aquifer Assessment Program (Table 1) would have little normative value but for the two letters from the Mexican and US Commissioners who approved the Joint Report. Absent the two letters, the Joint Report would simply be an aspirational informal arrangement.

In a somewhat different example, while each of the instruments comprising the series of agreements on the Nubian Sandstone Aquifer (Table 1) have the imprimatur of formality, each one addresses a narrow set of issues related to the management of the aquifer. However, when read together, they function as an interlocking and cohesive regime that builds on itself. In both examples, the integration of the instruments produces a far more authoritative and robust regime when compared with the value of the individual instruments.

Fifth, two of the informal arrangements included in Table 3 pertain to aquifers covered by two of the agreements in Table 1 but are independent of and not sub-instruments of those agreements. The Juárez–El Paso Memorandum of Understanding (Juárez–El Paso MoU) is an informal arrangement between the water utilities of the sister cities of Juárez in Chihuahua, Mexico, and El Paso in Texas, USA, for the Hueco Bolson Aquifer, but is unrelated to the series of documents constituting an agreement for aquifers traversing the Mexico–US border. Similarly, the Concordia–Salto MoU is an informal arrangement between the sister municipalities of Concordia, Argentina, and Salto, Uruguay, that is relevant to their local segment of the Guarani Aquifer but is unrelated to the Guarani Aquifer Agreement.

Sixth, one agreement listed in Table 1 and one informal arrangement listed in Table 3 are not specific to any single aquifer but rather apply to a series of aquifers along the border of the countries that are party to the respective agreement and informal arrangement. The agreement—designated as a “*Series of documents constituting an agreement for aquifers traversing the Mexico–USA border*”—purportedly applies to all the aquifers along the Mexico–US border. A recent study suggests there may be as many as 72 aquifers and hydrogeological units that traverse the 3,000 km frontier (Sanchez & Rodriguez, 2021). Similarly, the Lithuania/Latvia Informal Arrangement applies throughout the “*cross-border territories of Latvia and Lithuania*” without distinction as to any particular transboundary aquifer or groundwater resource.

Seventh, it is important to recognize that documentation regarding the existence of an agreement or informal arrangement occasionally is lacking. In some cases, countries and international institutions decline to provide original meeting minutes, resolutions, or other records evidencing the existence of the agreements and informal arrangements that they have entered into with their neighbors, leaving researchers to rely on secondary sources. This is sometimes justified on national security grounds or other defenses. Thus, in the case of the Stampriet Transboundary Aquifer System (STAS), the series of instruments identified for that cross-border aquifer have not been made public by the Orange–Senqu River Commission (ORASECOM). Only secondary sources that described those documents are available for review. As a result, the precise language and terms used in the documents and the process by which they were adopted have not been substantiated by primary sources, which leaves their obligatory status inconclusive. Thus, for the purpose of this book, the instruments governing the STAS are collectively categorized here as an *informal arrangement* rather than an *agreement*.

The existence of a transboundary agreement or informal arrangement may not always be known due to reporting breakdowns. Such breakdowns can be due to the lack of available groundwater data, as well as a disconnect between goals and obligations written in a cooperative instrument and what is actually achieved on the ground (Fraser, 2023).

For example, the United Nations Educational, Scientific and Cultural Organization/United Nations Economic Council for Europe (UNESCO/UNECE) Sustainable Development Goal Indicator 6.5.2 addresses the proportion of a transboundary basin area with an operational agreement or informal arrangement for water cooperation (UNESCO & UNECE, 2021). During the second reporting exercise for the indicator, which took place in 2020, only twelve countries reported having a total of eight aquifer-specific agreements or informal arrangements in place (UNESCO & UNECE, 2021), despite the existence of the fifteen aquifer-specific agreements and arrangements that have been identified in this book.⁷

Moreover, while the eight aquifers identified in the report resulting from that exercise collectively underlie 20 countries, only two aquifers had all of the overlying countries reporting about the existence of an agreement or informal arrangement:

- the Saq–Ram Aquifer System (shared by Jordan and Saudi Arabia), and
- the Northwest Sahara Aquifer System (NWSAS); shared by Algeria, Libya, and Tunisia.

In addition, of the 145 countries identified in the report as sharing groundwater with at least one neighboring state, only 50 reported that they had operational agreements or informal arrangements covering 30 percent or less of their aquifer areas (UNESCO & UNECE, 2021; Fraser, 2023). Thus, the report and its lackluster statistics suggests that data and information on transboundary groundwater resources is a significant challenge for many countries around the world (Fraser, 2023).

In addition to the above agreements and informal arrangements, there are several global instruments that are relevant to this analysis. These too can be subdivided into two categories that are akin to the agreement and informal arrangement structure discussed in this section. The key difference between the two is that the former can be legally binding under international law, while the latter is not.

⁷ Of the eight aquifer-specific agreements and informal arrangements referenced in the 2021 UNECE/UNESCO reporting exercise, five are formal agreements: North-Western Sahara Aquifer System Cooperation Mechanism; Guaraní Aquifer Agreement; series of instruments constituting an agreement for the Nubian Sandstone Aquifer; Agreement over the Al-Sag /Al-Disi Aquifer; series of documents constituting an agreement for aquifers traversing the Mexico–US border. Three others are informal arrangements: Statement of Intent on the Governance of the Ocotepaque—Citalá Aquifer; Cooperation Agreement between the Lithuanian Geological Survey under the Ministry of Environment (LGT) and the Latvian Environment, Geology and Meteorology Centre (LVĢMC) on cross-border groundwater monitoring; and Memorandum of Understanding for the Establishment of a Consultation Mechanism for the Integrated Management of the Water Resources of the Iullemeden, Taoudeni/Tanezrouft Aquifer System (UNESCO & UNECE, 2021).

The extent of the binding nature of formal global instruments depends on two criteria:

1. whether a nation has ratified the instrument thereby directly binding that nation, and
2. whether any specific provision contained in the instrument represents the codification of a customary international law norm, which effectively binds all nations regardless of ratification.

The global instruments with relevance for transboundary aquifers that have been identified for this assessment are provided in Table 4 and Table 5.

Table 4 - Formal global instruments related to transboundary groundwater resources and aquifers.

Instruments	Parties (as of 2 June 2024)
1992 UNECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes (UNECE Water Convention)	<p>Ratifying Parties: Albania, Austria, Azerbaijan, Belarus, Belgium, Bosnia and Herzegovina, Bulgaria, Cameroon, Chad, Croatia, Czech Republic, Denmark, Estonia, European Union, Finland, France, Gambia, Germany, Ghana, Greece, Guinea-Bissau, Hungary, Iraq, Italy, Kazakhstan, Latvia, Liechtenstein, Lithuania, Luxembourg, Montenegro, Namibia, Netherlands, Nigeria, North Macedonia, Norway, Panama, Poland, Portugal, Republic of Moldova, Romania, Russian Federation, Senegal, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Togo, Turkmenistan, Ukraine, and Uzbekistan</p> <p>Signatory Parties: United Kingdom⁸</p>
1997 UN Convention on the Non-navigational Uses of International Watercourses (UN Watercourses Convention)	<p>Ratifying Parties: Benin, Burkina Faso, Chad, Côte d'Ivoire, Denmark, Finland, France, Gambia, Germany, Ghana, Greece, Guinea-Bissau, Hungary, Iraq, Ireland, Italy, Jordan, Lebanon, Libya, Luxembourg, Montenegro, Morocco, Namibia, Netherlands, Niger, Nigeria, Norway, Portugal, Qatar, South Africa, Spain, State of Palestine, Sweden, Syrian Arab Republic, Tunisia, United Kingdom, Uzbekistan, and Viet Nam</p> <p>Signatory Parties: Paraguay, Venezuela, and Yemen</p>

⁸ In most cases, having a designated representative *sign* a treaty does not equate with ratification. Ratification constitutes the process of formally approving a treaty within a country's legal system in conformity with its domestic legal authorization procedures. Official signatures, however, are not without legal significance. Under Article 18 of the 1969 Vienna Convention on the Law of Treaties, nations that have signed a treaty are obligated to refrain from acts that would defeat the object and purpose of that treaty even prior to its formal entry into force. Thus, signatory states have, at least, a duty to not contravene any treaty they have signed.

Table 5 - Informal global instruments related to transboundary groundwater resources and aquifers.

Informal Global Instruments	Parties
2008 UN Draft Articles on the Law of Transboundary Aquifers ⁹	n/a
2012 UNECE Model Provisions on Transboundary Groundwaters	n/a

In addition, it is important to note that the scope of the UNECE Water Convention, Draft Articles, and UNECE Model Provisions are universal in the sense that they apply to all groundwater and aquifers that traverse international political boundaries. The UN Watercourses Convention, however, has a more limited scope in that it only applies to aquifers that are part of a *watercourse*, which is defined in Article 2(a) as “*a system of surface waters and groundwaters constituting by virtue of their physical relationship a unitary whole and normally flowing into a common terminus.*” Thus, only aquifers that are hydrologically linked to a cross-border-surface body of water are included within the scope of that instrument. Fossil aquifers (recharging aquifers that have no meaningful connection to a surface water body) and aquifers that do not normally flow into a common terminus with a hydrologically linked river or lake are excluded from the Convention.

While this list of agreements, informal arrangements, and global instruments is notable given that the first treaty to focus squarely on a transboundary aquifer was not crafted until 1978,¹⁰ it stands in stark contrast to the more than 3,600 treaties over transboundary rivers and lakes that have been catalogued between 805CE and 2002, and over 400 between 1820CE and 2002 (UN Environmental Programme, 2002). Moreover, the two formal global agreements identified here focus on the world’s transboundary watercourses and only secondarily consider within their scope the various transboundary aquifers that traverse the world’s international boundaries—while both purport to encompass some or all transboundary aquifers within their scope, the principles and norms articulated in the two documents are squarely designed and intended for surface water resources.

As a result, both codified and customary practice is lacking in this area, making it difficult to definitively identify international norms governing transboundary groundwater resources.

⁹ The UN Draft Articles on the Law of Transboundary Aquifers were drafted by the UN International Law Commission and submitted to the UN General Assembly in late 2008. While the General Assembly has not endorsed the Draft Articles, they have included them in six resolutions commending them to the attention of the Member States (in 2008, 2011, 2013, 2016, 2019, and 2022). They will next appear on the agenda of the UNGA in 2026 (UNGA, 2022).

¹⁰ Convention relative à la protection, à l'utilisation, à la réalimentation et au suivi de la Nappe Souterraine Franco–Suisse du Genevois (Convention on the Protection, Utilisation, Recharge and Monitoring of the Franco–Swiss Genevese Aquifer) (Genevese Convention).

Nevertheless, a comparative analysis of these documents does offer some insight into trends and gaps in the evolution of international law in this budding area. With this in mind, the contents of the instruments identified above were scrutinized for their focus, subject matter, and language to identify or extrapolate possible international legal norms. In particular, two categories of norms were explored—those that impose procedural obligations, and those with substantive normative value—both of which together set the stage for the rights and obligations that govern nations and their conduct under international law.

Figure 12 through Figure 25 illustrate the diverse transboundary aquifers discussed in this section.

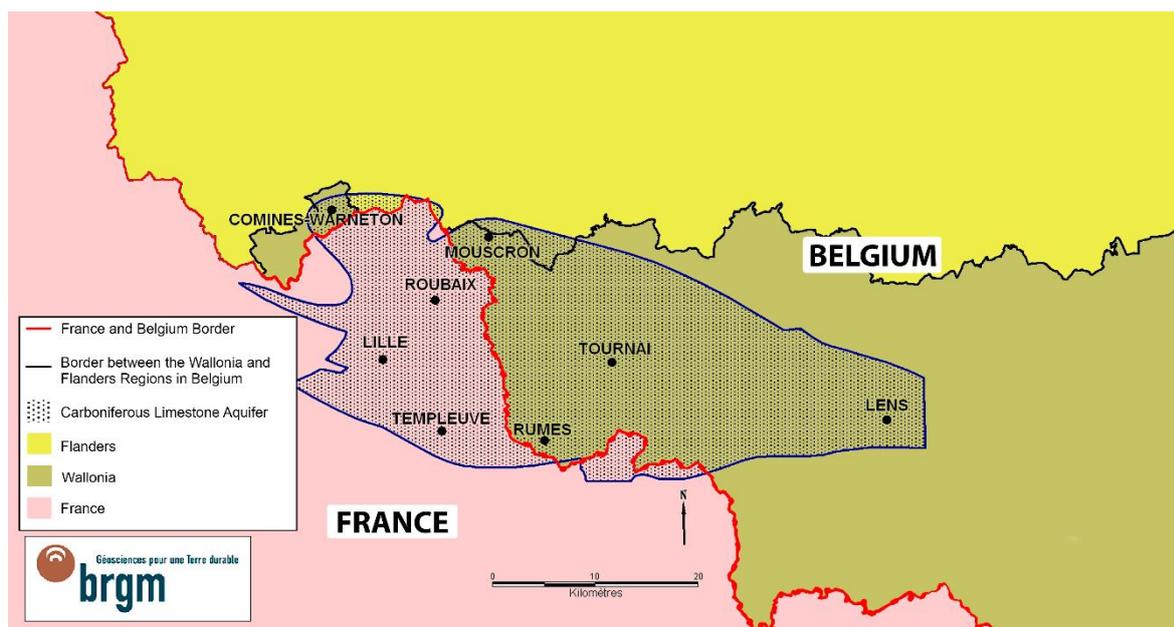


Figure 12 - The Carboniferous Limestone Aquifer shared between Belgium and France (adapted from Dewandel et al., 2017).

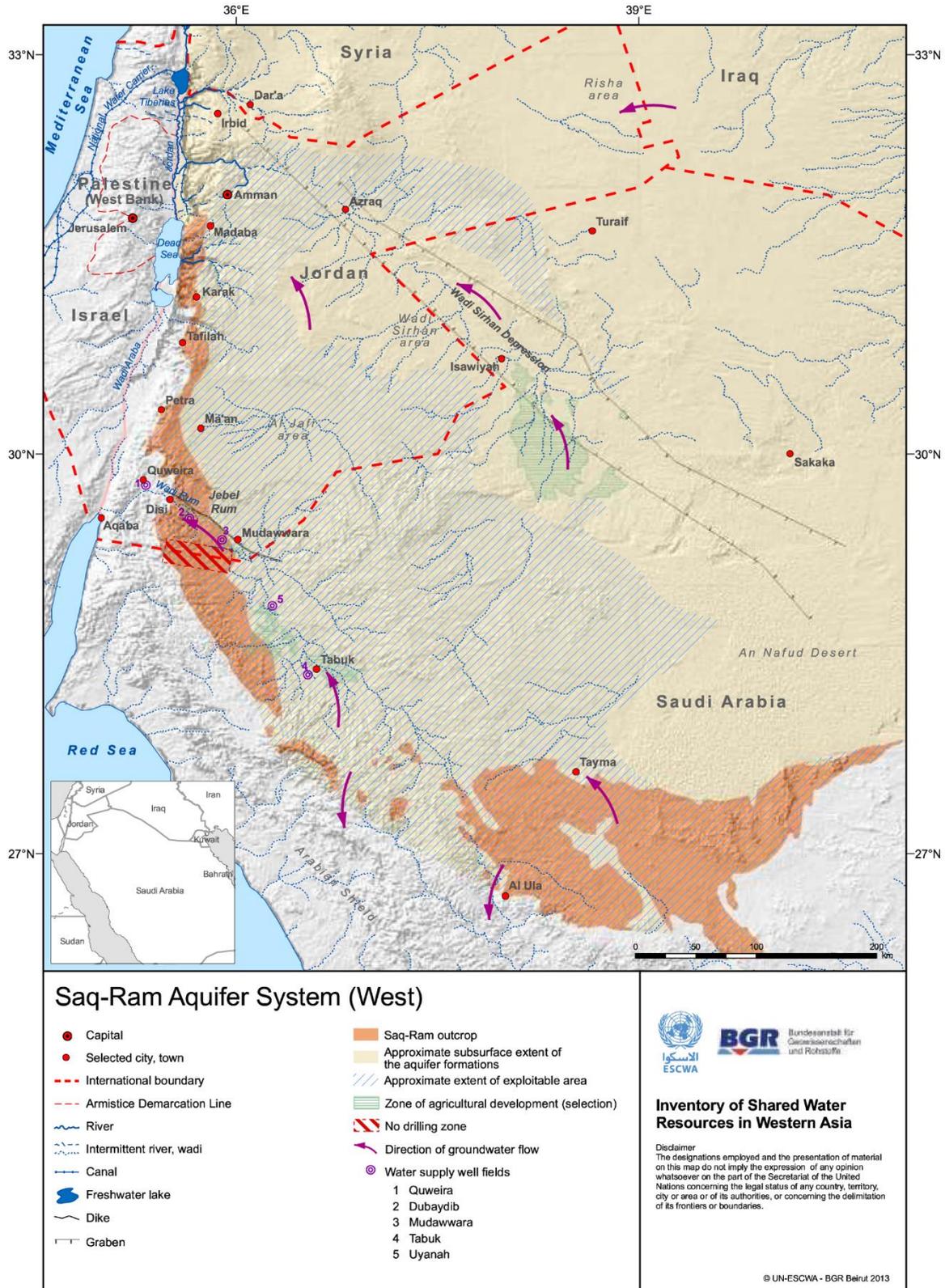


Figure 13 - The Disi Aquifer (also known as the Saq Ram Aquifer) underlying southern Jordan and northern Saudi Arabia (adapted from United Nations-Economic and Social Commission for Western Asia (UN-ESCWA) & Bundesanstalt für Geowissenschaften und Rohstoffe (BGR) [Federal Institute for Geosciences and Natural Resources], 2013).

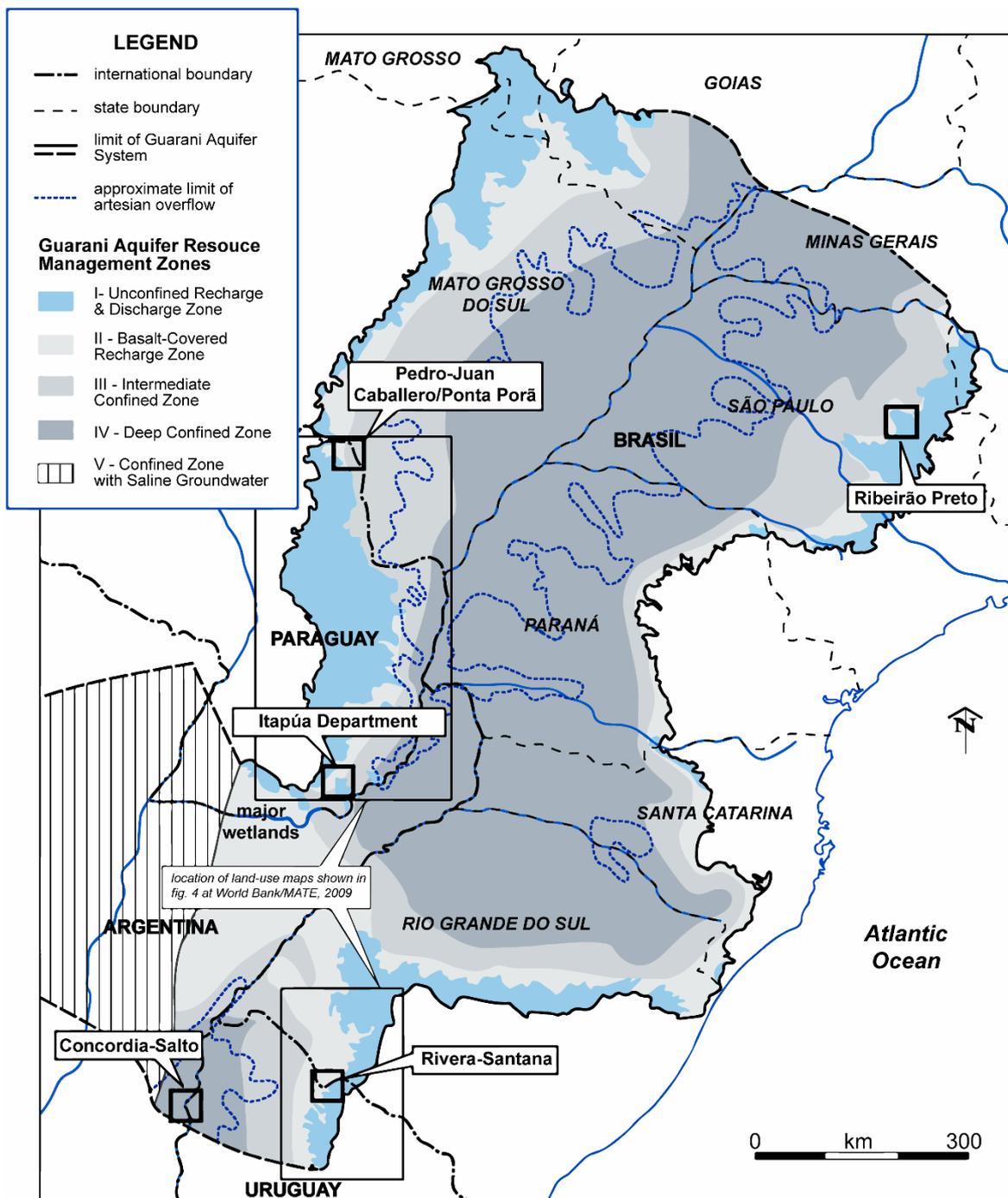


Figure 14 - The Guarani Aquifer shared by Argentina, Brazil, Paraguay, and Uruguay (adapted from Foster et al., 2009).

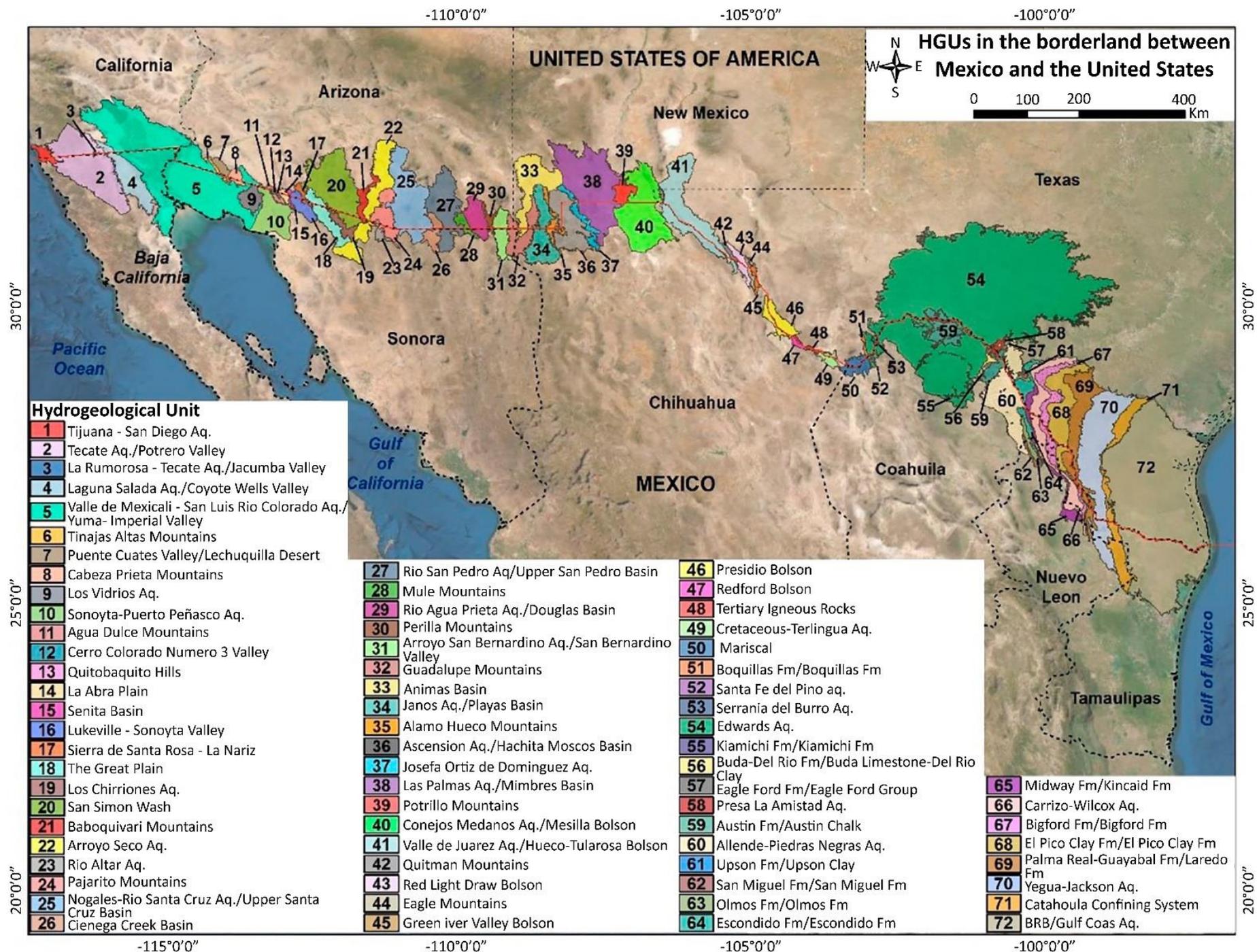


Figure 15 - Aquifers on the Mexico–US border (adapted from Sanchez & Rodriguez, 2022).

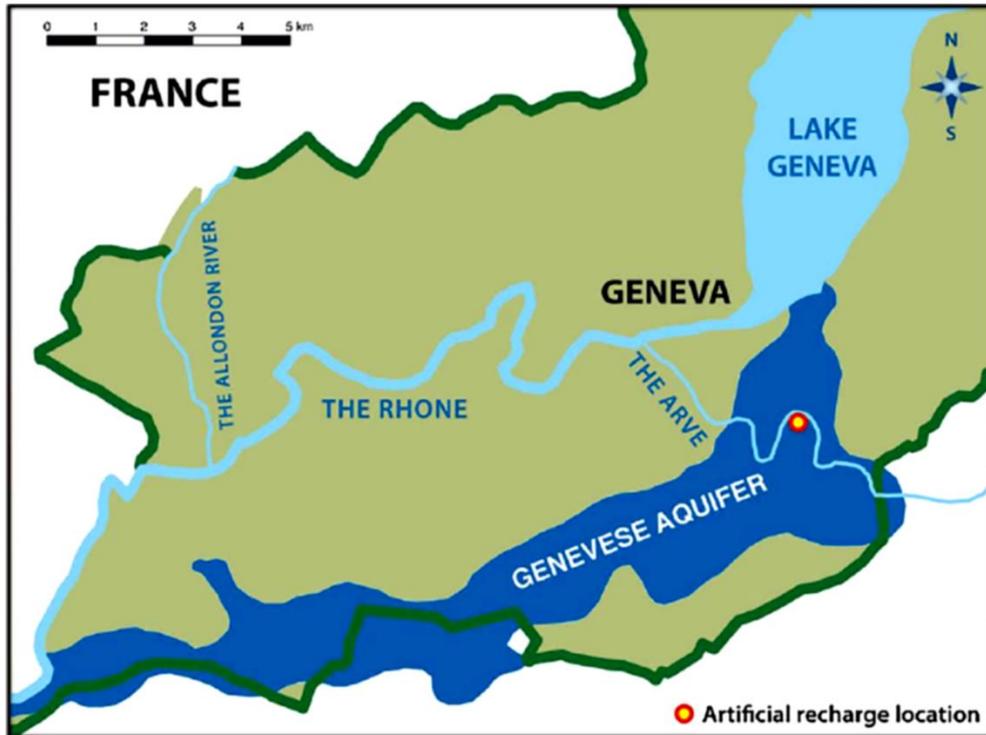


Figure 16 - The Genevese Aquifer shared by France and Switzerland (adapted from de los Cobos, 2018).

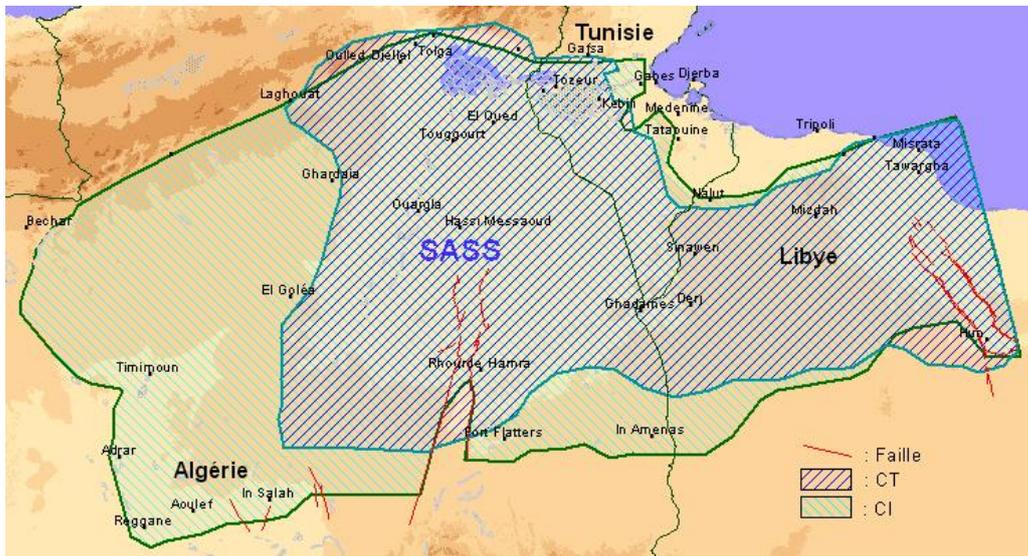


Figure 17 - The North Western Sahara Aquifer System is a series of large fossil aquifers in northern Africa underlying Algeria, Libya, and Tunisia (adapted from North Western Sahara Aquifer System, n.d.).

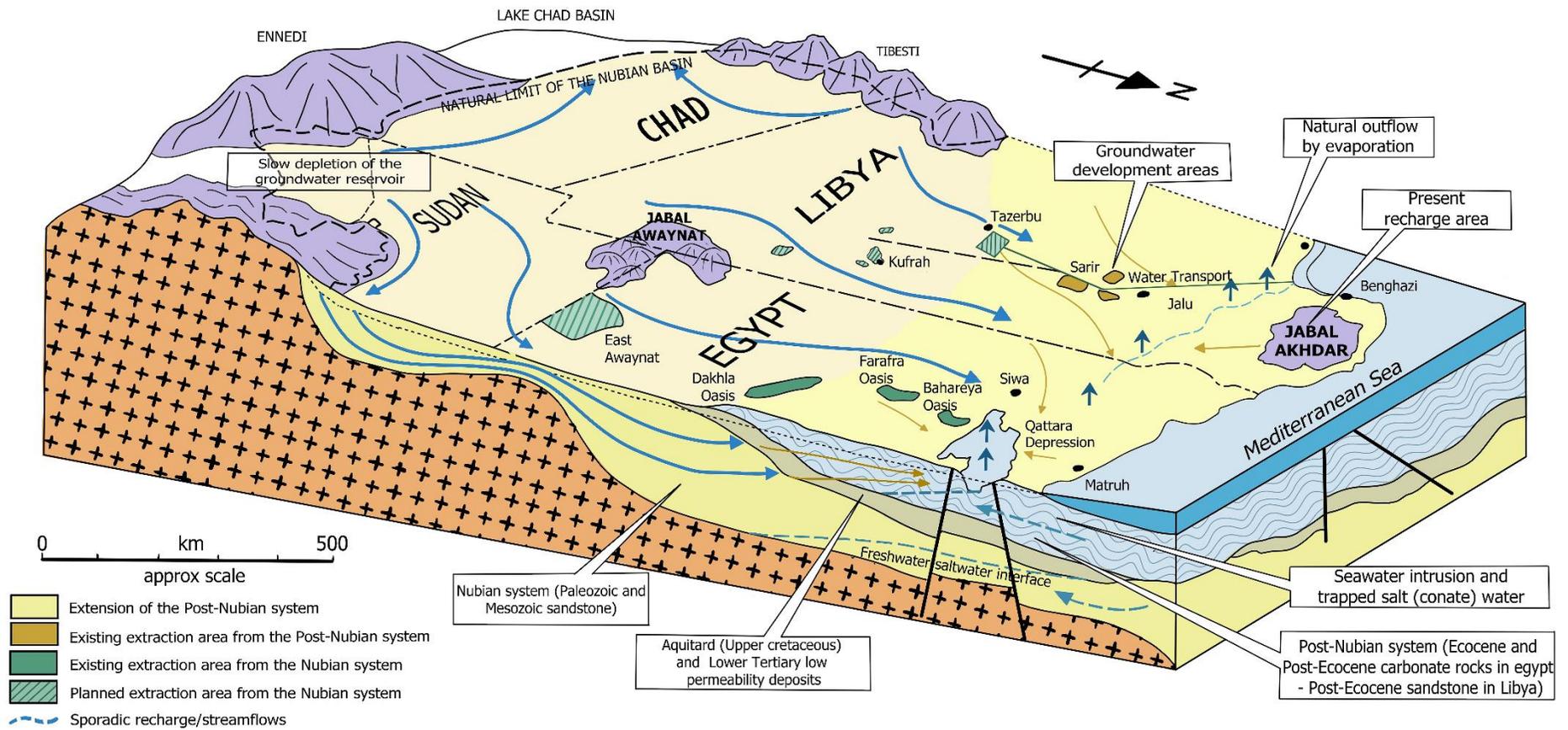


Figure 18 - The Nubian Sandstone Aquifer underlying parts of Libya, Chad, Egypt, and Sudan (modified from Abdellatif & Sirag, 2015).

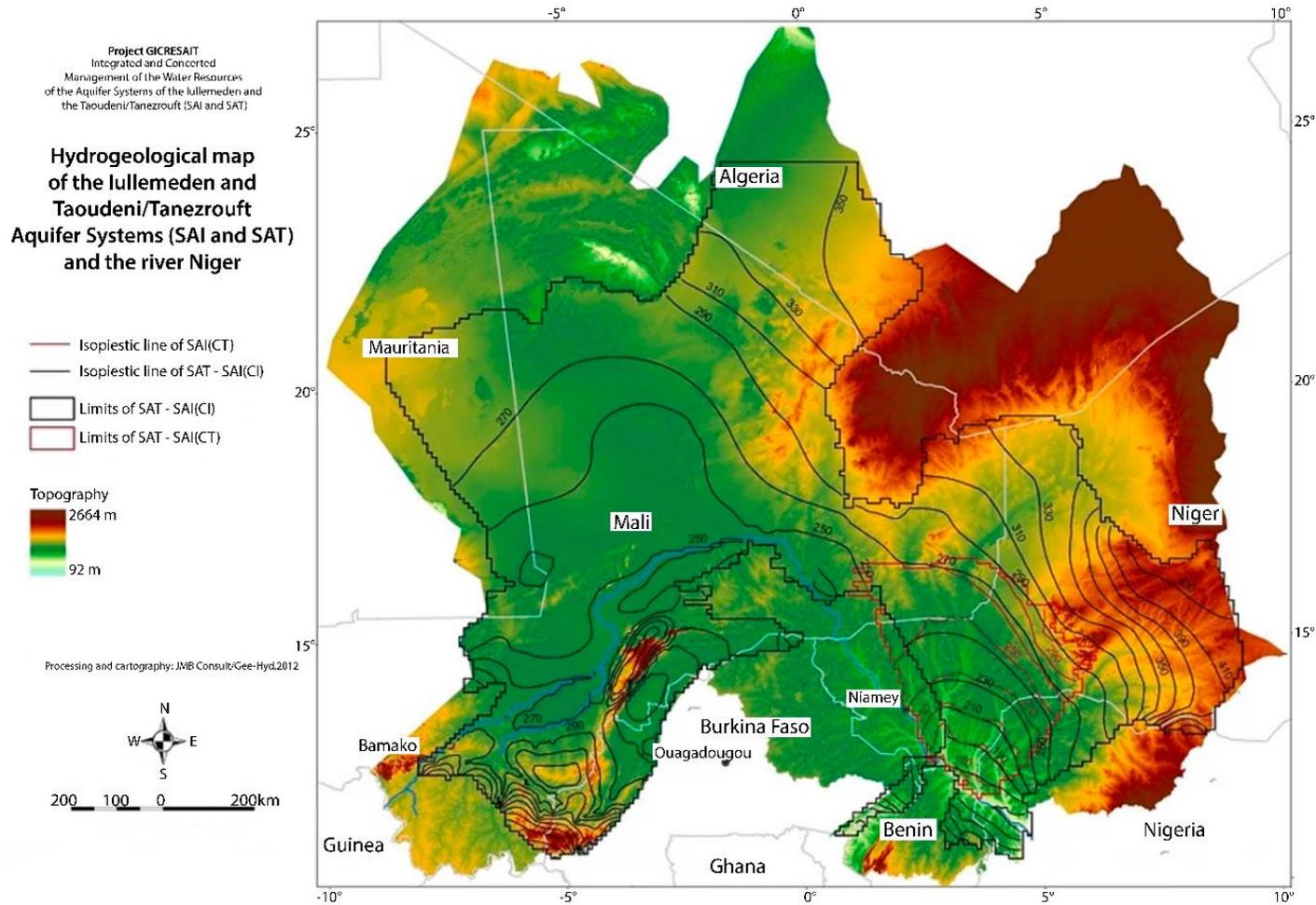


Figure 19 - Iullemeden, Taoudeni/Tanezrouft Aquifer System underlying Algeria, Benin, Burkina Faso, Mali, Mauritania, Niger, and Nigeria (adapted from Antea Group, 2013).

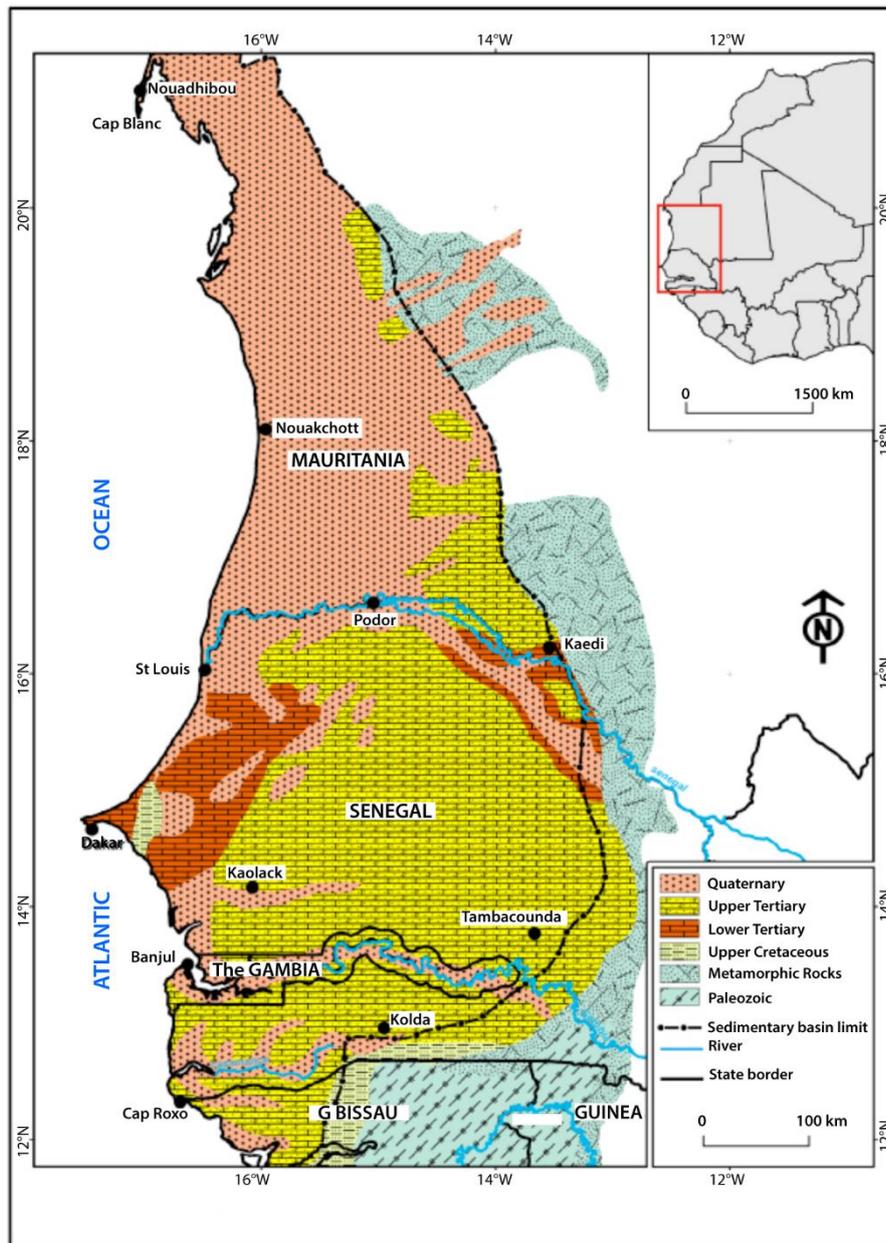


Figure 20 - Senegalo-Mauritanian Aquifer Basin (adapted from Diène et al., 2014).

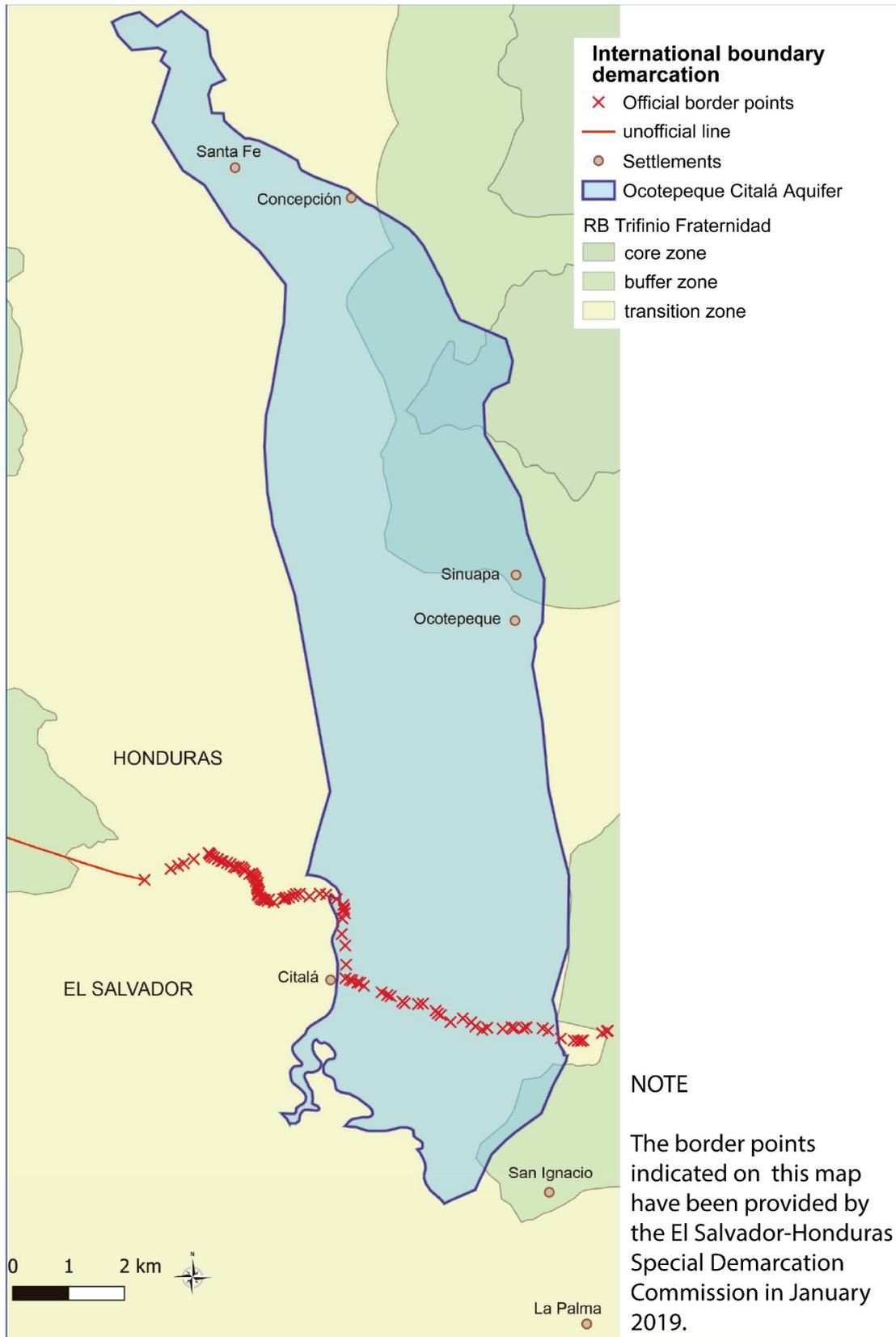


Figure 21 - Ocoatepeque–Citalá Aquifer shared by El Salvador and Honduras. (adapted from Sindico, 2019).

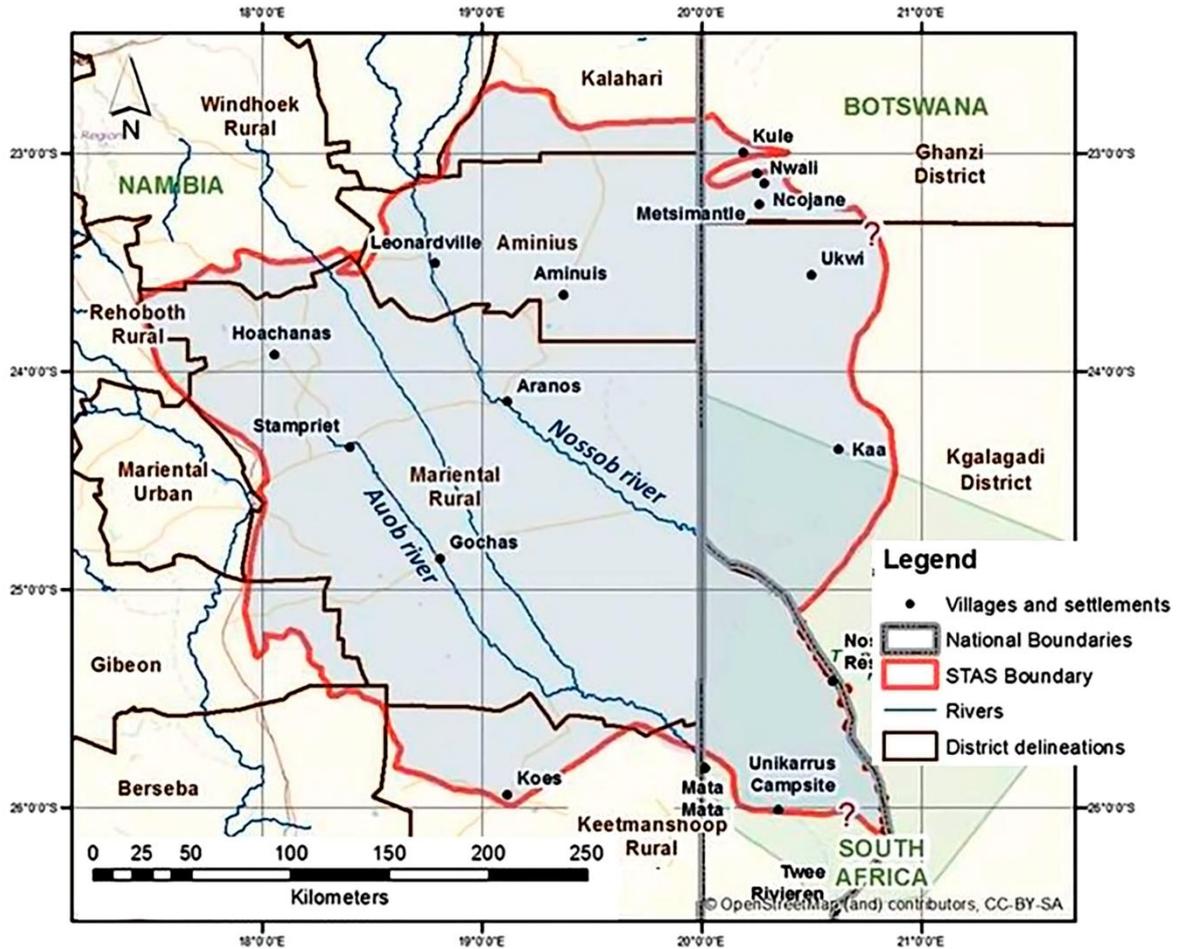


Figure 22 - Stampriet Transboundary Aquifer System shared by Botswana, Namibia, and South Africa (adapted from IGRAC, n.d.-b).

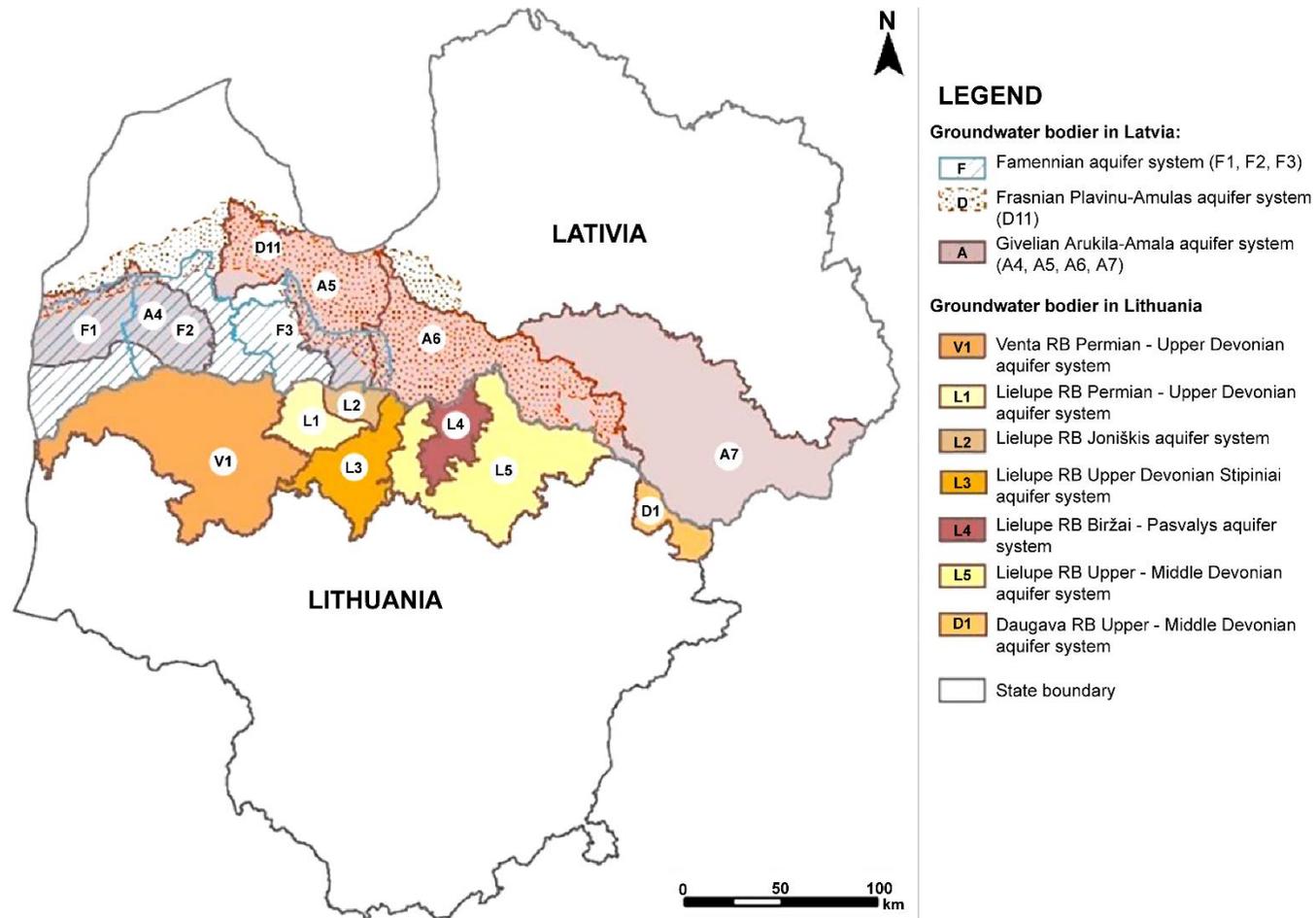


Figure 23 - Cross-border groundwater resources on the Lithuania/Latvia border (adapted from B-solution Project, 2019).

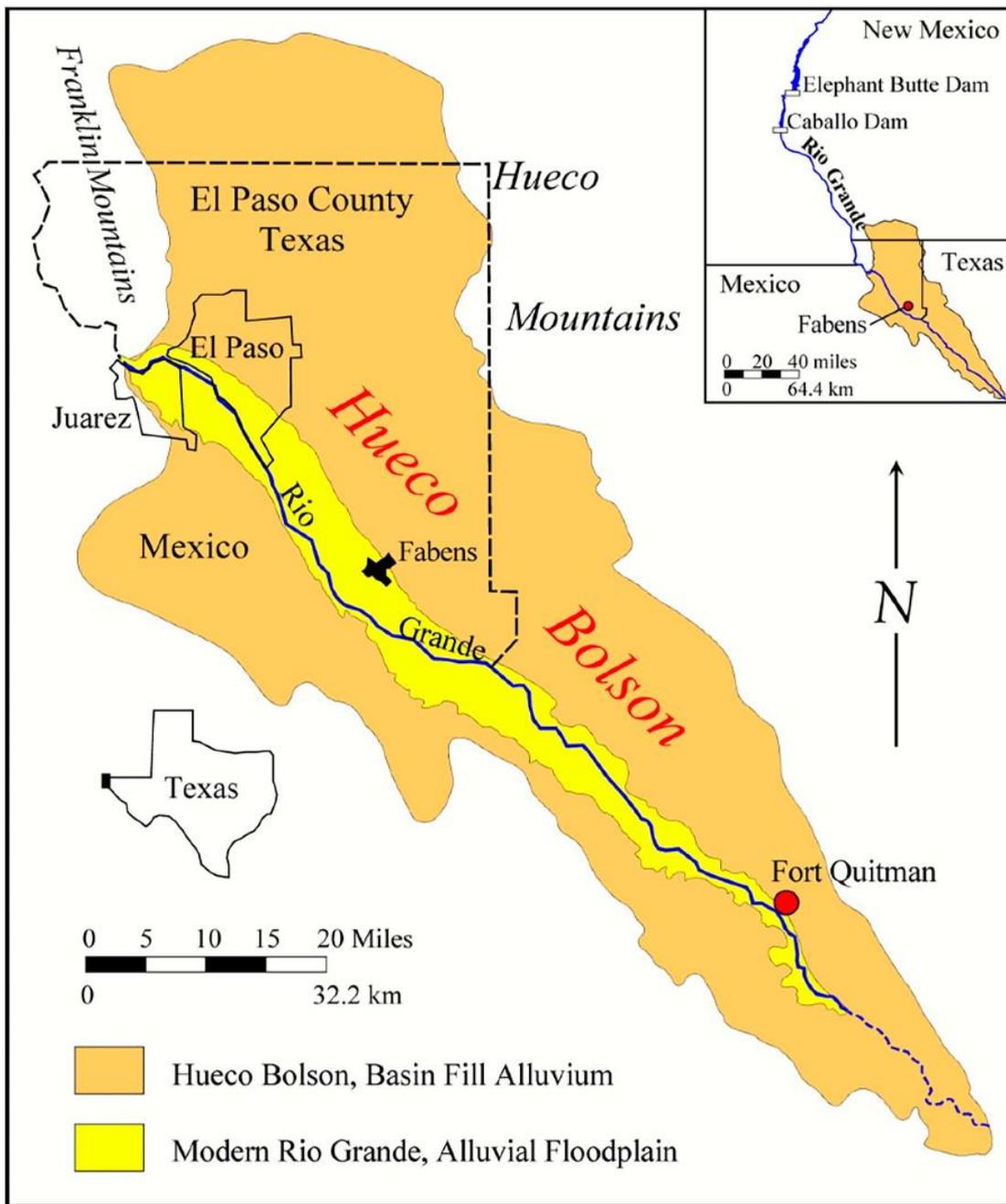


Figure 24 - Hueco Bolson underlying northern Mexico and southern United States (adapted from Hibbs & Merino, 2020).

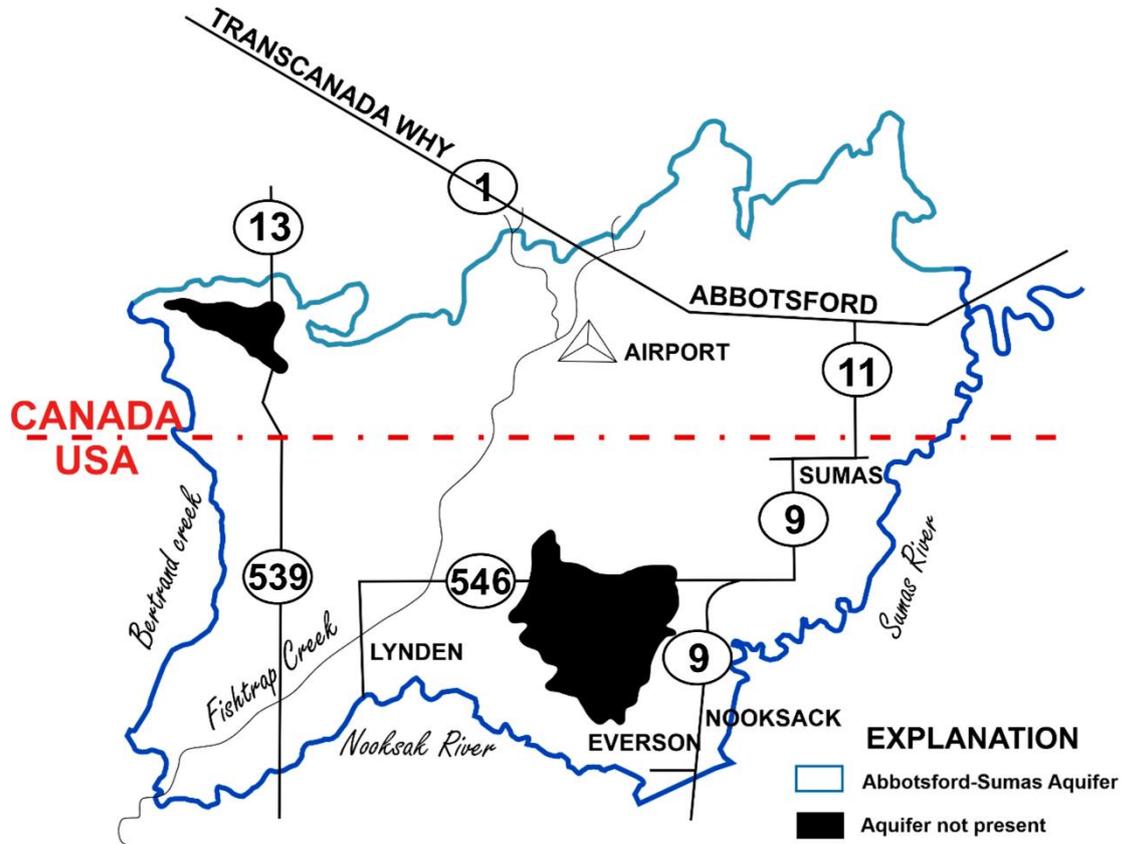


Figure 25 - Abbotsford–Sumas Aquifer underlying southern British Columbia in Canada and northern Washington State in the United States (modified from British Columbia Ministry of Environment, Abbotsford–Sumas Aquifer International Task Force, n.d.).

4 Developing International Legal Norms for Transboundary Aquifers

As suggested above, international law for managing and allocating transboundary groundwater resources is still in a nascent state, and the rights of countries to such resources have yet to be fully defined; there is as yet no broadly accepted series of customary norms that encapsulate the rules governing state conduct in this realm (Eckstein, 2017). Nevertheless, there is a growing international interest in the subject matter, as evidenced by the increasing number of agreements and informal arrangements between nations over their shared aquifers. Taken as a whole, it may be possible to discern trends and priorities that have the potential to achieve the status of customary norms of international law (Eckstein, 2017).

The following discussion highlights those trends that suggest the potential evolution of such principles and concepts. It is divided into substantive and procedural principles of law. While it is difficult to differentiate precisely between the two, substantive law may be described as establishing the rights and obligations that govern nations in the international community and, thereby, the standards that states must meet through their actions and conduct (Brunnée, 2019). In other words, substantive law violations in the context of transboundary waters harm the rights and interests of riparians and are gauged in terms of physical or economic impacts, such as would occur from flooding, resource depletion, crop failures, subsidence, destruction of dependent ecosystems, or negative effects on human health. Typical penalties for substantive law violations include an obligation to refrain from repeating the offending conduct as well as compensation for the harm suffered by the impacted riparian.

In contrast, procedural law constitutes the rules of process by which substantive legal norms are created, effectuated, applied, and enforced (Brunnée, 2019). Thus, violations of procedural obligations impact the process by which riparian states engage with each other, such as through the exchange of data and information, providing notice of planned actions, meeting on a periodic basis, developing joint projects and institutions, and so on. The typical penalty for procedural law violations is compliance with the duty, however late that fulfillment may be.

4.1 Norms imposing procedural obligations

Figure 26 summarizes the procedural obligations for transboundary groundwaters that are discussed in this section.

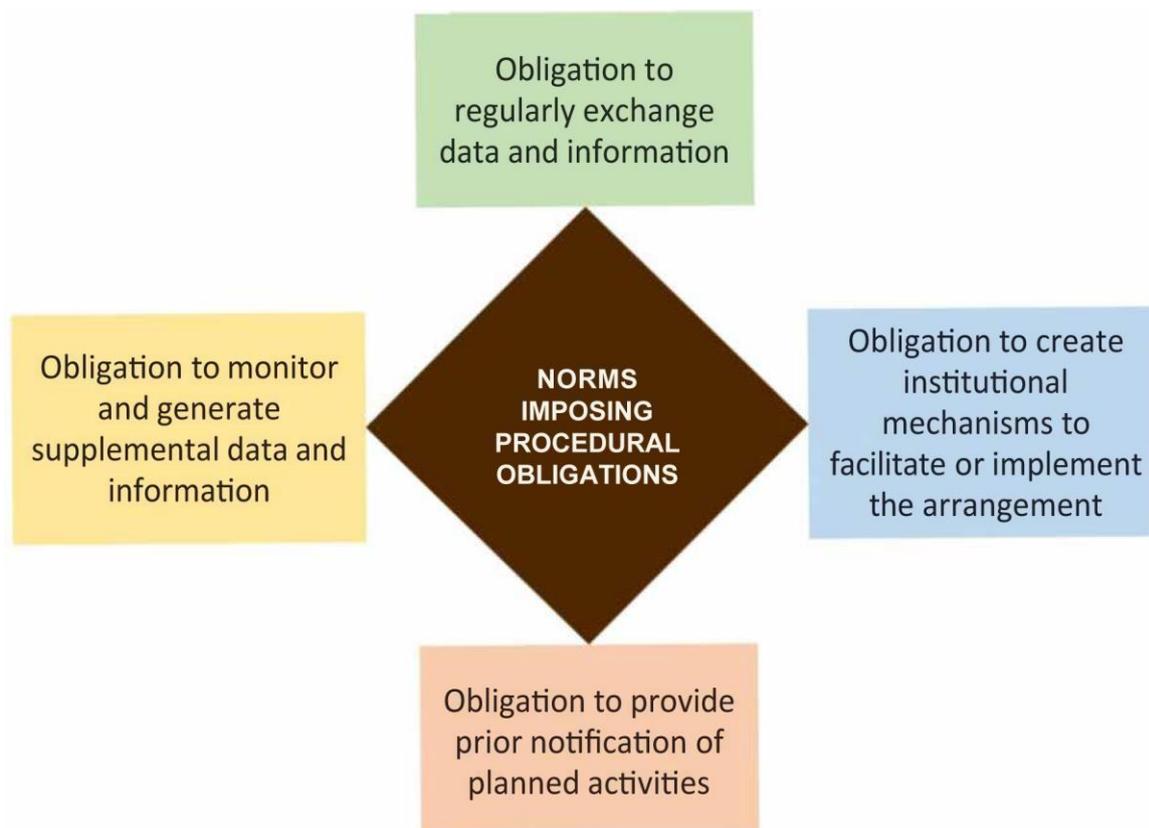


Figure 26 - Norms imposing procedural obligations for transboundary groundwater resources that may be emerging as customary international law.

4.1.1 Obligation to regularly exchange data and information

Possibly the most palpable and consistent conduct emerging from the various agreements and informal arrangements applicable to transboundary groundwater resources is a procedural obligation to regularly exchange data and information. This norm is consistent with customary international water law accepted for transboundary surface water bodies, as depicted in Article 9 of the UN Watercourses Convention (1997),¹¹ and Articles 6 and 13 of the UNECE Water Convention (1992).¹²

¹¹ United Nations Convention on the Law of Non-navigable Uses of International Watercourses.

¹² United Nations Economic Commission for Europe Convention on the Protection and Use of Transboundary Watercourses and International Lakes.

Appearing directly or indirectly in each of these instruments, the duty to regularly exchange data and information is fundamental to the sound management and protection of transboundary aquifers. Absent such sharing of information, aquifer states are faced



with the consequences of the *blank map syndrome* whereby researchers on one or the other side of the border characterize and describe only the portion of the aquifer located within their side (Sanchez et al., 2016). Through the exchange of information, nations can better project the transboundary aquifer—its particular contours and characteristics—and mitigate any deleterious cross-border consequences that might result from its utilization.

For example, the North-Western Sahara Aquifer System (NWSAS) Agreement, through the creation of a consultative mechanism charged with collecting data and information from the three parties, creates a *de facto* obligation to produce, process, and analyze data; develop a database of information; promote and facilitate joint studies; and, more generally, share information as a function of the responsibilities and activities of the consultation mechanism. In contrast, the Carboniferous Limestone Aquifer Agreement explicitly asserts in Article 1 that “*The purpose of this exchange agreement is to set the reciprocal commitments between the three parties and define the nature, conditions of exchange and use of data relating to the management of groundwater in Carboniferous limestones.*”

The precise type of data and information that must be shared by aquifer riparians, however, is not always spelled out in the various agreements and informal arrangements. For example, the Al-Sag/Al-Disi Agreement simply refers to, “*The collection and exchange of information, statements and studies and their analysis*” (Article 3.4.c), while the UNECE Model Provisions generally provides for “*the exchange of information and available data on the condition of transboundary groundwaters*” (Provision 6).

In contrast, the Guarani Aquifer Agreement (GAS) offers more details on what is to be shared in terms of “*technical information about studies, activities and works that contemplate the sustainable utilization of the*” GAS (Article 8), while the Iullemeden, Taoudeni/Tanezrouft Aquifer System (ITAS) MoU specifies:

“easily accessible data and information on the state of the ITAS within their national jurisdiction, in particular those of geological, hydrogeological, hydrological, meteorological and ecological nature and those related to the hydrochemistry of the aquifers or aquifer systems, as well as the relevant forecasts.” (Article 18)

The Draft Articles use language in Article 8 that is quite similar to that of the ITAS MoU. Using more aquifer-specific and descriptive language, the British Columbia–Washington (BC–WA) MoA provides that the parties shall “*cooperate in sharing relevant water quantity information necessary to provide management of those water resources*” (Article I.b)

and, subject to any domestic legal restricting disclosure, “commit to freely sharing and exchanging information on water licenses and permits,” as well as applications for new and modification of existing licenses/permits, and regional water availability and development studies (Article III).

4.1.2 Obligation to monitor and generate supplemental data and information

A corollary procedural obligation to the duty to regularly exchange data and information is the duty to generate supplemental data and information on an on-going basis through monitoring and related activities (Figure 27). While the notion does not appear in the UN Watercourses Convention, it is a prominent component of the UNECE Water Convention in Articles 4, 11, and 13, and has been determined obligatory by the International Court of Justice in the *Case Concerning the Pulp Mills on the River Uruguay* ((ICJ, 2010, ¶ 205). The obligation, which appears in six of the seven agreements and five of the eight informal arrangements identified in this book, acknowledges the need to maintain vigilance in managing a transboundary aquifer and, therefore, is indispensable to fulfilling the duty to exchange data and information.



Figure 27 - Flow Cell Well in use (photo credit: Brockerhoff Environmental Services).

As evidenced by its very title (Convention on the Protection, Utilisation [sic], Recharge and Monitoring of the Franco-Swiss Genevese Aquifer), the Genevese Convention—developed in part for the purpose of monitoring and further developing information about the Genevese aquifer—has an extensive series of provisions related to monitoring. For example, Chapter Four of the agreement addresses *Quantitative and Qualitative Monitoring of the Resource* and mandates periodic assessment of water quality and quantity as well as the exchange of that new information (Article 10), while Article 17 requires the parties to “maintain a monitoring network ... intended for the issuance of warnings

in the case of accidental pollution likely to affect the water quality of the aquifer.” Moreover, Article 10 mandates that “data from the extractions shall be developed by each user and reported at the end of the year to all users,” while Article 16 provides that water pollution analyses “shall be made at regular intervals.”

In a similar vein, the Nubian Sandstone Aquifer Agreement (NSAS) Agreement No. 2 utilizes *Monitoring and Data Sharing* in its title and explicitly focuses on the development and exchange of new data and information:

Hence, it is herewith agreed between the four countries...to monitor and share among them the following information:

–Yearly extraction in every extraction site, specifying geographical location and number of producing wells and springs in every site.

–Representative Electrical Conductivity measurements (EC), taken once a year in each extraction site, followed by a complete chemical analysis if drastic changes in salinity is [sic] observed.

–Water level measurements taken twice a year in the locations shown in the attached maps and tables. The proposed monitoring network is subject to changes upon the feedback of the National Coordinators of the concerned countries.

Using more general language, Provision 3 of the UNECE Model Provisions discusses monitoring in terms of *“quantity and quality of transboundary groundwaters.”* However, the Provision adds the critical requirements that the Parties must harmonize their monitoring standards and methodologies, agree on assessment criteria and parameters to be regularly monitored, and (where appropriate) link the monitoring of ground and surface waters. A similar approach was adopted in Article 13 of the Draft Articles, and also adopted in the Lithuania/Latvia Informal Arrangement in which the parties explicitly noted that the instrument was created *“with special interest to development of common methodology for national groundwater monitoring programs ... in accordance with requirements of [European Council] reporting”* (Paragraph 1.2). Moreover, the Appendix to that document provides more details on quantitative parameters, sampling and hydrochemical analysis, timeframe, inter-calibration, other monitoring standards and methodologies, and assessment criteria and parameters.

The obligation to monitor and continuously generate additional data accords with the comparable duties imposed on riparians of transboundary surface waters. In his separate opinion in the *Case Concerning the Gabčíkovo-Nagymaros Project* before the International Court of Justice (ICJ), Judge Christopher Weeramantry argued for emergence of a principle of continuing environmental impact assessment. In that opinion, Judge Weeramantry opined that *“[a]s long as a project of some magnitude is in operation, [an environmental impact assessment] must continue, for every such project can have unexpected consequences; and considerations of prudence would point to the need for **continuous monitoring**”* (ICJ, 1997, p. 108).

Subsequently, in the *Case Concerning the Pulp Mills on the River Uruguay*, the ICJ asserted that environmental impact assessments are now considered “a requirement under general international law” and must be undertaken “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” (ICJ, 2010, ¶204). It further states that “once operations have started and, where necessary, throughout the life of the project, **continuous monitoring** of its effects on the environment shall be undertaken” (ICJ, 2010, ¶205). While both cases applied this recurring obligation in the context of a transboundary watercourse, the logic utilized by the ICJ is equally and undeniably pertinent to transboundary groundwater resources.

4.1.3 Obligation to create institutional mechanisms to facilitate or implement the agreement or informal arrangement

One of the most interesting trends that can be deduced from the various agreements and informal arrangements is the admonition to create a joint institutional mechanism to carry out the aims of the various regimes. It is still unclear whether this obligation is part of customary international water law given the small sample size. Moreover, while the



UNECE Water Convention mandates the creation of joint bodies to pursue the treaty’s objectives (Articles 9 and 10), the UN Watercourses Convention merely encourages the establishment of such a mechanism (Articles 8 and 11).

Nevertheless, this obligation to form a joint institutional mechanism is particularly noteworthy because of the 310 internationally transboundary rivers and lakes found on Earth (McCracken & Wolf, 2019; Figure 28), fewer than 40 percent employ some type of water management institution (Drieschova & Eckstein, 2014). In contrast, of the handful of agreements and informal arrangements that have been implemented or proposed for transboundary aquifers, six of the seven agreements and six of the eight informal arrangements have proposed or implemented some type of joint institutional mechanism. Moreover, the Draft Articles in Article 7 (General Obligation to Cooperate) and Article 14 (Management), as well as the Model Provisions in Provision 9, clearly contemplate the creation of such mechanisms. While the structures and levels of authority granted these entities vary across the regimes, it remains clear that most aquifer nations that have entered into a cross-border relationship recognize both the value of and the need for institutional and other cooperative mechanisms to facilitate and realize the sound and sustainable management of their shared groundwater resources.

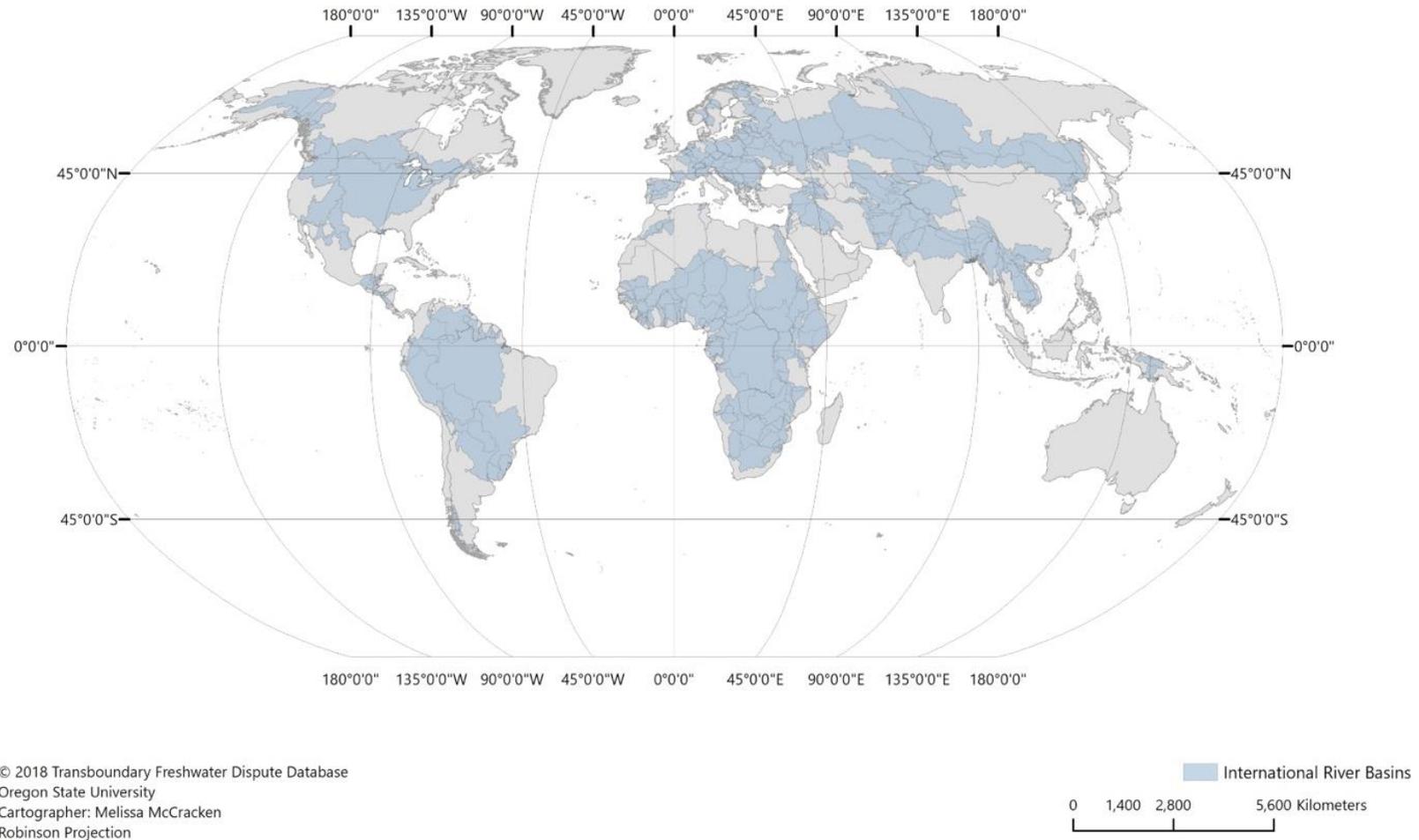


Figure 28 - International River basins of the world (McCracken, 2018).

For example, the Model Provisions (Provision 9), Guarani Aquifer Agreement (Article 15), Al-Sag/Al-Disi Agreement (Article 3), Juárez–El Paso MoU (Paragraph 1), and the Senegalo–Mauritanian Declaration (Paragraphs 5 and 6) all call for the creation of an institutional mechanism to carry out the purposes of the respective agreements (albeit in the case of the Senegalo–Mauritanian Declaration, that instrument calls for establishing a new legal and institutional framework as well as strengthening an existing Regional Working Group to undertake that responsibility). The Model Provisions (Provision 9), Draft Articles (Article 14), and Guarani Aquifer Agreement (Article 15) provide the simplest iteration of this obligation and offer no additional instructions about the structure and operation of such an entity.

The Guarani Aquifer Agreement, however, provides in Article 15 that the mechanism would be established in accordance with Article VI of the 1969 Treaty of the Plata River Basin and stipulates in Article 17 that it will be tasked with helping to resolve disputes by evaluating situations and formulating recommendations. Article 3 of the Al-Sag/Al-Disi Agreement offers slightly more details and notes that the institutional mechanism is composed of representatives of the national water resources agencies in the two member states, and that its mandate includes: *“The supervision and observation”* of groundwater levels, quality, and extraction; *“The collection and exchange of information, statements and studies and their analysis”* related to the aquifer; and the submission of such information and analyses to the two governments. Likewise, the Executive Committee of the Juárez–El Paso MoU is tasked in Paragraph 2 with data sharing and project coordination obligations and is also assigned to facilitate a number of locally-specific activities, including completion of a feasibility study that was begun prior to implementation of the MoU.

Regarding the Senegalo–Mauritanian Declaration, that instrument in its Annex revised the terms of a pre-existing Regional Working Group for Transboundary Cooperation to undertake implementation of the Declaration, and specifically *“to provide a framework for consultation, coordination and decision making among the States in the basin for concerted transboundary management of the Senegalo–Mauritanian Aquifer Basin.”*

In a similar vein, the Genevese Convention creates a commission whose purpose is to implement the agreement. However, the Genevese Aquifer Management Commission has more extensive authority than under the above-noted informal arrangements. Its mandate, for example, as described in Article 2, includes proposing an annual aquifer utilization program, providing technical opinions on construction of new groundwater extraction operations and modification of existing equipment, and performing audits of investment and operational costs related to the recharge installation. It is also responsible for overseeing waterworks and equipment construction (Article 5), recording water extractions (Article 6), collecting water level and quality data (Article 10), and establishing water quality analysis criteria (Article 16).

In contrast to the above five agreements and informal arrangements, where creation of a joint institution was an important—albeit a secondary—component to the agreement, the NWSAS Agreement, the ITAS MoU, and the Nubian Constitution of the Joint Authority, by their very titles and purposes, were formulated and implemented specifically to create a joint cooperative mechanism. The NWSAS Agreement (Paragraph I), for example, creates a Consultative Mechanism to “coordinate, promote and facilitate the rational management of the NWSAS water resources” while the ITAS MoU (Article 3) creates an identically named mechanism “to promote and foster cooperation between the Signatory States ... based on solidarity and reciprocity for a sustainable, equitable, coordinated and collaborative use of the ITAS water resources.” Although the Nubian Constitution of the Joint Authority does not include a purpose statement, the tasks outlined in Article 3 of the agreement are representative of the functions and responsibilities assigned to the mechanisms under each of these three agreements:

- collect and develop all data and information relevant to the shared aquifer;
- promote and facilitate additional studies;
- formulate proposals for the sustainable management of the aquifer; and
- undertake and facilitate appropriate training programs and other mechanisms for disseminating information.

4.1.4 Obligation to provide prior notification of planned activities

While not as widely adopted as the previous obligations, the duty to provide prior notification of planned activities also may be trending toward customary acceptance. Found in all four of the formal and informal global instruments (UNECE Water Convention, UN Watercourses Convention, Draft Articles, and UNECE Model Provisions), as well as in one agreement and two informal arrangements (Guarani Aquifer Agreement, ITAS MoU, and Abbotsford–Sumas Aquifer Memorandum of Agreement), this procedural obligation suggests that where a proposed project has the potential to adversely affect either the territory of another aquifer state or the transboundary aquifer itself, the acting state is obligated to notify other aquifer states of its plans and their possible ramifications. The purpose of this obligation is to allow potentially affected states to evaluate the possible consequences and implications of the planned activity, and to seek an understanding or compromise with the acting state to mitigate or otherwise address any adverse impact (Eckstein, 2007).

The UN Watercourses Convention has one of the more developed formulations of this obligation and includes nine separate articles (Articles 11 to 19) on the various steps that nations should take in complying with the requirement. These include timeframes for notification, for responses to notifications, and for refraining from pursuing the planned project while the notification process unfolds. It also includes obligations to provide data and information on the planned activity and any potential cross-border effects. Whether this substantially detailed series of procedures apply to the governance of transboundary aquifers is still unclear.

With one exception, none of the various prior notification formulations found in the instruments reviewed here provide such a thorough series of procedures. The exception is the ITAS MoU, which proffers a series of rigorous notification requirements and processes that is analogous to what is found in the UN Watercourses Convention. While Article 27 provides the basic prior notification obligation for *“activities, policies and strategies, plans, programs and projects proposed in the area, which may pose a risk to”* the water resources of the transboundary aquifer or otherwise cause transboundary adverse impacts, Article 31 calls for *“technical data and information, including the results of any evaluation of the environmental and social impact”* to accompany the notification, and requires the notifying state to *“refrain from implementing or permitting the implementation of the planned measures”* during a six-month review process.

Article 32 authorizes the notifying state to proceed with the planned activity in the absence of a response to the notification within six months. Article 33 requires that states engaged in consultations and negotiations over planned measures must do so *“according to the principle of good faith, taking into account the legitimate interests of any other signatory State.”* Article 34 permits potentially affected states to request a state engaging in planned measures to comply with the notification obligations and requires disagreements on such obligations to be pursued through consultation and negotiation. Finally, Article 34 allows planned measures to proceed without notification in emergency situations.

The other instruments that include prior notification requirements do so in one or two less-detailed provisions. The Memorandum of Agreement relevant to the Abbotsford–Sumas Aquifer merely states that the chief purpose of the instrument is *“to provide for the timely prior consultation on water quality allocation permits”* and the *“timely sharing of the above information.”*

Using somewhat more forceful language, Article 15 of the Draft Articles commands aquifer states to provide timely notification *“accompanied by available technical data and information...to enable the notified State to evaluate the possible effects of the planned activities.”* Similarly, the Guarani Aquifer Agreement requires in Article 9 that the parties provide prior notification of *“all activities and works ... Which may have effects on the Guarani Aquifer System beyond their boundaries”* as well as technical data to accompany the notification. Indirectly emphasizing consultation in good faith, Article 11 of that treaty also imposes the additional obligation that the party proposing the actions that may have a transboundary impact must delay implementation of those measures for at least six months while negotiating with the potentially affected state. In addition, Provision 8 of the UNECE Model Provisions mandates an environmental impact assessment for all planned activities that are likely to have a significant effect on transboundary groundwater resources and requires that the assessment be transmitted to all potentially impacted states upon request.

One of the more ambiguous components of this trend pertains to the question of when is the obligation of prior notification of planned activities triggered. The documents reviewed here provide a variety of thresholds that offer no clear trend. For example, the Guarani Aquifer Agreement obligates such notice when the planned activity *“may have*

effects on the Guarani Aquifer System beyond their boundaries" (Art. 9). Here, the language activating the obligation is "may have effects," which is a relatively low threshold in terms of impact and could encompass both positive and negative effects. In contrast, the Abbotsford–Sumas Aquifer Memorandum of Agreement imposes the prior notification requirement where a proposed activity "may have the potential for significantly impacting water quantity on the other side of the border" (Paragraph 1.01). The language in this provision is narrower and has a higher threshold as it is triggered only where it affects water quantity and only when the cross-border impact is significant. Nevertheless, like the Guarani Aquifer Agreement provision, the character of the impact is not specified and could be positive or negative.

In a further example, the ITAS MoU offers three rather inconsistent triggers for prior notification. In Article 27, it states that prior notice is required for all proposed "activities, policies and strategies, plans, programs and projects ... which may pose a risk to ITAS water resources or trans-boundary adverse impacts." Later, in Article 31, it asserts that prior notification is mandated for all "measures ... that are likely to have significant negative impacts on other ITAS states." Thus, it appears that such notification is required where the proposed activity (1) may pose a risk to ITAS water resources, (2) may pose trans-boundary adverse impacts, and (3) are likely to have significant negative impacts on other ITAS states. The first is a very low threshold ("may pose a risk") with an undefined outcome that could be either positive or negative. The second sets a rather higher threshold for triggering the prior notification obligation since: "may pose ... impacts" is a more rigorous criterion than "may pose a risk;" the outcome must be transboundary in nature; and the outcome must be "adverse" (suggesting an unfavorable outcome). The third provision establishes an even higher threshold since it mandates prior notification only where: the proposed activity is "likely to have ... impacts" where "likely" is a considerably more rigorous standard than "may pose"; and where the outcome must be "significant," "negative," and affect other ITAS states. Which of these standards and thresholds will endure remains to be seen. However, it suffices to say that there is no clear trend as to what triggers the obligation of prior notification of planned activities under customary international law.

In the context of the *Dispute Over the Status and Use of the Waters of the Silala*, the International Court of Justice recently concluded "that each riparian State is required, under customary international [water] law, to notify and consult the other riparian State with regard to any planned activity that ***poses a risk of significant harm*** to that State" (ICJ, 2022, ¶118). Here, the activity triggering the obligation to provide prior notification is "poses a risk of significant harm." For comparative purposes, while the phrase "poses a risk" is less rigorous than the "likely to have" standard found in Article 31 of the ITAS MoU, the "significant harm" language places considerable constraints on the circumstances under which prior notification is obligatory. That phraseology requires that the outcome must result in "harm" (which is more rigorous and limited than "impacts", and clearly refers to a negative outcome) and that the harm must rise to the level of "significant." Together, these criteria are more rigorous, and therefore more restrictive, than the "significant

negative impacts” found in Article 31 of the ITAS MoU. According to the ICJ, this is the current standard under customary international law for activities related to transboundary watercourses. However, as the decision focused exclusively on the surface flows of the Silala transboundary watercourse, its relevance to cross-border groundwater and aquifers is uncertain. In addition, it is unclear from the Court’s decision who has the right or obligation to decide whether a risk of significant harm has arisen—the State undertaking the planned activity, or the State that may be at risk of significant harm—thereby triggering the notification requirement.

4.2 Norms creating substantive obligations

While these obligations may properly be described as procedural in nature, the various agreements and informal arrangements discussed here also endeavor to create several substantive responsibilities. The most prolific of these is the ITAS MoU, which commits the parties to that instrument to variations of well-recognized principles of customary international water law, including uses that “do not cause damage to other Signatory states” and “equitable and reasonable,” as well as broader customary principles of international environmental law. Among others, these broader doctrines include

- the *user pays principle*, which seeks to impose the costs of externalities services resulting from a harmful activity —such as effects on the environment—on the users of the goods or (Article 25);
- the *polluter pays principles*, which seeks to impose the costs of externalities on the individual or entity causing the harm (Article 24);
- *sustainable development*, which is an approach that seeks to achieve the needs of the present without compromising the ability of future generations to meet their own needs (Article 16); and
- the *precautionary principle*, which seeks to prevent delay in the implementation of preventative measures even where the science and causation are still inconclusive (Article 23).

A closer review of the agreements, informal arrangements, and global instruments included in this survey, however, reveals that no conclusive trends of cross-cutting substantive norms can be identified. Varying references to adverse transboundary effects, impacts, and harm are found in Articles 6 and 7 of the Guarani Aquifer Agreement, Article 20 of the ITAS MoU, Article 6 of the Draft Articles, and Provision 1 of the UNECE Model Provisions. All of these impose a due diligence obligation to prevent, control, and reduce such impacts. Of these four instruments, all also refer to the cornerstone international water law principle of equitable and reasonable utilization (Article 4 of the Guarani Aquifer Agreement, Article 13 of the ITAS MoU, Article 4 of the Draft Articles, and Provision 1 of Model Provisions). However, only the ITAS MoU and the Draft Articles offer factors that should be considered when assessing the circumstances under which utilization of transboundary groundwater resources or a cross-border aquifer may be deemed equitable and reasonable.

Beyond this conclusion, though, there is one other obligation that could be deemed a substantive principle, and which permeates every agreement, informal arrangement, and global instrument reviewed in this book. However, that principle—the general obligation to cooperate—is more rightly described as a hybrid principle that is both substantive and procedural in nature.

- It is substantive in the sense that it is a right and obligation of all nations and violation of which could result in physical or economic harm.
- It is procedural in the sense that it is at the core of and lays the foundation for the other procedural duties, such as the exchange of data and information and of prior notification of planned measures.

This general obligation is a hallmark of all of the instruments reviewed in this book because, at their very core, they embody an effort to cooperate and prevent conflict over cross-border groundwater resources. Even where an instrument makes no formal reference to an obligation to cooperate (such as in the Carboniferous Limestone Aquifer Agreement, Genevese Convention, Al-Sag/Al-Disi Agreement, 2009 Joint Report, NWSAS Agreement, and Concordia-Salto MoU), the act of engaging in either a formal agreement or informal arrangement constitutes a cooperative act. The BC-WA MoA, for example, simply declares in its first article that *“it is imperative that the Ministry [of Environment of British Columbia] and [the Washington State Department of] Ecology ... cooperate in sharing relevant water quantity information necessary to provide management of those water resources.”*

For those instruments that do include a formal obligation to cooperate, the obligations typically focus on the basis of the cooperation and the objectives of that cooperation. Thus, for example, Article 7 of the Draft Articles and Article 14 of the ITAS MoU both require that cooperation be based on *“sovereign equality, territorial integrity, sustainable development, mutual benefit and good faith”* to achieve *“equitable and reasonable utilization and appropriate protection of their transboundary aquifers or aquifer systems.”* Others specify more directly what the parties should cooperate over. Provision 3.1 of the UNECE Model Provisions, for instance, asserts that:

“The Parties shall cooperate in the common identification, delineation and characterization of their transboundary groundwaters ... [and] shall also strive to develop common conceptual models whose level of detail depends on the complexity of the system and the pressures weighing on it.”

Meanwhile, Provision 4 of that instrument states that *“The Parties shall cooperate on the integrated management of their transboundary groundwaters and surface waters.”*

Similarly, the Guarani Aquifer Agreement (Article 14) asserts that *“The Parties shall cooperate in the identification of critical areas, especially boundary areas that require specific treatment and measures,”* while Article 12 obligates the parties to *“establish cooperation programs with the purpose of extending the technical and scientific knowledge on the Guarani Aquifer System, promoting the exchange of information and management practices, and developing joint projects.”*

Aside from the general obligation to cooperate, the lack of consistent appearance of additional principles in the various instruments and mechanisms reviewed in this book indicates that no other substantive norm or obligation is trending toward customary status. However, as the practice of states pertaining to transboundary groundwater and aquifers continues to evolve and new agreements are forged, this conclusion will have to be periodically reevaluated.

4.3 Process Over Substance

While it may not be so obvious, there is one additional trend. States engaging with their neighbors over their transboundary groundwater resources overwhelmingly emphasize procedural mechanisms and legal obligations—such as data sharing and joint activities—over those that address substantive legal obligations including sovereignty, ownership or use rights, allocation, and interference with rights. In other words, the relatively few nations that have engaged with their neighbors over their transboundary groundwater and aquifer resources seem to prefer to focus on procedures for cooperation rather than on mechanisms that allocate specific volumes of water or benefits from those shared resources.

On the one hand, this may seem appropriate given the lack of information that most countries have on groundwater and aquifers that traverse their common borders, and the need to generate data and information prior to raising or claiming any rights. Then again, it may be due to what some authors suggest is a broader movement in international relations from one of co-existence to one of cooperation. While the former predominated earlier in the modern global order where the focus was more internal and on preventing interference with the sovereign rights of other nations, the latter emphasizes engagement with the international community as well as affirmative obligations of assistance, most notably reflected in the procedural and substantive duties of cooperation that now permeate much of international law and relations (Meshel, 2019). Regardless of the rationale, this trend is quite stark and promising.

5 Gaps

5.1 Gaps in the Law

Although the evidence suggests the emergence of trends in the evolution of international law for cross-border groundwater resources, the law is still at a very early stage in its development and evolution. Moreover, the trends that have been identified are limited in both scope and subject matter and leave huge legal and policy gaps. In particular, while some of the norms and obligations proposed under the various instruments have incorporated the unique characteristics of groundwater and aquifers, others have not. Figure 29 illustrates some of the conditions and activities that may lead to issues of concern at an international boundary. These gaps are especially concerning where agreements and informal arrangements invoke norms that historically have applied solely to transboundary surface waters.

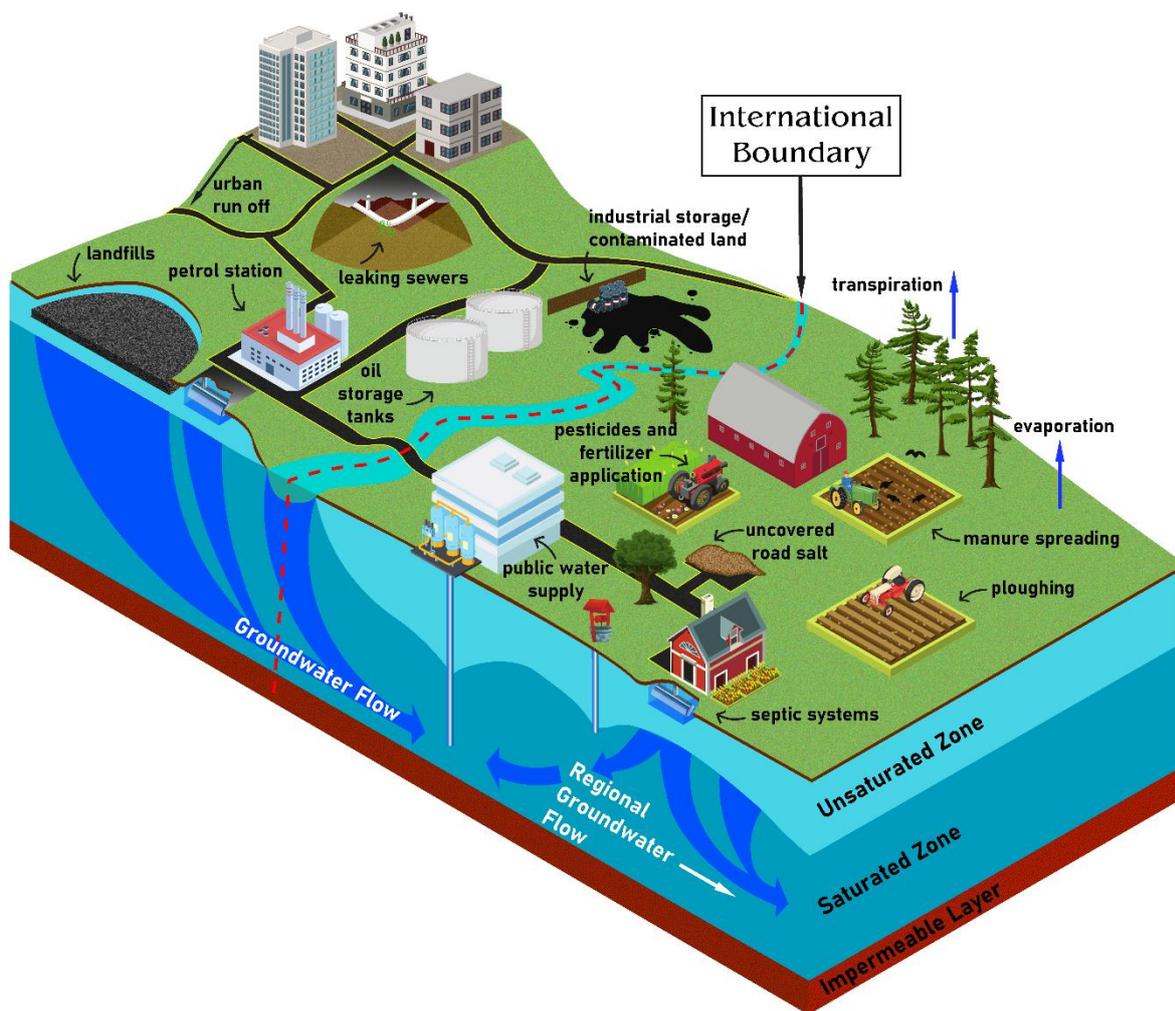


Figure 29 - Potential sources of groundwater contamination (adapted from The Pennsylvania State University, n.d.).

For example, as compared to water flow in rivers, relatively slower groundwater flow rates can affect an aquifer's natural filtration abilities and, thereby, its capacities to reclaim and cleanse itself of pollutants. As a result, groundwater can be more vulnerable than surface water to agricultural, industrial, and municipal pollution as well as other sources of contamination (Eckstein, 2007). Moreover, because of the geographic extent of most aquifers and the challenges associated with monitoring underground formations, the artificial reclamation of a polluted aquifer can be prohibitively complex and expensive. Thus, once an aquifer has been polluted, depending on the extent of contamination it may be rendered unusable for years, decades, or longer (Eckstein, 2007).

Among other issues, this raises the question of whether the threshold for actionable harm should be different for transboundary groundwater resources as compared to cross-border surface water bodies. In other words, when might pollution seeping into the ground achieve the threshold of harm such that liability would apply to the responsible party?

- At the time the pollutant entered the ground?
- At the time the pollution plume began migrating toward the saturated segment of the formation?
- Once the plume reached the saturated section; at the time it inundated the saturated matrix? or
- Once the groundwater is determined to be unusable for its intended purpose?

In addition, when contemplating appropriate regulatory mechanisms for the sound management of transboundary groundwater resources, the recharge and discharge processes of each aquifer also require special attention. Recharge and discharge zones regulate the flow and quality of water moving into and out of aquifers. Hence, these processes, as well as the geographical area in which they operate, must be properly maintained and protected.

In the case of recharge zones, this consists of ensuring both the quantity and quality of water flowing to and through the recharge zone into the aquifer. Thus, recharge zone protection might include restrictions on industrial and municipal developments in the recharge area, as well as constraints on agricultural activities that might contaminate the recharge area and, thereby, the aquifer. They also might include regulations related to the environment and habitats in the recharge area that help maintain the quantity and quality of water infiltrating the aquifer. Similarly, discharge zone protection could include restrictions on construction, recreational, and other activities that might impact the discharge process, the water flow within the aquifer, the water table, or the aquifer's natural cleansing abilities. Restrictions for both zones might also include limitations on mining activities that remove or modify the strata within the recharge or discharge area.

The UN International Law Commission sought to address some of these concerns by including an article in the Draft Articles that specifically focuses on preventing and

minimizing “detrimental impacts on the recharge and discharge process” (Article 11). However, that article is limited in that it does not afford the recharge and discharge zones the same protections as provided to the aquifer and limits the obligations of states to only “take appropriate measures” toward ensuring the integrity of those zones. Figure 30 illustrates recharge and discharge areas.

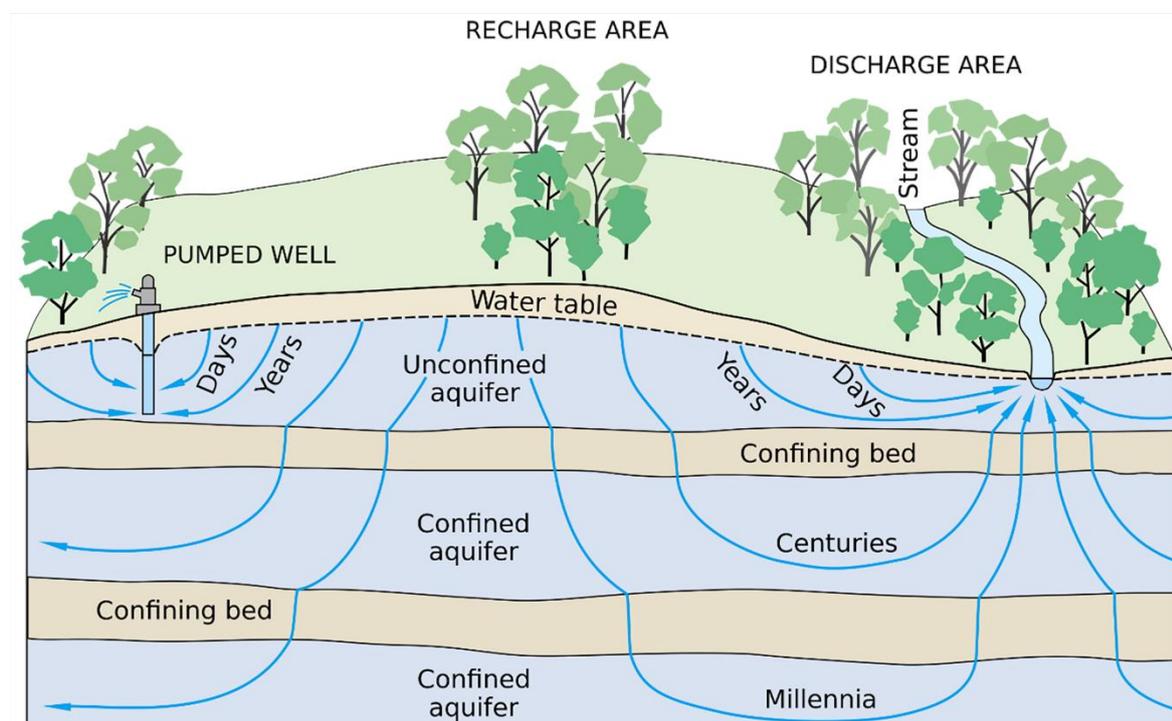


Figure 30 - The recharge area in this diagram encompasses the land surface on which precipitation falls. Discharge areas depicted in this diagram include the natural stream and the artificial well (adapted from Winter et al., 1998).

In addition, while Article 11 does purport to impose obligations—to protect the aquifer and related ecosystems—on non-aquifer states in whose territory a recharge or discharge zone is located, whether in whole or in part, there are no incentives for non-aquifer states to abide by such requirements or to join agreements with such commitments.

A third area that needs attention pertains to metadata and the need by riparian nations to harmonize their methodologies, approaches, techniques, and technologies when assessing shared transboundary groundwater resources. Metadata refers to the information that characterizes data. It defines the who, what, when, where, why, and how of every facet of a datum documented for a particular analysis (USGS, 2016). Having such information is critical for determining the extent to which the results of studies developed in neighboring states are compatible and comparable with each other. Where riparian nations overlying a common aquifer utilize different techniques, procedures, methodologies, assumptions, or technologies, the data and information resulting from their analyses may not be compatible or comparable to evaluate the conditions of the aquifer on both sides of the frontier.

For example, the depth of a water table in a transboundary aquifer may be determined by measurements taken by neighboring states near the border. If the results produced by each state differ, the metadata could be helpful to understand why the results differ (Figure 31). Factors like methodology employed in the measurements, as well as the technology used and calibration of equipment, could prove crucial in evaluating both similarities and differences and, ultimately, whether those results could be used as a basis for subsequent research or policy decisions by the two riparians.

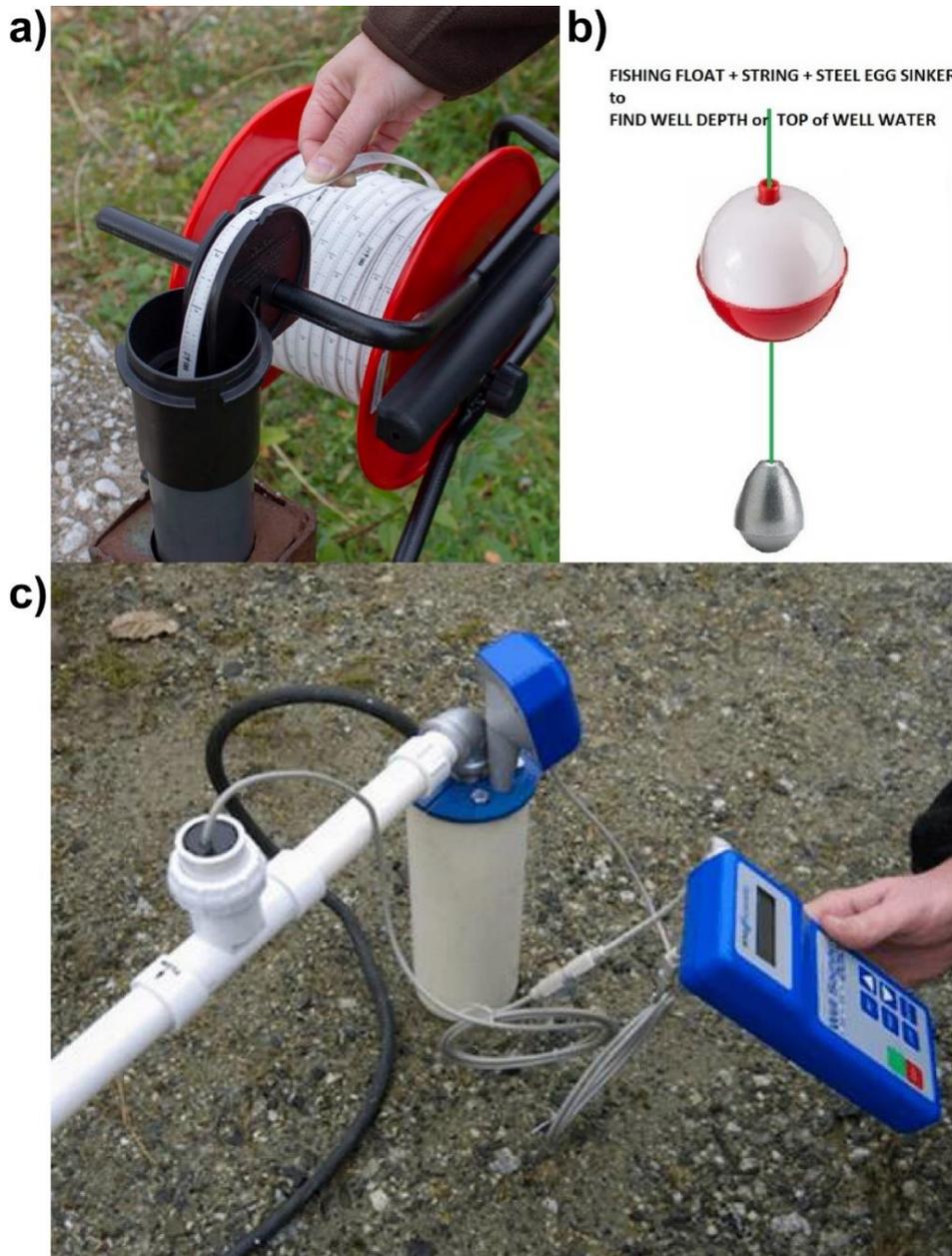


Figure 31: The use of different methods and technologies for assessing the depth of the water table may lead to discrepancies in data collected by different states: a) water level indicator b) fishing float, string, and weight c) sonic water level meter.

Other factors that can provide critical metadata include:

- the education, training, experience, and preferences of the professionals conducting the studies;
- the software and electronic programs used in the analysis;
- the geography and surrounding physical characteristics of the region where the measurements were taken; and
- the precise chemical, physical, and biological characteristics that the researchers focused on in the analyses.

Accordingly, states overlying a transboundary aquifer must cooperate over their metadata. They must ensure harmonization of the type, quantity, and quality of the data and information they generate, as well as the procedures used to collect and process that data and information, to facilitate an exchange that is meaningful and productive. This can be achieved through a variety of actions, including—among other things—joint studies, establishing common standards and procedures for data gathering and processing, and employing the same data gatherers and analyzers.

A fourth topic that needs further exploration is whether the legal rules and procedures applied to recharging transboundary groundwater resources and aquifers should be applied equally to non-recharging cross-border resources, or whether they require a distinct legal and governance regime. A non-recharging aquifer, often termed a fossil aquifer, refers to a formation that is not connected to the hydrologic cycle and has been completely or almost completely cut off from all sources of recharge and discharge for an appreciable period of geologic time. Groundwater contained in these aquifers was deposited in some past geologic era—thousands or even millions of years ago—when climatic and geologic conditions allowed for regular recharge of the aquifer.

As a result, the groundwater found within these aquifers is not renewable; any extraction will deplete the aquifer. While the procedural principles discussed above certainly could apply with few concerns, it is the applicability of substantive rules that raise a variety of questions, such as:

- How can notions of sustainability be applied to a non-recharging aquifer?
- How would the concepts of responsibility, liability, and harm apply in the context of extraction when any pumping is guaranteed to diminish the aquifer?
- Under what circumstances might the pollution of a fossil aquifer result in liability or harm, given the absence of natural flow and recharge?
- Should the aquifer be divided equitably or based on some other formula, such as in relation to the percentage of the formation situated within each nation's territory?
- Should such aquifers should be managed akin to other depletable natural resources, like oil and gas deposits?

While three of the seven formal agreements identified in this book apply to a specific non-recharging aquifer, none employ or address substantive legal issues. Hence,

the legal rules and procedures applicable to non-recharging cross-border groundwater resources and aquifers require considerable attention and consideration.

As noted in the introduction, yet another issue that has recently come to the fore pertains to whether international regulatory mechanisms should focus on groundwater, on aquifers, or both (Rivera, 2021). As indicated previously, groundwater refers to water found in the saturated portion of an aquifer, while an aquifer is a permeable geologic formation that has the capacity to store and transmit water. On the one hand, agriculture, industry, people, and the environment depend on the physical thing known as *water*. And in the context of lakes and rivers, regulators and policymakers typically focus legal and management tools on the uses of the water contained in the vessels. Lake and river basins are rarely if ever even addressed. Yet, in the case of groundwater and aquifers, there is much to be said about regulating both the water and the container.

Groundwater is clearly the *thing* that is used by farmers, manufacturers, communities, and the environment. However, aquifers have a *function* that is indispensable for the existence and availability of groundwater and provides for other critical, natural phenomenon.

The *functioning* of aquifers encompasses how subsurface strata can store and transport water, dilute wastes and other contaminants, provide a habitat for aquatic biota, serve as a source of fresh water and nutrients for aquifer-dependent ecosystems, and even provide geothermal heat. Each of these characteristics is dependent on the particular aquifer's structure; hydrostatic pressure; hydraulic conductivity; interaction with other geophysical phenomenon; as well as its mineralogical, biological, and chemical attributes. Moreover, all these traits may be interdependent to the extent that an aquifer's sustained operation as a dynamic hydrogeologic system depends on the continuation of a particular function or series of functions (Heath 2004). If any of these natural characteristics were to be impaired or destroyed, it could detrimentally affect the viability and integrity of the aquifer as a whole, and thereby the groundwater contained therein, as well as communities and ecosystems dependent on that aquifer.

Accordingly, to manage transboundary groundwater in ways that maximize both the utility and sustainability of the resource, regulatory mechanisms must address both the use and management of the groundwater as well as the functioning and unique vulnerabilities and characteristics of the aquifer formation.

These concerns do not reflect all the gaps afflicting the management and regulation of transboundary groundwater resources and aquifers. Some of the other issues and topics that need to be addressed include:

- the extent to which international principles of national sovereignty apply to the groundwater flowing through a transboundary aquifer but located within the territory of one riparian;

- the relevance of the principles of no significant harm and equitable and reasonable use to transboundary aquifers;
- whether the no significant harm standard is subordinate or superior to that of equitable and reasonable use in the context of transboundary groundwater and aquifers;
- whether and the extent to which an aquifer state has obligations, and the content of those obligations, to protect habitats and ecosystems dependent on the groundwater of a transboundary aquifer; and
- whether and the extent to which cross-border public participation may be permissible in decision-making affecting one or both sides of a transboundary aquifer.

5.2 Gaps in the Analysis

As noted in the introduction, the focus of this book is on state conduct and practice emerging from the few available formal agreements and informal arrangements that exist between nations over specific transboundary groundwater resources. The book, however, does not address conduct and practice that may occur between states pertaining to a transboundary aquifer that has not been memorialized in a formal agreement or informal arrangement.

While it may be possible to identify and assess such conduct through newspaper stories, interviews, surveys, and meeting minutes, such an assessment is beyond the scope of this book. The absence of a pact, however, does not negate the value of such interactions for purposes of identifying international customary practices. These activities and relations still constitute important state actions toward cooperation that likewise can be explored for potential trends and customs in how these nations manage their transboundary aquifers.

Accordingly, it is worth noting that several nations overlying common aquifers not discussed in this book have begun to co-ordinate preliminary investigations into their shared groundwater resources and explore opportunities to cooperate. Such efforts have been evident, among others, for the following transboundary groundwater resources and aquifers:

- the Ramotswa Aquifer that is shared between Botswana and South Africa, but is also relevant to the upper part of the Limpopo River Basin, which is shared by Botswana, Mozambique, South Africa, and Zimbabwe (International Water Management Institute (IWMI), 2021);
- aquifers in the Kavango Zambezi Transfrontier Conservation Area shared by Angola, Botswana, Namibia, Zambia, and Zimbabwe (Groundwater Solutions for Policy and Practice (GRIPP), 2021);
- the artesian Pretashkent Transboundary Aquifer system shared by Kazakhstan and Uzbekistan (IGRAC, n.d.-a); and

- the Dinaric Karst Aquifer System shared by Albania, Bosnia and Herzegovina, Croatia, and Montenegro (DIKTAS Project Website, n.d.).

While these efforts have yet to result in any informal or formal accord, they should be explored and evaluated for purposes of identifying state practices related to the management of transboundary aquifers.

In addition, this book has not included international relations and instruments that are not directly focused on the administration and management of particular cross-border groundwater resources, but which nevertheless are pertinent to specific transboundary aquifers. Thus, for example, the book does not consider any of the following:

- the outcome of the dispute between the Czech Republic and Poland over the planned expansion of Poland's Turów coal mine on its southern border, the potential impact on their shared aquifer (as well as other forms of cross-border impacts; Stejskal and Eckstein, in press) in the Hrádek sub-basin of the Zittau Basin in the borderland Frýdlant area (Nádaskay, et al., 2020), and the agreement that was forged in 2022 between the two nations to respond to the concerns (České republiky a vládou Polské republiky [Czech Republic and Poland], 2022);
- the 2019 agreement between the Grand Duchy of Luxembourg and the Walloon Region in Belgium that addresses wastewater treatment, protection of drinking water catchments, and monitoring for nitrates, which includes provisions pertaining to shared aquifers that are used as a source of drinking water (le Grand-Duché de Luxembourg et Région wallonne [Grand Duchy of Luxembourg and the Walloon Region], 2019);
- the joint management of the Karavanke aquifer between Slovenia and Austria, which is based in part on the 1955 Agreement on Water Management Issues of the Drava River entered into by the former Yugoslavia and Austria, and is administratively managed by the Permanent Slovenian–Austrian Commission for the Drava River (UNECE, 2020); or
- the overall water management regime for freshwater resources in Europe developed at the European Union level and implemented by the Member States, in large part through the Water Framework Directive and its daughter Groundwater Framework Directive (Reichert, 2016).

Such assessments are beyond the scope of this volume.

Despite these shortcomings, the above sources of state practice are no less important for identifying and characterizing trends in customary international law and should be attempted. Accordingly, this book should be viewed as a preliminary step in the exploration of emerging international law for transboundary groundwater resources.

6 Conclusion

Transboundary groundwater resources today play a critical role in providing fresh water for people, industries, nations, and the environment worldwide. For billions of people, they serve as the bulwark against the challenges posed by expanding demands for freshwater and the declining supplies resulting from overexploitation and climate change. As a result, transboundary groundwater resources and aquifers are now receiving greater international attention from overlying nations, non-governmental advocacy groups, and UN entities. Moreover, many states around the world are beginning to pursue various strategies for their exploitation and management.

While the level of attention that these subsurface resources receive still pales in comparison with that paid to rivers and lakes, it is reasonable to expect that nations will continue to explore their transboundary groundwater and aquifers. The value of these resources is undeniable, and growing water scarcity is driving many nations to investigate all new possibilities. As a result, it is also reasonable to expect that more states will work with their cross-border neighbors to collaborate and co-ordinate their activities. Moreover, as cooperation over shared groundwater and aquifers expands and the number of formal agreements and informal arrangements grows—as is certain to happen—trends and priorities will become more evident and will lead to the development of more definite customary norms for the management of transboundary groundwater resources and aquifers.

7 Questions for Reflection on the Topics on this Book

In the following exercises, you are tasked with reading and interpreting agreements and informal arrangements. Read through the following two instruments and respond to the questions 1 through 6.

- Agreement on the Guarani Aquifer, signed in San Juan, Argentina, 2 August 2010 [linked here in [English](#) / [Portuguese](#) / [Spanish](#)]
- Memorandum of Understanding between the City of Juárez, Mexico Utilities and the El Paso Water Utilities Public Services Board (PSP) of the City of El Paso, Texas, 6 December 1999 [linked here in [English and Spanish](#)]

Question 1

Who are the parties to the instrument?

[Answer to Question 1](#) ↓

Question 2

At what level of governance is the instrument operationalized?

[Answer to Question 2](#) ↓

Question 3

What is the basic purpose of the instrument?

[Answer to Question 3](#) ↓

Question 4

What legal principles or norms does the instrument proffer?

[Answer to Question 4](#) ↓

Question 5

What obligations does the instrument require of the parties?

[Answer to Question 5](#) ↓

Question 6

Should this instrument be construed as a formal agreement or an informal arrangement? Why?

[Answer to Question 6](#) ↓

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Treaties, agreements, informal arrangements, and related international instruments

Note: The reader is reminded that Table 1, Table 2, Table 3, Table 4, and Table 5 provide breakouts of the following documents by the name of the document, the parties (i.e., states), the name of the transboundary groundwater system, and the date the instrument came into force.

- Acuerdo de Entendimiento Entre la Municipalidad de Concordia, Republica Argentina e Intendencia de Salto, Republica Oriental de Uruguay [Memorandum of Understanding Between the Authorities of Concordia, Republic of Argentina, and Salto, Republic of Uruguay], March 23, 2017.
- Acuerdo sobre el Acuífero Guarani [Guarani Aquifer Agreement]. (2010). Signed in San Juan, Argentina, 2 August 2010. http://internationalwaterlaw.org/documents/regionaldocs/Guarani_Aquifer_Agreement-English.pdf.
- Agreement between the Government of the Hashemite Kingdom of Jordan and the Government of the Kingdom of Saudi Arabia for the Management and Utilization of the Ground Waters in the Al-Sag/Al-Disi Layer. (2015). Signed in Riyadh, Saudi Arabia, 30 April 2015. http://internationalwaterlaw.org/documents/regionaldocs/Disi_Aquifer_Agreement-English2015.pdf.
- Agreement no. 16-28. On cooperation between the Lithuanian Geological Survey under the Ministry of Environment (LGT) and the Latvian Environment, Geology and Meteorology Centre (LVGMC) on cross-border groundwater monitoring.

- Carta de Intención Para la Gobernanza del Acuífero Ocotepeque—Citalá [Statement of Intent for the Governance of the Ocotepeque–Citalá Aquifer], El Salvador y Honduras. (2019). Signed in Esquipulas, 22 February 2019.
https://www.internationalwaterlaw.org/documents/regionaldocs/Ocotepeque-Cital%C3%A1_2019.pdf.
- Constitution of the Joint Authority for the Study and Development of the Nubian Sandstone Aquifer Waters, 1992.
http://internationalwaterlaw.org/documents/regionaldocs/Constitution_of_the_Joint_Authority-Nubian_Sandstone_Aquifer.pdf.
- Convention de Mise à Disposition et D'échange de Données Relatives à la Gestion de Eaux Souterraines des Calcaires du Carbonifère [Convention for the Provision and Exchange of Data Relating to the Management of Groundwater from Carboniferous Limestones]. (2017). Signed at Mons, 14 December 2017. <https://www.isc-cie.org/fr/bibliotheque/convention-de-mise-a-disposition-et-dechange-de-donnees-relatives-a-la-gestion-des-eaux-souterraines-des-calcaires-du-carbonifere/>.
- Convention entre le Grand-Duché de Luxembourg et la Région wallonne relative à l'assainissement des eaux usées, à la protection des captages d'eau potabilisable et au suivi de la directive nitrates [Agreement between the Grand Duchy of Luxembourg and the Walloon Region relating to the treatment of waste water, the protection of drinking water catchments and the monitoring of the Nitrates Directive]. (2019). Signed in Martelange on April 9, 2019.
<http://environnement.wallonie.be/legis/international/convention052.htm>.
- Convention relative à la protection, à l'utilisation, à la réalimentation et au suivi de la Nappe Souterraine Franco–Suisse du Genevois [Convention on the Protection, Utilisation, Recharge and Monitoring of the Franco–Swiss Genevese Aquifer], Community of the Annemassienne region, the Community of the Genevese Rural Districts, and the Rural District of Viry, on one part, The Republic and Canton of Geneva, on the other. (2008). Signed in Geneva, 18 December 2007; in force on 1 January 2008.
<http://internationalwaterlaw.org/documents/regionaldocs/2008Franko-Swiss-Aquifer-English.pdf>.
- Declaration ministérielle sur le Bassin aquifère sénégal–mauritanien [Ministerial declaration on the Senegalo–Mauritanian aquifer basin] (Senegalo–Mauritanian Declaration). (2021). Signed in Geneva, September 29, 2021.
https://www.internationalwaterlaw.org/documents/regionaldocs/Senegal-Mauritanian_Aquifer_Basin_Declaration-Eng.pdf.
- Dohoda mezi vládou České republiky a vládou Polské republiky o spolupráci k řešení vlivů těžební činnosti v povrchovém hnědouhelném dole Turów v Polské republice na území České republiky [Agreement between the Government of the Czech Republic and the Government of the Republic of Poland on cooperation to address the effects

of mining activity in the Turów surface lignite mine in the Republic of Poland in the territory of the Czech Republic], Prague, 3 February 2022.

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Joint Report of the Principal Engineers Regarding the Joint Cooperative Process - United States–Mexico for the Transboundary Aquifer Assessment Program. (2009). Signed in El Paso, August 19, 2009.

https://www.ibwc.gov/Files/Minutes/Joint_Report_TAAP_081909.pdf.

Letter from USA Commissioner C.W. Ruth to Mexican Commissioner Roberto F. Salmon Castelo approving the 2009 Joint Report of the Principal Engineers Regarding the Joint Cooperative Process - United States–Mexico for the Transboundary Aquifer Assessment Program, August 19, 2009.

Letter from Mexican Commissioner Roberto F. Salmon Castelo to USA Commissioner C.W. Ruth approving the 2009 Joint Report of the Principal Engineers Regarding the Joint Cooperative Process - United States–Mexico for the Transboundary Aquifer Assessment Program, August 19, 2009.

Memorandum of Agreement Related to Referral of Water Right Applications between the State of Washington as represented by the Department of Ecology and the Province of British Columbia as represented by the Minister of Environment, Lands and Parks. (1996). Signed on 10 October 1996.

<http://internationalwaterlaw.org/documents/regionaldocs/Local-GW-Agreements/1996-BC-WA-Water-Right-Referral-Agreement.pdf>.

Memorandum of Understanding between City of Juárez, Mexico Utilities and the El Paso Water Utilities Public Services Board of the City of El Paso, Texas. (1999). Signed on 6 December 1999. http://internationalwaterlaw.org/documents/regionaldocs/Local-GW-Agreements/El_Paso-Juarez_MoU.pdf.

Memorandum of Understanding for the Establishment of a Consultation Mechanism for the Integrated Management of the Water Resources of the Iullemeden, Taoudeni/Tanezrouft Aquifer Systems (ITAS). (2014). Signed in Abuja, Nigeria, 28 March 2014.

http://internationalwaterlaw.org/documents/regionaldocs/Iullemeden_MOU-2014.pdf.

Programme for the Development of a Regional Strategy for the Utilisation of the Nubian Sandstone Aquifer System (NSAS). (2000). Signed in Tripoli, 5 October 2000.

Agreement No. 1 - Terms of Reference for the Monitoring and Exchange of Groundwater Information of the Nubian Sandstone Aquifer System, signed in Tripoli.

Agreement No. 2 - Terms of Reference for Monitoring and Data Sharing, signed in Tripoli.

Regional Strategic Action Programme for the Nubian Aquifer System. (2013). Signed in Vienna, 18 September 2013.

http://internationalwaterlaw.org/documents/regionaldocs/Regional_Strategic_Action_Plan_for_the_Nubian_Aquifer.pdf.

United Nations Convention on the Law of Non-navigational Uses of International Watercourses. [UN Watercourses Convention] (1997). G.A. Res. 51/229, UN GAOR, 51st Session, UN Doc. A/RES/51/229. (1997).

United Nations Economic Commission for Europe Convention on the Protection and Use of Transboundary Watercourses and International Lakes [UNECE Watercourses Convention]. (1992). Done at Helsinki, 17 March 1992.

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United Nations Food and Agriculture Organization and Observatoire du Sahara et du Sahel. (2002). Minutes of the Tripartite Regional Workshop, Establishment of a Consultation Mechanism for the Northwestern Sahara Aquifer System (SASS), Rome 19 & 20 December 2002.

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9 Answers to Questions

Answer to Question 1

Agreement on the Guarani Aquifer, signed in San Juan, Argentina, 2 August 2010.

The republic of Argentina, the Federative Republic of Brazil, the Republic of Paraguay, and the Oriental Republic of Uruguay.

Memorandum of Understanding between the City of Juárez, Mexico Utilities and the El Paso Water Utilities Public Services Board (PSP) of the City of El Paso, Texas, 6 December 1999.

The city-owned water utilities of the City of Juárez, Mexico (Junta Municipal de Agua y Saneamiento de Juárez) and the City of El Paso, US (El Paso Water Utilities Public Services Board).

[Return to Question 1](#) ↑

Answer to Question 2

Agreement on the Guarani Aquifer, signed in San Juan, Argentina, 2 August 2010.

The instrument is operationalized at the international level among the governments of the four countries.

Memorandum of Understanding between the City of Juárez, Mexico Utilities and the El Paso Water Utilities Public Services Board (PSP) of the City of El Paso, Texas, 6 December 1999

The instrument is operationalized at the sub-national (municipal) level by agencies of the municipalities of Juárez and El Paso.

[Return to Question 2](#) ↑

Answer to Question 3

Agreement on the Guarani Aquifer, signed in San Juan, Argentina, 2 August 2010.

The basic purpose of the instrument is the conservation, environmental protection, and sustainable utilization of the Guarani Aquifer System, which is described in the first paragraph of the preamble, as well as Articles 3 and 4.

Memorandum of Understanding between the City of Juárez, Mexico Utilities and the El Paso Water Utilities Public Services Board (PSP) of the City of El Paso, Texas, 6 December 1999.

The basic purpose of the instrument is to identify mechanisms between the parties to increase communication, cooperation, and implementation of transboundary projects of common interest, which is described in the paragraph beginning with “Now Therefore” on page 3.

[Return to Question 3](#) ↑

Answer to Question 4

Agreement on the Guarani Aquifer, signed in San Juan, Argentina, 2 August 2010.

- Sovereignty over the respective portions of the aquifer found within each nation’s territory: Article 2.
- Reasonable and sustainable use of the waters of the aquifers: Article 3.
- Promotion of the conservation and environmental protection of the aquifer: Article 4.
- No significant harm to other parties or the environment: Articles 6 and 7.
- Exchange of data and information: Article 8.
- Prior notification of planned activities and works: Articles 9 and 10.
- Cooperation: Articles 12 to 14.
- Use of joint institutional mechanism: Article 15.
- Peaceful settlement of disputes: Articles 16 to 19.

Memorandum of Understanding between the City of Juárez, Mexico Utilities and the El Paso Water Utilities Public Services Board (PSP) of the City of El Paso, Texas, 6 December 1999.

- Exchange of data and information: Recitals VI, IX, X, and Articles 3(a) to (c), 3(f).
- Cooperation: Recitals V, IX, X, XI, and Articles 1, 3(d) to (e), 3(g) to (h).
- Joint institutional mechanisms: Articles 1, 4.

[Return to Question 4](#) ↑

Answer to Question 5

Agreement on the Guarani Aquifer, signed in San Juan, Argentina, 2 August 2010.

The instrument creates obligations for the parties by using the term “*shall*” (which indicates a legally binding obligation) with reference to specific legal principles and norms. This is a well-designed effort to bind the parties to those principles and norms.

However, the instrument does not define the various principles and norms and does not explain the process of implementation or standards by which compliance will be judged. Accordingly, while the instrument creates generally binding obligations, the specific modalities and factors for each of the obligations is not clear. Essentially, the Parties to the treaty have left such concerns to be addressed at some future date when a situation or dispute necessitates the clarification of a particular provision.

- Obligation to make reasonable and sustainable use of the waters of the aquifers: Article 3.
- Obligation to promote the conservation and environmental protection of the aquifer to ensure multiple, reasonable, sustainable, and equitable uses of its waters: Article 4.
- Obligation to adopt all necessary measures to avoid causing significant harm to other parties or the environment: Article 6.
- When causing significant harm to other parties or the environment, the obligation to eliminate or mitigate such harm: Article 7.
- Obligation to adequately exchange technical information about studies, activities and works that contemplate the sustainable utilization of the aquifer: Article 8.
- Obligation to inform all parties in advance about activities and works that are intended to be executed or authorized within their territory and that may have effects on the aquifer system beyond their territory, and to include with that notice available technical data and results from an evaluation of environmental effects sufficient to allow the receiving parties the opportunity to evaluate the potential effects of the activities and works: Articles 9 and 10.
- Obligation to cooperate: Articles 12 to 14.
- Obligation to establish a joint institutional mechanism to coordinate cooperation among the parties and compliance with the agreement: Article 15.
- Obligation to settle disputes peacefully through negotiations, through the support of the joint institutional mechanism, or through an arbitration process: Articles 16 to 19.

Memorandum of Understanding between the City of Juárez, Mexico Utilities and the El Paso Water Utilities Public Services Board (PSP) of the City of El Paso, Texas, 6 December 1999.

The instrument does not impose any specific obligations on the parties. Article 1 simply explains what the parties are doing (establishing the executive committee) without requiring that they take any specific action. While Article 2 uses the term “*shall*” in defining the immediate objectives of the committee, it does not create any obligations for the parties. Article 3 identifies the general objectives of the instrument without imposing any responsibilities or commitments on the parties, thus making those objectives aspirational. While Article 4 uses the term “*shall*” with reference to when the committee will meet, it then softens the commitment using “*as often as it is considered necessary ...*” to the point of making the obligation non-enforceable.

[Return to Question 5](#) ↑

Answer to Question 6

Agreement on the Guarani Aquifer, signed in San Juan, Argentina, 2 August 2010.

This instrument should be construed as a formal agreement. It was entered into by and creates obligations for the national governments of the four parties.

Memorandum of Understanding between the City of Juárez, Mexico Utilities and the El Paso Water Utilities Public Services Board (PSP) of the City of El Paso, Texas, 6 December 1999.

This instrument should be construed as an informal arrangement. It was entered into by subnational units without any evidence (in the instrument) that it was authorized by (or otherwise had the imprimatur of) the respective federal governments of Mexico and the United States. In addition, the language used in the instrument creates no binding obligations for any of the parties.

[Return to Question 6](#) ↑

10 About the Author



Gabriel Eckstein is an internationally recognized expert in international and comparative water and environmental law and policy with over 30 years of experience consulting, teaching, and researching in these fields. At Texas A&M University, he serves as professor of law[↗] and director of the law school's Energy, Environmental & Natural Resources Systems Law Program[↗]. Professor Eckstein regularly advises United Nations agencies, national and sub-national governments, non-governmental organizations, and other groups on international and US water and environmental issues. He currently chairs the Executive Council of the International Association for Water Law[↗], and previously served as President of the International Water Resources Association[↗]. He is also an Associate Editor for *Brill Research Perspectives: International Water Law*[↗], and a member of the Editorial Board of the *Journal of Water Law*[↗]. Professor Eckstein holds the degrees of Juris Doctor, L.L.M. in International Environmental Law, M.S. in International Affairs, and B.A. in Geology.

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Modifications to Original Release

Changes from the Original Version to Version 2

Original Version: June 20, 2024, Version 2: July 11, 2024

Page numbers refer to the original PDF.

page ii, restarted pagination at i

page iii, now page ii, added Version 2

page vi, now page v, changed 592 to 468 in the Groundwater Project Foreword as explained in footnote #1 on page 2

page 81, is now followed by page A, to accommodate this modification section