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Characterizing Legal Implications for the Use of Transboundary Aquifers

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Abstract

Groundwater resources that traverse political boundaries are becoming increasingly important sources of freshwater in international and intranational arenas worldwide. This is a direct extension of the growing need for new sources of freshwater, as well as the impact that excessive extraction, pollution, climate change, and other anthropogenic activities have had on surface waters. It is also a function of the growing realization that groundwater respects no political boundaries, and that aquifers traverse jurisdictional lines at all levels of political geography.

Due to this growing awareness, questions pertaining to responsibility and liability are now being raised in relation to the use, management, exploitation, and governance of cross-border aquifers by stakeholders and policymakers who want to maximize their access to subsurface freshwater, as well as minimize their legal vulnerability and exposure. This is occurring both at the international level where two or more sovereign nations, and at the domestic level where two or more subnational political units, overlay a common aquifer.

The law applicable to transboundary groundwater resources at both levels of governance is presently quite primitive and inadequate. Moreover, the relationship of groundwater law to surface water law is often absent from treaties as well as national laws and regulations. While a few promising trends appear to be emerging in the international realm, clear rules and regulations addressing questions of responsibility and liability in relation to the use, management, exploitation, and administration of transboundary groundwater remains elusive at all level of governance.

To provide a foundation for the development of such norms, this paper explores circumstances under which the use, management, exploitation, or administration of a transboundary groundwater body might cause harm to a neighboring political unit—either to their territory, or to important economic, societal, or other interests—and, thereby, result in legal responsibility and/or liability. It assesses cause and effect relationships with reference to conceptual models of transboundary aquifers developed by Eckstein & Eckstein (2005) and Eckstein (2017). Notions of gaining and losing stream relationships, recharging and non-recharging aquifers, groundwater flow direction, the impact of groundwater pumping, anthropogenic contamination, and other concepts are utilized to describe scenarios in which harm could traverse a political boundary. The paper then translates that analysis into notions of responsibility and liability that are common to the legal realm. This research area is novel and has only marginally been addressed in the domestic interstate context of the United States (Hall & Regalia 2016).

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The Quandary of Mixing Groundwater and Law

Boundaries demarcating the territorial lines of sovereign states and subnational political units typically serve as the basis for claims of right to solid natural resources found within each jurisdiction. For example, rights to coal, uranium, and other mineral deposits that traverse political frontiers are typically divided in relation to geographic boundaries with each state's or sub-state unit's entitlement directly related to those resources physically found within its territory.

Divvying up fluidic resources, like groundwater, flowing between two or more jurisdictions, however, presents unique challenges. Groundwater flows do not respect political boundaries or other artificially drawn demarcation. Rather, groundwater courses toward and through the path of least resistance as a function of gradient, permeability, porosity, pressure, and other geophysical and natural factors (Heath, 1987). As a result, groundwater flows can traverse international and intranational administrative boundaries, thereby making national and subnational political units "riparian" to the same groundwater system.

The challenge, in terms of law, sovereignty, and ownership claims for groundwater resources, lies in determining the particular quantities or benefits, or rights thereto, that should accrue to each riparian. The situation, however, is further complicated by the fact that groundwater flows occur unseen underground and do not typically move in a linear fashion—not like rivers, but rather in a 3-dimensional spatial context—thereby making it difficult to measure accurately. Thus, for purposes of allocating legal ownership or usufructuary rights to groundwater resources, it is impracticable even to attempt to attach a point of origin to any drop of water, or to predict the precise moment that a particular droplet in a transboundary aquifer crosses a political frontier.

In addition, with the possible exception of fossil and connate groundwater resources, most aquifers are hydrologically linked to the water cycle, and regularly receive water from and transmit water to other components of the system. As a result, an aquifer may be subject to fluctuations in both water quantity and quality in relation to recharge, discharge, precipitation, evaporation, and other changes in and impacts on the system. This, in turn, further complicates designation of sovereign and other rights related to transboundary subsurface freshwater resources, and requires a holistic understanding of the science of groundwater when assessing the legal implications stemming from the use of transboundary groundwater resources.

Under what circumstances might groundwater or an aquifer raise transboundary legal implications at either the international level or among subnational political units? What conditions might trigger adverse cross-border consequences, and under what scenarios might they be negated? These queries, and others, are the types of questions now being asked by sovereigns at the national and sub-national levels, and that necessitate further scrutiny. This article addresses these particular issues and seeks to enhance understanding of the legal dimension of transboundary groundwater and aquifers grounded in the science of hydrogeology.

Background

In Eckstein & Eckstein (2005) and Eckstein (2017), the authors highlight basic definitions and concepts of hydrogeology that are essential to understanding how groundwater flows and interacts with surface water systems, and what effects extraction through wells can have on both. Among others, these include the influent (or losing) and effluent (or gaining) relationships that often exist between surface waterbodies and aquifers, aquifer recharge and discharge processes and zones, recharging and non-recharging aquifers, groundwater flow direction, and the impact of groundwater pumping and pollution. The publications present six simple conceptual models of aquifers whose use and exploitation could have transboundary effects with legal implications. Building on these publications, this article identifies the circumstances in which the use, management, exploitation, or administration of groundwater in a transboundary aquifer might infringe on the legal rights of a neighboring political unit and, thereby, result in legal responsibility and/or liability.

Before discussing these legal implications, it is necessary first to identify what rights aquifer riparians typically enjoy. At the national intrastate level, the law applicable to such cross-jurisdictional resources necessarily depends on the domestic laws of the country in which the resource is found. In federal systems, where subnational units have some measure of sovereignty over resources and activities occurring within their borders—like those of the United States, India, Brazil, and Australia—the law hinges on the legal relationship between the federal and state governments, as well as the intrastate jurisprudence that may exist in the country. Thus, for example, in the United States, disputes over interstate waters are resolved by the United States Supreme Court under the doctrine of equitable apportionment. That venerable Court, in fact, recently adjudicated its first case involving interstate groundwater resources ruling that equitable apportionment applies equally to disputes involving transboundary groundwater resources as it does for those involving cross-border surface water bodies (Mississippi v. Tennessee, 2021). Other nations' high courts have never, or only marginally, addressed intrastate groundwater disputes. As a result, there is a dearth of experience and jurisprudence from which responsibility and liability for cross-border impacts can be derived.

In the international realm, the situation is not much better. The international law of transboundary groundwater resources is still in its infancy and the rights of countries to such resources have yet to be fully defined (Eckstein 2017). The most significant attempt to formulate legal norms for the use, management, exploitation, and administration of groundwater traversing international frontiers was undertaken from 2002-2008 by the UN International Law Commission in its Draft Articles on the Law of Transboundary Aquifers. That work product was submitted to the UN General Assembly for its consideration and has been on the Assembly's agenda in 2008, 2011, 2013, 2016, and 2019. Each time, however, the subject matter was commended to the attention of UN Member States and further considerations tabled for a future meeting (UNGA, 2019). The Draft Articles are slated again for the Assembly's agenda in 2022.

Other relevant global instruments include the 1992 UNECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes, and the 1997 UN Convention on the Law of the Non-navigational Uses of International Watercourses. Both include various principles that are applicable generally to transboundary watercourses and, ostensibly

thereby, to cross-border groundwater resources that are part of the watercourse regime. In both cases, though, groundwater is a secondary concern to rivers and lakes and most of the precedence underpinning the instruments are grounded in disputes and practices related to the governance of transboundary rivers and lakes. Accordingly, while the two conventions are purported to codify the customary international law for transboundary watercourses (McCaffrey 2019), it is questionable whether they equally represent the codification of customary norms for transboundary groundwater and aquifers.

As a matter of substantive international law, based on the Draft Articles, the two global watercourse conventions, and the handful of treaties formulated for specific transboundary aquifers globally, the most that can be said today is that: (1) an aquifer riparian has some yet-to-be fully defined rights to use and enjoy groundwater from an aquifer that underlays both its territory and that of a neighboring jurisdiction; and (2) when that use and enjoyment interferes with the equivalent rights of the neighboring aquifer riparian to use and enjoy the groundwater underlying its own territory, such rights may be subject to restrictions and possible liability (Eckstein 2017). Whether the conflicting rights are grounded in the two cornerstone principles of international water law—equitable and reasonable use, and no significant harm—has yet to be established.

As a result, there are no broadly accepted substantive international legal rules governing the management or allocation of groundwater flowing through an international transboundary formation, or of benefits that may be derived from that groundwater. In terms of procedural rights and obligations, however, four principles appear to be trending toward customary legal acceptance. These include the obligations to: (a) regularly exchange data and information about the transboundary aquifer; (b) monitor and generate supplemental data and information about the transboundary aquifer; (c) provide prior notice of planned activities that may adversely affect either the territory of another aquifer riparian or the transboundary aquifer itself; and (d) create an institutional mechanism to facilitate or implement the above obligations (Eckstein 2017).

Given that the rights and obligations of aquifer riparians are still in their early development and remain inconclusive, the scrutiny that follows is somewhat crude in that it simply considers various scenarios of cross-border interference with the potential legal rights of neighboring political units. Despite its simplistic approach, the analysis offers some insight into when legal responsibility and/or liability might arise from the use, management, exploitation, or administration of groundwater from a transboundary aquifer.

Transboundary Legal Implications of Aquifers

As suggested above, legal responsibility and/or liability might arise when one aquifer riparian's utilization of groundwater from a transboundary aquifer within its territory interferes with a neighboring aquifer riparian's equivalent right to use the same aquifer. In the context of a cross-border aquifer, such interference will manifest as either depletion or contamination, or both, of the groundwater found beneath a neighboring riparian's territory.

Generally speaking, though, not all negative impacts on the rights or interests of a neighboring riparian are actionable under law. A *de minimis* or insignificant impact is unlikely to be deemed unlawful. Rather, the impact has to be significant

enough to result in an appreciable (non-*de minimis*) infringement of the neighboring riparian's ability to use the groundwater from the shared aquifer, or possibly a hydrologically related river or lake, on its side of the political boundary (McCaffrey 2019). However, whereas substantive rights in transboundary groundwater resources have yet to be defined under international law, the threshold for harm—between non-actionable (de minimis) and actionable (non-*de minimis*) impacts—remains unclear. Absent such an impact, and at a level above the threshold for unlawful conduct, it is unlikely that the neighboring riparian could have any legal grounds to raise against the acting aquifer riparian's activities in relation to the aquifer, regardless of the aquifer's transboundary geology and geography.

Circumstances that could result in transboundary legal implications pertain to the extent to which one aquifer riparian takes action in relation to a transboundary aquifer and thereby negatively impacts the ability of a neighboring riparian to use the aquifer. Such impacts can be both quantitative and qualitative in nature and can be related to activities that change the natural flow direction, volume, or quality of the groundwater within a specific portion or the entirety of the aquifer. Among other causes, such impacts could result from extraction of groundwater from the aquifer, land use practices that result in diffuse pollution, injection of fluids and gases into the formation, deposition or burial of wastes over or within the formation, diminution or increase of the natural recharge into the aquifer, diminution or increase of the natural discharge out of the aquifer, mining of the aquifer matrix, and other activities that have a detrimental impact on the functioning of the aquifer.

One example of such cross-border harm might occur where one aquifer riparian pumps groundwater from a transboundary aquifer in the vicinity of the border causing a cone of depression (in an unconfined aquifer) or reduction of the pressure head (in a confined aquifer) to expand toward that boundary. In the simplest case, where the aquifer in the immediate border region has no hydrologic connections to any transboundary surface water bodies, such as found in Model C in Eckstein (2017), the cross-border impact will occur strictly through the aquifer. Where the cone of depression crosses underneath the artificial political line, it will affect the natural flow of the aquifer beneath the neighboring riparian's territory within the cone's radius of influence. The extent to which that artificial alteration affects the ability of the neighboring riparian to use and enjoy the aquifer will determine whether the impact on the affected riparian is greater than the *de minimis* threshold and, therefore, whether that riparian might have a cause of action against the acting riparian.

In a more complicated example, the aquifer in the immediate vicinity of the border region could have a hydrologic connection with either a contiguous transboundary river (where the surface water body forms the border, as depicted in Model A in Eckstein (2017)) or a successive transboundary river (where the river flows across a frontier from one political jurisdiction and into another, as shown in Model B in Eckstein (2017)). In such cases, the hydrologic connection creates additional complexities in which the aquifer riparian pumping from the aquifer could cause negative impacts to be felt across the border. Moreover, those complexities will be further muddled depending on whether the aquifer-river relationship is an influent or effluent one, as well as whether excessive pumping changes an effluent relationship to an influent one.

For example, where one aquifer riparian extracts groundwater from a transboundary aquifer with an effluent relationship to an adjacent contiguous river, the pumping could affect the water in the river. Where pumping

substantially exceeds the aquifer's natural capacity to replenish, thereby causing the well's cones of depression to extend to the river, the artificial extraction could change the aquifer-river effluent relationship to one that is influent within the cone of depression. Referred to as "streamflow depletion" or "capture" (Barlow & Leake 2012), this conduct could cause water in the river to be pulled into the aquifer and toward the well on the pumping riparian's side of the border. To the extent that this appreciably impacts the non-pumping riparian's ability to use or enjoy an equitable and reasonable share—the recognized standard for the right to utilize surface waters from a transboundary watercourse under international law (McCaffrey 2019)—of the water from the transboundary river, the latter riparian may have a claim against the pumping riparian.

It is noteworthy, though, that in this scenario, the cone of depression was described as only reaching the river and not the aquifer segment located in the territory of the non-pumping riparian. If pumping was increased and the cone of depression were to extend into the neighboring territory (and if the *de minimis* threshold was crossed), that riparian's claim for harm could pertain both to the impact on the contiguous river as well as to the aquifer segment underneath its territory. Moreover, while the latter claim would be limited geographically to the radius of influence of the cone of depression reaching into the neighboring riparian's territory, the geographic scope of the claim related to the river could be much larger since the impact on a flowing river can be felt downstream beyond the geographic contours of a cone of depression.

Although the above addresses the potential transboundary consequences to water quantity, a transboundary aquifer hydrologically linked in an effluent relationship to a transboundary contiguous river also could cause negative, cross-border water quality concerns. For example, a naturally flowing effluent, contiguous river bisecting an unconfined aquifer, under homogeneous and "text-book" conditions, will impede pollutants and other negative traits on one side of the aquifer from crossing over to the opposing sides by drawing them into the river. Thus, if one of the riparian jurisdictions introduces any pollutants into the river, because of the effluent relationship of the river to the aquifer, the aquifer is unlikely to be contaminated. Of course, the riparian introducing the pollution may be responsible for consequences in and to the river, as well as to other riparians utilizing the river downstream from the point of contamination. Similarly, if one of the riparians introduces a pollutant into the aquifer that is drawn into the effluent river, that riparian could be liable for harming its neighboring and other downstream riparians by diminishing the water quality of the river.

In another distinct scenario involving water quality, one aquifer riparian might artificially introduce contaminants into its own section of a transboundary aquifer, which then migrate across the border into the aquifer portion of a neighboring riparian as a result of the latter riparian's substantial pumping activities (Burke, et.al., 1999). The assignment of responsibility and/or liability to the polluting riparian would not be automatic and would depend on additional circumstances. For example, if the natural flow of the aquifer was from the polluting aquifer riparian toward the neighboring jurisdiction, responsibility and/or liability might be applicable if the *de minimis* threshold of harm to the neighboring riparian was surmounted. However, if the contamination migrates across the border because the neighboring riparian was pumping from the aquifer and its cone of depression "pulled" the contaminants across the political frontier, the polluting jurisdiction might avoid liability and responsibility. It would depend on a variety of additional factors, such as whether or not the riparian extracting the

groundwater knew about the contamination across the border prior to engaging in its pumping activities, whether the polluting riparian provided adequate notification to the pumping riparian about the contamination and its potential to flow across the border, whether the contamination would have migrated across the frontier regardless of the pumping riparian's extraction activities, and whether the pumping riparian's extraction activities accelerated or amplified the cross-border flow of groundwater along with the contamination.

While the above examples focused on an effluent aquifer-river relationship where the river is contiguous, similar scenarios could be crafted where the hydrologic relationship is an influent one and where the river is successive across the neighboring jurisdictions. Moreover, adding a further dose of reality, and thereby complexity, it is entirely possible for a river's hydrologic relationship to an underlying aquifer to alternate between effluent and influent as it courses toward its terminus. This can depend on a host of factors ranging from geology, topography, permeability, and other physical characteristics that are often very unique to each river and aquifer basin, as well as changes in precipitation and climatic events. Moreover, some rivers can be contiguous between neighboring political units and then successive with the same or other bordering jurisdictions.

The Special Case of Non-Renewable Groundwater

One area that may require special consideration involves fossil and connate groundwater and aquifers, as depicted in Model F in Eckstein (2017). These non-renewable resources are uniquely vulnerable to depletion since in the absence of recharge, any withdrawal will result in the mining of the resource. Likewise, they are distinctively susceptible to pollution because the lack of significant recharge and flow reduces their ability to naturally attenuate contaminants.

Consider, for example, where one jurisdiction begins to extract groundwater from a fossil aquifer that traverses the political boundary of its neighboring jurisdiction. Since the aquifer has no contemporary source of recharge (or, only *de minimis* recharge), the pumping eventually will begin to lower the water table, or pressure head, beneath the neighboring riparian's territory. Yet, because a non-recharging aquifer, by definition, cannot be pumped sustainably, it may seem unreasonable to assign liability merely for the depletion. Otherwise, neither state would be permitted to withdraw any water from the aquifer.

As for harm arising from the anthropogenic contamination of the aquifer, assigning liability also would be complicated. If none of the riparians was actively withdrawing or planned to withdraw groundwater from the aquifer, the pollution would be unlikely to migrate far from the point of contamination. This is because fossil and connate aquifers usually have little or no flow. However, if one of the overlying aquifer riparians started to extract groundwater, it would create an artificial flow in the direction of the well's intake, which would cause the contaminants to migrate across the frontier. Whether liability might arise in such a scenario would depend on a variety of criteria, including many of the same factors identified earlier for pollution migrating underneath the border into the aquifer portion of a neighboring riparian. Yet, because of the lack of recharge, flow, and discharge in a non-recharging aquifer, which prevent it from naturally cleaning itself, it may be reasonable to heighten the liability, and possibly further lower the threshold for harm, for such contamination.

Some scholars have drawn comparisons between fossil and connate aquifers to other non-renewable, depletable natural resources, like oil and gas deposits, and suggest applying similar legal regimes to non-renewable groundwater resources (Caponera, 1992; Jarvis, 2014). Such rules, however, typically focus on maximizing the exploitation of the resource rather than on the uses to which groundwater can and should be put. As a result, ownership rights for oil and gas deposits are divided *vis a vis* negotiated and agreed-upon volumes, or in relation to the pumpers capacity to extract the resource. Moreover, liability for cross-border harm or interference with rights to subsurface, transboundary oil and gas resources arises primarily in the context of contract violations, and occasionally for allegations of intentional theft of resources.

While the exploitation-focus of this approach may not negate its relevance and applicability to transboundary groundwater resources, it must be recognized that groundwater, whether recharging or non-recharging, has qualities that are distinctly unique from those of oil and gas deposits. For one, the hydrocarbon development regime is not designed to account for the human right and environmental benefits aspects of groundwater resources. It also cannot compensate for the reality that while energy resources like oil and gas have alternatives (e.g., solar, wind, hydro, etc.), water does not. In addition, non-recharging aquifers can be recharged through artificial means, by injection or infiltration pools, from excess surface runoff, return flows, and treated wastewaters. Thus, the life of such resources can be extended in ways that oil and gas deposits cannot, and managed in ways that would be uneconomical in the hydrocarbon sector.

The lack of experience in managing non-renewable resources in an interstate or intrastate manner have hampered the emergence of relevant principles and rules for their governance. Thus, the similarities to oil and gas deposits does present appealing possibilities. Nevertheless, given the disparities noted above, it may be reasonable to suggest that responsibility and liability for transboundary fossil and connate groundwater depletion or contamination should probably be broader in scope to account for the non-economic aspects of groundwater. In addition, the regime should have a threshold for harm and interference that is lower than that applied to cross-border oil and gas deposits.

Conclusion

Transboundary groundwater and aquifers at both the national and international levels are becoming increasingly critical sources of freshwater for communities worldwide. Simultaneously, excessive extraction, pollution, climate change, and other anthropogenic activities are placing many of these resources in jeopardy. As a result, policymakers and stakeholders at various levels of civil society are now seeking rules and norms for their governance in order to safeguard the resources into the future. In particular, many seek to understand the responsibilities and possible liabilities that may arise from transboundary impacts resulting from the use and exploitation, and even careless protection, of these subsurface treasures. This is occurring both at the international level among two or more sovereign nations that overlay a common aquifer, as well as at the domestic level between two or more subnational political units.

The reality, however, is that the law applicable to transboundary groundwater resources at both levels of governance is at a very nascent stage.

Moreover, establishing responsibility and liability in the context of transboundary groundwater resources can be a rather complex endeavor that requires specialized knowledge of the science of groundwater resources. This article sought to provide a foundation for the development of such laws and regulations by exploring circumstances under which the use, exploitation, protection, management, and administration of cross-border groundwater resources might result in harm to a neighboring political unit. As nations and subnational political units continue to expand their reliance on transboundary groundwater resources, they will need to develop principles and norms that are both grounded in sound science and built on an understanding of the distinct value of groundwater for people and the environment.

Lastly, it is worth stating that this article is far from comprehensive and leaves numerous issues and challenges unaddressed. As the field evolves, additional research will be needed to fill in the many gaps on responsibility and liability related to such topics as: the surface water-groundwater interface; harmful impacts that become evident only after years or decades; challenges in establishing causation and identifying wrongdoers; and land uses in recharge areas.

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