

A Hydrogeological Perspective of the Status of Ground Water Resources Under the UN Watercourse Convention

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I. INTRODUCTION

When the U.N. General Assembly adopted the Convention on the Non-Navigational Uses of International Watercourses¹ in 1997, it took a decisive step in recognizing the important role that transboundary ground water resources play in human progress and development. In so doing, it also acknowledged the need to establish principles of law governing this “invisible” but valuable

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1. G.A. Res. 51/229, U.N. Doc. A/RES/51/229 (May 21, 1996) [hereinafter Watercourse Convention].

natural resource.² Transboundary ground water historically has been neglected in treaties, ignored in projects with international implications, and cursorily misunderstood in much of legal discourse.

While the Convention provides substantial clarification on the status of ground water under international law, it also leaves considerable gaps and generates confusion about the types of aquifers that fall within the scope of the treaty. A close review of the scope and definitions of the treaty reveals that the Convention's focus on surface water overshadows its ground water cousin and excludes many of the world's aquifers.

Focusing on the scope and definitions, this article critically examines the treatment of ground water under the Convention from a hydrogeological perspective. Using six science-based aquifer models with transboundary implications (representing the majority of transboundary aquifers presently known in nature), the analysis identifies the types of aquifers that are included within the scope of the Convention and assesses the rationale for excluding other aquifer types. The article also considers the special case of non-recharging aquifers.

Ground water³ is the world's most extracted natural resource.⁴ It

2. Today, a majority of the world's population is dependent on groundwater for its basic needs. S. C. McCaffrey, *Seventh Report on the Law of the Non-Navigational Uses of International Watercourses*, U.N. Doc. A/CN.4/436 (1991), reprinted in [1991] 2(1) Y.B. INT'L L. COMM'N 45, 52, ¶ 18, U.N. Doc. A/CN.4/SER.A/1991/Add.1 (Part 1) [hereinafter McCaffrey, *Seventh Report*].

3. Ground water generally refers to subsurface water that is below the ground water table, *i.e.*, where the porous geologic formations are completely saturated with water, or where water occupies the entire porous space within a porous geologic formation. See MICHAEL PRICE, *INTRODUCING GROUNDWATER* 7 (1996) (providing a basic explanation of the difference between surface and ground water); see also RALPH C. HEATH, *BASIC GROUND-WATER HYDROLOGY*, U.S. Geological Survey Water-Supply Paper 2220 4 (1987), available at http://onlinepubs.er.usgs.gov/djvu/wsp/WSP_2220.pdf (explaining that only underground water found in the saturated zone is considered ground water); Gabriel Eckstein & Yoram Eckstein, *A Hydrogeological Approach to Transboundary Ground Water Resources and International Law*, 19 AM. U. INT'L L. REV. 201 (2003) [hereinafter Eckstein & Eckstein 2003] (providing a basic explanation of ground water and analyzing the various transboundary implications related to ground water resources).

4. See generally U.N. ADMIN. COMM. ON COORD., SUB-COMM. ON WATER RES. [UN-ACC/SCWR], *WATER FOR PEOPLE, WATER FOR LIFE, THE UNITED NATIONS WORLD WATER DEVELOPMENT REPORT 78* (March 2003) [hereinafter *WATER FOR PEOPLE*], available at http://www.unesco.org/water/wwap/wwdr/table_contents.shtml (discussing the significance of ground water and its exploitation).

provides more than half of humanity's freshwater needs for everyday uses, such as drinking, cooking, and hygiene, as well as twenty percent of irrigated agriculture.⁵ In Europe, ground water accounts for at least seventy-five percent of drinking water, and for more than ninety percent in Austria, Croatia, Denmark, Hungary, Italy, Lithuania, and Slovenia.⁶ In the United States, ground water is the source for approximately one half of all potable water, and provides nearly all the drinking water consumed in rural areas.⁷

Despite growing dependence on ground water,⁸ legal and regulatory attention to ground water has long been secondary to surface water resources, especially among legislatures and policymakers.⁹ The emphasis on surface water was and is due, in large part, to the prevalence and importance that streams, rivers and lakes have had on the course of human development.¹⁰ It also

5. *Id.* at 78-80 (discussing ground water use in agriculture and noting that ground water is more widely used for irrigation than surface water in many parts of the world, including India, Bangladesh, and Iran); see McCaffrey, *Seventh Report*, *supra* note 2.

6. E. Almássy & Zs. Busás, *Guidelines on Transboundary Ground water Monitoring, Volume 1: Inventory of Transboundary Ground waters*, UN/ECE Task Force on Monitoring & Assessment 21 (1999) (identifying the percent of ground water in various European countries' drinking water supplies: Austria (99%), Belarus (80%), Bulgaria (60%), Croatia (90%), Estonia (70%), Finland (57%), Germany (75-90%), Hungary (95%), Lithuania (100%), The Netherlands (67%), Portugal (60%), Slovak Republic (80%), Slovenia (90%), Switzerland (84%), Ukraine (65%)); Stefano Burchi, *National Regulation for Ground water: Options, Issues and Best Practices*, in *GROUND WATER: LEGAL AND POLICY PERSPECTIVES, PROCEEDINGS OF A WORLD BANK SEMINAR* 55 (Salman M.A. Salman ed., 1999), available at http://www-wds.worldbank.org/servlet/WDSContentServer/WDSP/IB/1999/12/30/000094946_99122006354976/Rendered/PDF/multi_page.pdf; S. Burchi, *National Regulation for Ground Water: Options, Issues and Best Practices*, in *GROUND WATER: LEGAL AND POLICY PERSPECTIVES, PROCEEDINGS OF A WORLD BANK SEMINAR* 55 (Salman ed., 1999); McCaffrey, *Seventh Report*, *supra* note 2, at 53, ¶ 21.

7. See Burchi, *supra* note 6, at 55; Ludwik A. Teclaff & Eileen Teclaff, *Transboundary Ground Water Pollution: Survey and Trends in Treaty Law*, 19 NAT. RESOURCES J. 629 (1979).

8. See WATER FOR PEOPLE, *supra* note 4, at 78 (describing the "boom" in ground water resource exploitation).

9. See Eckstein & Eckstein 2003, *supra* note 3 (discussing the status of ground water under international law and its historical absence from treaties); see also Albert E. Utton, *The Development of International Groundwater Law*, 22 NAT. RESOURCES J. 95, 98 (1982) (noting that "The laws governing groundwater nationally are inadequately developed, and the law governing transboundary groundwaters is only at the beginning state of development."); Dante A. Caponera & Dominique Alhérière, *Principles for International Groundwater Law*, 18 NAT. RESOURCES J. 589, 590, 592-94, 612-13 (1978) (discussing the few references to ground water resources found in treaties and contending that most legal research, until recently, was directed towards surface water issues).

10. Cf. Gabriel Eckstein, *Development of International Water Law and the UN Watercourse Convention*, in *HYDROPOLITICS IN THE DEVELOPING WORLD: A SOUTHERN AFRICAN PERSPECTIVE* 81, 82 (Anthony Turton & Roland Henwood eds., 2002) [hereinafter Eckstein

may be due to the inability of the modern legal system to keep pace with scientific knowledge.¹¹ In the past, legal professionals have described ground water as “secretive,” “mysterious,” and even “occult,”¹² thus evidencing the gap in scientific understanding among jurists and practitioners.

In September of 1997, the United Nations General Assembly adopted the Convention on the Non-Navigational Uses of International Watercourses (Watercourse Convention).¹³ In so doing, the UN took a decisive first step in recognizing the important role ground water resources play in human progress and development, as well as the need to establish principles of law governing this “invisible” but valuable natural resource. While the bulk of the treaty focused on surface water resources, wedged into the article on definitions was the clear understanding that certain types of ground water must be considered within the meaning of a watercourse.¹⁴ Placing ground water within the definition of watercourse inserted ground water into the scope of the document and officially recognized this invaluable resource as a legitimate

2002] (discussing the development of international water law).

11. See R.D. Hayton, *The Ground Water Legal Regime as Instrument of Policy Objectives and Management Requirements*, in INTERNATIONAL GROUNDWATER LAW 57, 60 (Ludwik A. Teclaff & A.E. Utton eds., 1981) [hereinafter Hayton 1981] (noting that legal and political systems do not adequately anticipate the needs of society). In his dissenting opinion in the *North Sea Continental Shelf*, Judge Lach’s asserted that “the acceleration of social and economic change, combined with that of science and technology, have confronted law with a serious challenge: one it must meet, lest it lag even farther behind events than it has been wont to do.” *North Sea Continental Shelf* (F.R.G. v. Den.; F.R.G. v. Neth.), 1969 I.C.J. 472 (Feb. 20).

12. See, e.g., *Perkins v. Kramer*, 423 P.2d 587, 590-91 (Mont. 1966) (quoting *Chatfield v. Wilson*, 28 Vt. 49, 54 (1855) for the proposition that “The fact that groundwater is not easily traced in its movement is the reason why this court has said: ‘The secret, changeable, and uncontrollable character of underground water in its operations is so diverse and uncertain that we cannot well subject it to the regulations of law, nor build upon it a system of rules, as is done in the case of surface streams.’”); *New York Continental Jewel Filtration Co. v. Jones*, 37 App. D.C. 511, 516 (1911) (asserting that “[p]ercolating subterranean water is a wandering thing, which, like the air, is not subject to any fixed rules of law. The existence, origin, course, and movement of such waters, and the causes which govern and direct their movements, are so involved in mystery, secrecy, and uncertainty as to render any attempt to establish or administer any set of legal rules with respect to them practically impossible”); *Houston & T.C. Ry. Co. v. East*, 81 S.W. 279, 281 (Tex. 1904) (quoting *Frazier v. Brown*, 12 Ohio St. 294, 311 (1861) for the proposition that “the existence, origin, movement and course of such waters, and the causes which govern and direct their movements, are so secret, occult and concealed, that an attempt to administer any set of legal rules in respect to them would be involved in hopeless uncertainty, and would be, therefore, practically impossible”).

13. See Watercourse Convention, *supra* note 1.

14. See *id.* at art. 2 (defining “watercourse” and other terms used in the Convention).

subject of international law.

While this inclusion is not insignificant, the Watercourse Convention was never intended to serve as a comprehensive elucidation of the status of ground water under international law. In fact, the drafters of the Watercourse Convention, members of the UN's International Law Commission (ILC), were tasked with the more general effort of addressing "the law of the non-navigational uses of international watercourses with a view to its progressive development and codification . . ." ¹⁵ Accordingly, the Convention is heavily focused on surface water resources ¹⁶ and does not fully address the world's most significant source of freshwater. ¹⁷ As a result of the generality of the Convention, the treaty leaves considerable gaps and even generates confusion about the applicability and appropriateness of the Convention's principles to the management (use, allocation, development, regulation,

15. G.A. Res. 2669, ¶ 1, U.N. GAOR, 25th Sess. Supp. No. 28, at 127, ¶ 1, U.N. Doc. A/8202 (Dec. 8, 1970). The Watercourse Convention is a general framework Convention designed to provide guidance in the use, management, and preservation of transboundary watercourses, as well as for the development of more specific bilateral and regional agreements relating to particular watercourses. See *Report of the Commission to the General Assembly on the Work of its Thirty-First Session, The Law of the Non-Navigational Uses of International Watercourses*, U.N. Doc. A/34/10 (1979), reprinted in [1979] 2(2) Y.B. INTL L. COMM'N 160, 166-67 ¶¶ 134-35, A/CN.4/SER.A/1979/Add.1; Eckstein 2002, *supra* note 10, at 81. The Convention was developed to promote sustainable development and protection of global water supplies, as well as to prevent and resolve conflicts over transboundary water resources. See *Watercourse Convention*, *supra* note 1 ("Expressing the conviction that a framework convention will ensure the utilization, development, conservation, management and protection of international watercourses and the promotion of the optimal and sustainable utilization thereof for present and future generations" and referring to Articles 1 and 2 of the Charter of the United Nations, which relate to the maintenance of international peace and security, development of friendly relations among nations, and the peaceful settlement of disputes.).

16. In the development of the Convention, the ILC asserted in its Thirty-Second Session Report that "the main stem of a river traversing or forming an international boundary" is the "core" of a watercourse. *Report of the Commission to the General Assembly on the Work of its Thirty-Second Session, The Law of the Non-Navigational Uses of International Watercourses*, A/CN.4/SER.A/1980/Add.1 (Part 2) (1980), reprinted in [1980] 2(2) Y.B. INTL L. COMM'N 104, ¶ B(1) comt. (2), U.N. Doc. A/CN.4/332 and Add.1 [hereinafter *Thirty-Second Session Report*].

17. See Eckstein & Eckstein 2003, *supra* note 3, at 204. Global ground water reservoirs dwarf all surface water resources by a factor of one hundred to one. Even when subtracting those aquifers that are not easily accessible – due to the depth at which the ground water is found, or the geology of the surrounding strata – accessible ground water constitutes more than thirty-three times the volume of water found in all of the world's lakes and streams. See *WATER FOR PEOPLE*, *supra* note 4, at 78 (discussing ground water systems as the "predominant reservoir and strategic reserve of freshwater storage on planet Earth").

conservation, protection, etc.) of numerous transboundary aquifers.

The following analysis critically examines the scope of the Watercourse Convention with regard to ground water resources.¹⁸ The intention here is not to assess the suitability of the Convention's principles and concepts to ground water resources.¹⁹ Rather, the article takes a more preliminary step and considers the scope of the Watercourse Convention and the extent to which it encompasses the principal types of aquifers found in nature.

Part II of the article is a historical review of the development of the scope of the Watercourse Convention and the debates surrounding the inclusion of ground water resources within that scope. The purpose of this analysis is to develop an understanding of how and why the scope of the Convention excludes many types of transboundary aquifers from its reach. It also serves as a basis for the subsequent sections: Part III, which presents scientific models of six generic aquifer types that have transboundary implications and that represent the majority of transboundary aquifers presently known in nature; and Part IV, which uses a hydrogeological perspective²⁰ to identify the aquifer types that are included within and excluded from the scope of the Convention, and then assess the rationale for the exclusions.

II. DEVELOPING THE SCOPE OF THE WATERCOURSE CONVENTION

The ILC took nearly twenty-five years to formulate the principles

18. While the Watercourse Convention is not yet in force, it is, to date, the only official effort addressing the international law applicable to transboundary ground water resources. Accordingly, it is the best evidence currently available on the subject.

To date, only thirteen states have become party to the Convention: Finland, Hungary, Iraq, Jordan, Lebanon, Libya, Namibia, The Netherlands, Norway, Qatar, South Africa, Sweden, and Syria. Another eight states have signed but not yet submitted their instrument of ratification, acceptance, approval or accession: Côte d'Ivoire, Germany, Luxembourg, Paraguay, Portugal, Tunisia, Venezuela, and Yemen. See Status of the Watercourse Convention, available at http://www.internationalwaterlaw.org/IntlDocs/Watercourse_status.htm (last visited Oct. 20, 2005). Under Article 36(1) of the Convention, the Convention will enter into force ninety days following the submission to the UN Secretary-General of the thirty-fifth instrument of ratification, acceptance, approval or accession.

19. The question of which principles of law are suitable for ground water, as well as whether the 1997 Watercourse Convention is applicable at all, is presently before the International Law Commission. See *infra* note 146 and accompanying text.

20. For a basic introduction to hydrogeology, see Eckstein & Eckstein 2003, *supra* note 3, at 207-221. For more in-depth review of the science of ground water resources, see Price, *supra* note 3. See also C.W. FETTER, APPLIED HYDROGEOLOGY (4th ed. 2001).

that were eventually codified in the UN Watercourse Convention. While not necessarily unusual for development of international law, it is certainly an indication of the intricacies of the subject matter as well as of the importance that states ascribed to transboundary watercourses.

Undoubtedly, one of the significant sticking points in the process was the formulation of the scope of the Convention. This was especially evident in the determination of the geographic unit that would be subject to the Convention's provisions, and whether and to what extent ground water should be included within that scope. As noted in the 1974 report of the Subcommittee on the Law of the Non-navigational Uses of International Watercourses, various terms and definitions had been used over the years in treaties, declarations, and reports of international organizations and conferences to describe the geographic unit subject to principles of international water law.²¹ These included "successive international rivers," "contiguous international rivers," "river basins," "drainage basin," "international drainage basin," and "hydrographic basin."²² Over the years during which the ILC process evolved, these diverse phraseologies became controversial because the definition selected for the geographic unit that would be subject to the new convention would, in effect, become part of the scope of the treaty.²³ It would determine whether and to what extent streams, tributaries, canals, lakes, and other surface water bodies, and more specifically, ground water resources, would be subject to the new convention.

The core of the debate was a classical upstream-downstream

21. *Report of the Commission to the General Assembly on the Work of its Twenty-Sixth Session, The Law of the Non-Navigational Uses of International Watercourses*, U.N. Doc. A/9610/Rev.1 (1974), reprinted in [1974] 2(1) Y.B. INTL L. COMM'N 301, 301-02, ¶¶ 7-16, A/CN.4/SER.A/1974/Add.1.

22. *Id.*

23. The deliberations over this issue, in fact, were so contentious that the ILC had to postpone discussions on the Convention's scope and definitions on at least two occasions. See *Report of the Commission to the General Assembly on the Work of its Twenty-Eighth Session, The Law of the Non-Navigational Uses of International Watercourses*, U.N. Doc. A/31/10 (1976), reprinted in [1976] 2(2) Y.B. INTL L. COMM'N 153, 162, ¶ 164, A/CN.4/SER.A/1976/Add.1 (Part 2); *Report of the Commission to the General Assembly on the Work of its Thirty-First Session, The Law of the Non-Navigational Uses of International Watercourses*, U.N. Doc. A/30/10 (1979), reprinted in [1979] 2(2) Y.B. INTL L. COMM'N 160, 164, ¶ 121, A/CN.4/SER.A/1979/Add.1 (Part 2); *Report of the Commission to the General Assembly on the Work of its Thirty-Eighth Session, The Law of the Non-Navigational Uses of International Watercourses*, U.N. Doc. A/41/10 (1986), reprinted in [1986] 2(2) Y.B. INTL L. COMM'N 60, 62, ¶ 236, A/CN.4/SER.A/1986/Add.1 (Part 2).

contest and the ages-old issue of sovereignty. It pitted advocates of the principle of absolute territorial sovereignty²⁴ against proponents of the principle of limited territorial sovereignty.²⁵ Those countries who sought to limit the scope of the Convention generally argued for unrestricted sovereign rights to resources such as ground water within their territories,²⁶ as well as for a more limited geographic scope akin to that offered in the 1815 Final Act of the Congress of Vienna.²⁷ The existence and fortification of immutable international boundaries, within which a state would have such unrestrained rights, appears to have been of paramount importance for states advocating this position.²⁸ Advocates of this

24. The principle of absolute territorial sovereignty suggests that states have the right to unrestrained use of resources found within their territories, regardless of the transboundary consequences of such use. See Cecil J. Olmstead, *Introduction*, in THE LAW OF INTERNATIONAL DRAINAGE BASINS 1, 3 (Albert H. Garretson et al. eds., 1967). Olmstead regards this principle as stemming from the historic paradigm that states, as sovereign nations, have unlimited control and jurisdiction over the entire physical territory of their domain. He also attributes the principle to a general aversion of states to accede to a negotiated compromise, or to the authority and decision of an international body for resolving disputes, over such important resources as water. The majority of states that have espoused this position have almost universally been upper riparians. Olmstead, *supra*, at 3. The great majority of states and scholars have rejected this principle outright. See, e.g., Lake Lanoux Arbitration (Fr. v. Spain), 24 I.L.R. 101 (Arbitral Trib. 1957) (concluding that upper riparian states are obligated to consider the rights and interests of lower riparian states).

25. The principle of limited territorial sovereignty is founded on the premise of *sic utere tuo ut alienum non laedas*, meaning that a state's sovereign right is limited by its obligation not to use or allow the use of its territory in a manner that would result in significant harm to another state. S. MCCAFFREY, THE LAW OF INTERNATIONAL WATERCOURSES: NON-NAVIGATIONAL USES 137 (2001) [hereinafter McCaffrey 2001]. This principle is widely recognized and accepted as a general principle of international law, See G. Eckstein, *Application of International Water Law to Transboundary Ground Water Resources, and the Slovak-Hungarian Dispute Over Gabčíkovo-Nagymaros*, 19 SUFFOLK TRANSNAT'L L. REV. 67, 75-77 (1995) [hereinafter Eckstein 1995]; McCaffrey 2001, *supra*, at 137, and is most often espoused by downstream riparians. See Eckstein 2002, *supra* note 10, at 85.

26. See, e.g., comments of Mr. Frank X. J. C. Njenga of Kenya who warned against placing great reliance on the Helsinki Rules, which he believed fail to consider States' permanent sovereignty over their natural resources. 1556th Meeting, *The Law of the Non-Navigational Uses of International Watercourses*, in Summary records of the meetings of the thirty-first session, [1979] I Y.B. INT'L L. COMM'N 117, 120, ¶ 25, U.N. Doc. A/CN.4/SER.A/1979 [hereinafter Summary records of the meetings of the thirty-first session].

27. The Final Act provides that "international rivers" are rivers that "separate or traverse different States." Final Act of the Congress of Vienna, June 9, 1815, arts. 108-110, *reprinted in* THE GREAT EUROPEAN TREATIES OF THE NINETEENTH CENTURY 89 (Oaks & Mowat eds., 1970).

28. S. Schwebel, *First Report on the Law of the Non-navigational Uses of International Watercourses*, U.N. Doc. A/CN.4/320, *reprinted in* [1979] 2(1) Y.B. INT'L L. COMM'N 143, 153, ¶ 43, U.N. Doc. A/CN.4/Ser.A/1979/Add.1 (Part 1) [hereinafter Schwebel, *First Report*].

position traditionally included upper riparian states.²⁹

In contrast, those states that argued for a broader drainage basin approach and to include the *divortium aquarum* of an international river within the scope of the treaty sought to ensure the integrity of water resources within every state's territory. Under this conception, states could use their water resources so long as such use did not result in substantial harm to the water interests of other riparian states. Supporters of this approach, who tended to be lower riparian states,³⁰ argued that it was a more rational and optimal use of shared water resources and, thus, required consideration of the entire drainage region of a watercourse.³¹

At the onset of their work in 1974, the Commission considered using the terms and definitions provided in the International Law Association's 1966 Helsinki Rules³² as a basis from which to formulate the new agreement.³³ The Helsinki Rules were regarded by some as "the most up-to-date code . . . available on the law of

29. *Id.*

30. *Id.* at 153, ¶ 44.

31. *See, e.g.*, comments of Mr. Julio Barboza of Argentina, who argued that the term "watercourse" should be understood to mean a drainage basin, justifying his position, in part, on the growing global need to improve efficiency in water use and allocation in light of the tremendous growth in global population. *See* Summary records of the meetings of the thirty-first session, *supra* note 26, at 227-28, ¶¶ 9-10; *see also* Replies of the Governments to the Commission's Questionnaire: Replies of Luxembourg to Question A, *The Law of the Non-Navigational Uses of International Watercourses*, in *Documents of the thirty-first session*, [1980] II Y.B. INT'L L. COMM'N 155, U.N. Doc. A/CN.4/SERA/1980/Add. 1 (Part 1) (asserting that "to ensure rational use of the water, the entire catchment area will have to be regarded in that way by all countries contiguous to or forming part of it, even when the tributaries in question are very distant").

32. Int'l Law Ass'n, Helsinki Rules on the Uses of the Waters of International Rivers and Comments, *Report of the Fifty-Second Conference* 484, Article II (1966) [hereinafter Helsinki Rules] (providing general rules for the use of waters of an international drainage basin), available at http://www.internationalwaterlaw.org/IntDocs/Helsinki_Rules.htm (last visited Aug. 15, 2004). The International Law Association is a private non-governmental organization tasked with the interpretation and codification of international law. *See* Stephen McCaffrey, *International Organizations and the Holistic Approach to Water Problems*, 31 NAT. RESOURCES J. 139, 141 (1991) (providing a more substantive history of the work of the ILA pertaining to the law of international water resources). Accordingly, the work of the ILA has always been regarded as aspirational in nature and not as hard and fast rules of state conduct. *See* Joseph Dellapenna, *Designing the Legal Structures of Water Management Needed to Fulfill the Israeli-Palestinian Declaration of Principles*, 7 PALESTINE Y.B. OF INT'L L. 63, 80 (1992/1994) (recognizing that work by the ILA, while significant, enjoys no official status in the development of international law).

33. *See* Schwebel, *First Report*, *supra* note 30, at 155-58, ¶¶ 51-61 (considering the appropriateness of the Helsinki Rules as a basis from which to begin the study).

international watercourses.”³⁴ The Commission focused, in particular, on Articles I and II of the Rules, which provide the scope of the Rules,³⁵ as well as a definition for “drainage basin.”³⁶

In using the Helsinki Rules, however, one of the main dilemmas among ILC Members was whether the “drainage basin” framework was appropriate for the task presently before them, and whether to include all or only certain types of ground water resources within the regime.³⁷ As used in the Helsinki Rules, the “drainage basin” phraseology was interpreted somewhat broadly to specifically include ground water resources, at least to the extent that such resources were a part of the “system of waters” and flowed to a “common terminus.”³⁸ Some ILC Members argued that the drainage basin approach was the most scientific and rational for sharing and managing transboundary waters.³⁹ A sizable group, however, criticized the phrase as a deviation from the traditional channel-based approach of international law and a threat to

34. *Id.* at 155, ¶ 51.

35. Article I provides that, “The general rules of international law as set forth in these chapters are applicable to the use of the waters of an international drainage basin except as may be provided otherwise by convention, agreement or binding custom among the basin States.” Helsinki Rules, *supra* note 32, at art. I.

36. Article II defines an international drainage basin as “a geographical area extending over two or more States determined by the watershed limits of the system of waters, including surface and underground waters, flowing into a common terminus.” Helsinki Rules, *supra* note 32, at art. II.

37. See Schwebel, *First Report*, *supra* note 30, at 156, ¶ 55; S. Schwebel, *Second Report on the Law of the Non-navigational Uses of International Watercourses*, U.N. Doc. A/CN.4/332, reprinted in [1980] 2(1) Y.B. INTL L. COMM’N 159, 167, ¶ 51, U.N. Doc. A/CN.4/Ser.A/1980/Add.1 (Part 1); see also 115th Meeting, *The Law of the Non-Navigational Uses of International Watercourses*, in *Summary of record of the meetings of the thirty-first session*, reprinted in [1979] 1 Y.B. INTL L. COMM’N 115 ¶ 23, A/CN.4/SER.A/1979. Approximately one-half of the Member States responding to a questionnaire voiced determined opposition to the use of the term “drainage basin.” See Schwebel, *First Report*, *supra* note 30, at 152, ¶ 42.

38. Helsinki Rules, *supra* note 32, at art. II.

39. For example, Mr. Edvard Hambro of Norway contended that while some river or drainage basins were indeed vast and extended far beyond the geography of the river itself, this fact should not prevent the ILC from considering the basin in its effort to codify international water law. Sovereignty, he argued, is not an appropriate basis for addressing the uses of international watercourses. Rather, Mr. Hambro asserted that the Commission must recognize the more important principle of the development of a social law, which delimited competence and sovereignty, as well as the interests of the international community as a whole in the use of fresh water for the benefit of all mankind. This, he believed was best represented by the drainage or river basin concept. See 1406th Meeting, *The Law of the Non-Navigational Uses of International Watercourses*, in *Summary records of the twenty-eighth session*, [1976] 1 Y.B. INT’L L. COMM’N 268, 273, ¶ 39, U.N. Doc. A/CN.4/SER.A/1976 [hereinafter Summary records of the twenty-eighth session].

sovereignty.⁴⁰ Opponents also objected to the basin concept for its perceived doctrinal approach to all watercourses without regard to unique hydrological, climatic, social or other circumstances.⁴¹ This approach was eventually rejected by the ILC for being over-inclusive.

Focusing on the boundary implications of international watercourses, many states that rejected the drainage basin concept argued for the more narrow meaning given to “international river” in the Final Act of the Congress of Vienna.⁴² The Final Act provides that international rivers are rivers that “separate or traverse different States.”⁴³ Notably, states supporting the Final Act concept were predominantly upstream states,⁴⁴ while those supporting the drainage basin model were mainly lower riparians.⁴⁵

Given the determined and conflicting positions, in 1976 the ILC decided to table the issue on the basis “that the question of

40. See J.L. Wescoat, Jr., *Beyond the River Basin: The Changing Geography of International Water Problems and International Watercourse Law*, 3 COLO. J. INT'L ENVTL. L. & POL'Y 301, 307 (1992) (discussion the development of the river basin concept in international water law); see also R.D. Hayton, *Observations on the International Law Commission's Draft Rules on the Non-Navigational Uses of International Watercourses: Articles 1-4*, 3 COLO. J. INT'L ENVTL. L. & POL'Y 31, 34-35 (1992) [hereinafter Hayton 1992] (noting that many countries' representatives addressed their lack of knowledge of technical and hydrological concepts by holding steadfast to the doctrine of absolute territorial sovereignty). Turkey's representative in the General Assembly asserted that “[h]ydrographic or drainage basins were part of the territory of the State and could not be treated differently from the rest of that territory.” See Schwebel, *First Report*, *supra* note 30, at 154, ¶ 50.

41. See J. Evensen, *First Report on the Law of the Non-navigational Uses of International Watercourses*, U.N. Doc. A/CN.4/367, reprinted in [1983] 2(1) Y.B. INT'L L. COMM'N 155, 162, ¶ 71, U.N. Doc. A/CN.4/Ser.A/1983/Add.1 (Part 1) [hereinafter Evensen First Report] (reviewing briefly the development of the scope of the instrument to date).

42. For example, Mr. José Sette Câmara of Brazil, who advocated for the international river concept under the Final Act of the Congress of Vienna, commented that the ILC's mandate was to focus on internal watercourses as embodied in numerous treaties and conventions, but not to address the concept of river basin, which he considered purely a territorial concept. See Summary records of the twenty-eighth session, *supra* note 39, at 270, ¶¶ 14-19 (1406th Meeting). Mr. Sette Câmara further noted that river basins vary from country to country and the fact that one country's territory lay within the basin or watershed of a particular river should not subject that territory to rules beyond the sovereign authority of that state. *Id.* at 270, ¶ 15.

43. See Final Act of the Congress of Vienna, *supra* note 27, at arts. 108-110.

44. States supporting the Final Act definition included Austria, Brazil, Canada, Colombia, Ecuador, the Federal Republic of Germany, Nicaragua, Poland, Spain, and the Sudan. Schwebel, *First Report*, *supra* note 30, at 153, ¶ 43.

45. States supporting the drainage basin approach included Argentina, Barbados, Finland, Hungary, Pakistan, the Philippines, Sweden, the United States, and Venezuela. *Id.* at 153, ¶ 44.

determining the scope of the term ‘international watercourses’ need not be pursued at the outset of the work. Instead, attention should be devoted to beginning the formulation of general principles applicable to legal aspects of the uses of those watercourses.”⁴⁶ This delay, however, did not table the discussion for long.

In 1980, Stephen Schwebel, the second Special Rapporteur for the topic of the non-navigational uses of international watercourses, proposed an “international watercourse system” approach as a substitute for the drainage basin concept.⁴⁷ The proposal included a working hypothesis of the approach, albeit with no definitions but rather an understanding that specific meanings could be officially agreed upon at a later time.⁴⁸ The watercourse system was described broadly as “formed of hydrographic components such as rivers, lakes, canals, glaciers, and *ground water* constituting by virtue of their physical relationship a unitary whole.”⁴⁹ While the focus on the basic unit of the “watercourse” was sufficiently analogous to the channel-based model for those supporting the river approach, Schwebel hoped that the emphasis on a “system” of waters would satisfy those advocating a unitary or drainage basin-like approach toward managing all interconnected waters, including ground water.⁵⁰ In order to encourage progress in the development of the text, a consensus was reached in 1980 to accept the proposal as a

46. *Report of the Commission to the General Assembly on the Work of its Twenty-Eighth Session, The Law of the Non-Navigational Uses of International Watercourses*, U.N. Doc. A/31/10 (1976), reprinted in 2(2) Y.B. INTL L. COMM’N 162, ¶ 164, U.N. Doc. A/CN.4/SER.A/1976/Add.1.

47. See S. Schwebel, *Second Report on the Law of the Non-navigational Uses of International Watercourses*, A/CN.4/332 and Add.1, reprinted in 2(1) Y.B. INTL L. COMM’N 159, 167, ¶ 52 (1980), U.N. Doc. A/CN.4/SER.A/1980/Add.1; see also Wescoat, Jr., *supra* note 40, at 314 (discussing the development of the scope of the Watercourse Convention).

48. See Thirty-Second Session Report, *supra* note 16, at 108, ¶¶ 88-89.

49. *Id.* at ¶ 90 (emphasis added).

50. See Wescoat, Jr., *supra* note 40, at 314; Thirty-Second Session Report, *supra* note 16, at 110, ¶ B(1), comt. (2). The Thirty-Second Session Report provides, in pertinent part:

An international watercourse is not a pipe carrying water through the territory of two or more States. While its core is generally and rightly seen as the main stem of a river traversing or forming an international boundary, the international watercourse is something more, for it forms part of what may best be described as a “system”; it comprises components that embrace, or may embrace, not only rivers, but other units such as tributaries, lakes, canals, glaciers, and groundwater, constituting by virtue of their physical relationship a unitary whole.

Id.

provisional working hypothesis.⁵¹

The consensus, however, was not long-lived. In subsequent ILC discussions, the “international watercourse system” approach proved controversial and was criticized by some for its drainage basin-like approach and perceived semantic maneuvering.⁵² By 1984, disagreement over scope and definitions forced the ILC to drop the word “system”⁵³ and to eliminate the 1980 working hypothesis.⁵⁴ In its place, the Commission reverted to the term “international watercourse,” albeit without defining the term. In his commentary, though, the third Special Rapporteur, Jens Evensen, asserted his understanding that “watercourses have a wide variety of ‘source components’, which include “groundwater and other types of aquifers.”⁵⁵

Subsequently, at its thirty-ninth session, in 1987, the 1980 working hypothesis defining the components of an international watercourse was revived so as to give some structure and guidance to the remaining articles and principles being formulated by the ILC. In addition, the Commission reintroduced the term “system,” albeit in square brackets.⁵⁶ The Commission, however, continued to postpone defining the term with the understanding that the scope and the use of the term “system” again would be tabled and

51. See *Report of the Commission to the General Assembly the Work of its Thirty-Second Session, The Law of the Non-Navigational Uses of International Watercourses*, A/35/10, reprinted in 2(2) Y.B. INT'L L. COMM'N 108, U.N. Doc. A/CN.4/SER.A/1980/Add.1 (Part 2) (discussing the Commission's activities in considering definitions for international watercourse and international watercourse system).

52. See S. Schwebel, *Third Report on the Law of the Non-navigational Uses of International Watercourses*, U.N. Doc. A/CN.4/348, reprinted in [1980] 2(1) Y.B. INT'L L. COMM'N 159, 167, ¶ 52, A/CN.4/SER.A/1980/Add.1; Hayton 1992, *supra* note 40, at 34-35 (describing the various attempts to reach consensus on the scope of the Convention); see Evensen, *First Report*, *supra* note 41, at 105, ¶ 16-17.

53. See 1831st Meeting, *The Law of the Non-Navigational Uses of International Watercourses*, in Summary records of the meetings of the thirty-sixth session, [1984] 1 Y.B. INT'L L. COMM'N 101, ¶5, U.N. Doc. A/CN.4/SER.A/1984/Add.1; J. Evensen, *Second Report on the Law of the Non-navigational Uses of International Watercourses*, U.N. Doc. A/CN.4/381, reprinted in 2(1) Y.B. INT'L L. COMM'N 106, ¶ 24 (1984), A/CN.4/SER.A/1984/Add.1 (Part 1) [hereinafter Evensen, *Second Report*].

54. See Evensen, *Second Report*, *supra* note 53, at 106, ¶ 24.

55. *Id.*

56. See 2028th Meeting, *The Law of the Non-Navigational Uses of International Watercourses*, in Summary records of the meetings of the thirty-ninth session, 1 Y.B. INT'L L. COMM'N 207, ¶ 16, U.N. Doc. A/CN.4/SER.A/1987 [hereinafter 2028th Meeting]; *Report of the Commission to the General Assembly on the Work of its Thirty-Ninth Session, The Law of the Non-Navigational Uses of International Watercourses*, A/42/10, art. 7(1), reprinted in [1987] 2(2) Y.B. INT'L L. COMM'N, FN 83, U.N. Doc. A/CN.4/SER.A/1987/Add.1 (Part 2).

addressed at a later time.⁵⁷

Despite the ongoing tension, in 1991, the ILC once more returned to the issue of scope to consider alternatives.⁵⁸ Following considerable debate, the Commission discarded the working hypothesis and agreed on a definition, which, with minor revision, eventually prevailed in the final version adopted by the UN General Assembly. The definition of “[w]atercourse” provided in the 1997 Watercourse Convention states that: “‘watercourse’ means a system of surface waters and groundwaters constituting by virtue of their physical relationship a unitary whole and normally flowing into a common terminus.”⁵⁹ For the purpose of the Convention, this definition is qualified by the definition of “international watercourse,” which “means a watercourse, parts of which are situated in different States.”⁶⁰

III. GROUND WATER AS A TRANSBOUNDARY RESOURCE

With some exception, most aquifers regularly receive and transmit water as part of the hydrologic cycle.⁶¹ This is not to say that all aquifers are interconnected with surface water. Nevertheless, it is rare that a river or lake is not somehow linked to ground water resources.⁶² Moreover, it is quite common for aquifers to be transboundary or to be hydraulically connected to a transboundary river or other surface body of water.⁶³

In a previous work,⁶⁴ the present author proposed six models to illustrate the main cases in which ground water resources can have transboundary and international implications.⁶⁵ While the models

57. 2028th Meeting, *supra* note 56, at 207, ¶ 16.

58. *Id.*

59. Watercourse Convention, *supra* note 13, at art. 2.

60. *Id.*

61. The hydrologic cycle is the system in which water – solid, liquid, gas or vapor – travels from the atmosphere to the Earth and back again in a constant cycle of renewal. *See* Price, *supra* note 3, at 13-19. For a basic discussion of the hydrologic cycle, see Eckstein & Eckstein 2003, *supra* note 3.

62. *See* Teclaff & Teclaff, *supra* note 7, at 630.

63. *See* Eckstein & Eckstein 2003, *supra* note 3, at Part III(B) (discussing six aquifer models that have transboundary implications and providing examples).

64. *See id.*

65. It is important to note that, while subtle in text, there is a significant and important distinction between the terms “transboundary” and “international” when modifying ground water resources. “Transboundary,” when used to define ground water or a specific aquifer, refers to a water resource that underlies an international political boundary between two or

do not represent every aquifer type conceivable, they do depict the vast majority of aquifers existing on Earth. The particular significance of these models lies in their scientific validity and their usefulness as generic archetypes on which to test, evaluate, and refine existing and proposed principles of international law. Following a review of the aquifer types, the models will be used to examine the scope of the Watercourse Convention and assess the types of aquifers that are covered by and excluded from the Convention.

1) Model A – An unconfined aquifer⁶⁶ that is linked hydraulically with a river,⁶⁷ both of which flow along an international border (i.e., the river forms the border between two States). Examples of this Model include: the Red Light Draw, Hueco Bolson, and Rio Grande aquifers underlying the United States and Mexico;⁶⁸ and

more sovereign states. See C. Yamada, *Shared Natural Resources: Addendum to the First Report on Outlines*, U.N. Doc. A/CN.4/533/Add.1 5-6, ¶ 13 (2003), available at <http://www.un.org/law/ilc/sessions/55/55docs.htm> (follow hyperlink to A/CN.4/533/Add.1) (last visited Oct. 10, 2005) [hereinafter Yamada Addendum] (discussing the definitions of transboundary and international aquifers); see also A. Székely, *Transboundary Resources: A View From Mexico*, 26 NAT. RESOURCES J. 669, 674-76 (1986) (discussing the definition of “transboundary” and “shared” in the contexts of resources that traverse international political borders). When modified by the term “international”, the ground water or aquifer so defined reflects two possibilities. The first is a water resource that, while in and of itself may not traverse an international political boundary, is hydraulically connected to a surface body of water that traverses such a boundary. See Yamada Addendum, *supra*, at 5-6, ¶ 13. Under this interpretation, such a “domestic” aquifer would still be bound by international law. The second possibility is an aquifer that is geographically completely domestic, but which has been “internationalized” in the sense that it is now subject to the interests of and governance by the international community.

66. An “unconfined” aquifer is an aquifer bounded by an impermeable base layer of rock or sediments and overlain by layers of permeable materials extending from the land surface to the impermeable base of the aquifer. See Price, *supra* note 3, at 10-11. For additional basic information diagramming and describing unconfined and confined aquifers, see Eckstein & Eckstein 2003, *supra* note 3, at 210-11.

67. “River” here and in the rest of the models is used generically to refer to any surface body of water.

68. All three of the aquifers are unconfined, are directly related to the Rio Grande, and flow along the border between the state of Texas in the United States and the state of Chihuahua in Mexico. For information on the Red Light Draw Aquifer, see B.J. Hibbs et. al., *Hydrogeological Regimes of Arid-Zone Aquifers Beneath Low-Level Radioactive Waste and Other Waste Repositories in Trans-Pecos, Texas and Northern Chihuahua, Mexico*, in Proceedings of the International Association of Hydrologists 28th Congress, GAMBLING WITH GROUNDWATER – PHYSICAL, CHEMICAL, AND BIOLOGICAL ASPECTS OF AQUIFER-STREAM RELATIONS 311 (Brahana et. al. eds., 1998) [hereinafter GAMBLING WITH GROUNDWATER]. For information on the Hueco Bolson Aquifer, see International Boundary & Water Commission, *Transboundary Aquifers and Binational Ground Water Data Base, City of El Paso/Ciudad Juárez Area*, International Boundary and Water Commission (1998), available at <http://www.ibwc.state.gov/html/>

the Danube alluvial aquifer underneath the portion of the Danube River flowing between Croatia and Serbia.⁶⁹

Transboundary impacts in this aquifer type can occur in a number of ways. For example, where one of the nations overlaying the aquifer overpumps the aquifer section underlying its territory, the pumping actions could result in an expansive cone of depression⁷⁰ that would cause the well to draw from both sides of the border, including the aquifer section underlying the non-pumping state.⁷¹ In addition to possible problems of transboundary depletion, the pumping also could cause contamination or pollution found in the aquifer section underlying the non-pumping state to flow to the section underlying the pumping state.⁷²

Another example of potential transboundary impact concerns the relationship of the aquifer to the border river. To the extent that the river is effluent,⁷³ pollutants or other negative

body_binational_waters.htm (last visited Mar. 27, 2005) [hereinafter IBWC Report]; B.J. Hibbs, *The City of El Paso/Ciudad Juarez Corridor International Case Study of Groundwater Depletion and Aquifer Salinization*, in *GAMBLING WITH GROUNDWATER*, *supra*, at 359 (Brahana et. al. eds., 1998); C.E. Heywood, *Monitoring Aquifer Compaction and Land Subsidence Due to Ground-Water Withdrawal in the El Paso, Texas-Juarez, Chihuahua, Area*, in U.S. GEOLOGICAL SURVEY SUBSIDENCE INTEREST GROUP CONFERENCE, EDWARDS AIR FORCE BASE, ANTELOPE VALLEY, CALIFORNIA, NOVEMBER 18-19, 1992: ABSTRACTS AND SUMMARY, OPEN FILE REPORT 94-532, 14-15 (Prince et. al. eds., 1995) available at <http://water.usgs.gov/pubs/of/1994/of94-532/> (last visited Mar. 27, 2005). For information on the Rio Grande Aquifer, see the IBWC Report, *supra*.

69. The Danube alluvial aquifer, which is hydraulically linked to the Danube River, flows below the Danube River along the border between Croatia and Serbia. For more information on the Danube alluvial aquifer, see B.F. Mijatovic, *Prevention of Over-Exploitation of Deep Aquifers in Vojvodina, Northern Yugoslavia*, in *GAMBLING WITH GROUNDWATER*, *supra* note 66, at 353 (Brahana et. al. eds., 1998).

70. A cone of depression is a curved funnel-shaped depression in the ground water table, centered at the pumping well that is caused by the pumping of ground water. See Eckstein & Eckstein 2003, *supra* note 3, at 219; Heath, *supra* note 3, at 20-25. The drop in the ground water level is larger in the center of the "funnel" (*i.e.*, at the pumping well) and diminishes with distance from the pumping well. See Eckstein & Eckstein 2003, *supra* note 3, at 219. Water within the radius of influence (the influence of the pump) will flow toward the pump intake, while water outside the radius of influence will flow in its natural flow pattern. *Id.*

71. See Eckstein & Eckstein 2003, *supra* note 3, at 219 (explaining the physical results of pumping on ground water flow).

72. See J. Burke, et al., *Groundwater and Society: Problems in Variability and Points of Engagement*, in *GROUNDWATER: LEGAL AND POLICY PERSPECTIVES*, PROCEEDINGS OF A WORLD BANK SEMINAR 31, 39-41 (Salman ed., 1999) (discussing the sustainability issues related to ground water pollution and over-pumping).

73. An "effluent" river describes a river that receives water from a hydraulically connected aquifer. See Eckstein & Eckstein 2003, *supra* note 3, at 214-15 (describing effluent and influent aquifer-river relationships); Fetter, *supra* note 20, at 58-59.

characteristics found in or introduced into either of the aquifer sections will impact the river. Because the river forms the border between the two states, the impact would be transboundary as the non-acting state will be affected by the pollutants. Similarly, any pollutants or other negative characteristics present in an influent river⁷⁴ could impact both sections of the aquifer, again resulting in a transboundary consequence. It is noteworthy that a river that is hydraulically linked to an aquifer can be influent at one point of the river and effluent at another point with the same or a different aquifer. Thus the possibility of transboundary impacts can be multiple and complex.

2) Model B – An unconfined aquifer⁷⁵ intersected by an international border and linked hydraulically with a river that is also intersected by the same international border. Examples of this aquifer type include: the Abbotsford-Sumas Aquifer flowing across the border between Canada and the United States;⁷⁶ the Mures/Maros Aquifer underlying Hungary and Romania;⁷⁷ the San Pedro Basin Aquifer traversing the border between Mexico and the United States.⁷⁸

The transboundary implications of this aquifer type are primarily based on slope and gravity. Water in the river and the related aquifer flow down-slope with gravity from the upper riparian⁷⁹ state

74. An “influent” river describes a river that feeds water to a hydraulically connected aquifer. See Eckstein & Eckstein 2003, *supra* note 3, at 214-15; Fetter, *supra* note 20, at 58-59.

75. See *supra* note 64.

76. The Abbotsford-Sumas Aquifer is an unconfined aquifer underlying southern British Columbia, Canada, and northern Washington State, USA. The aquifer is related directly to the Sumas River, Bertrand Creek, and Fishtrap Creek, all of which flow from Canada into the United States. For more information on the Abbotsford-Sumas Aquifer, see Abbotsford-Sumas Aquifer International Task Force website, <http://wapwww.gov.bc.ca/wat/aquifers/absumas.html> (last visited Oct. 21, 2003).

77. The unconfined Mures/Maros Aquifer lies underneath Romania and Hungary, and is related directly to the overlying Mures/Maros River, which flows into the Tisza River, a tributary of the Danube River. For more information on the Mures/Maros Aquifer, see R.C. Anderson, *The Management of International Rivers and Lakes*, ENVIRONMENTAL POLICY AND TECHNICAL PROJECT: NEW INDEPENDENT STATES 35, Report prepared for Central Asia Mission-USAID (August 1998) (*available from author*).

78. The predominantly unconfined San Pedro Basin Aquifer underlies Mexico and the United States and is linked hydraulically to the San Pedro River, which flows northward into the United States and merges with the Gila River, a major tributary of the Colorado River. For more information on the San Pedro Basin Aquifer, see H.M. Arias, *International Groundwaters: The Upper San Pedro River Basin Case*, 40 NAT. RESOURCES J. 199, 204 (2000).

79. The term “riparian” is used to here to describe a state that has physical contact with a transboundary aquifer or a transboundary surface body of water (*i.e.*, lake or river). When modified by the term “upper” or “lower”, the phrase reflects the position of the state, in

to the lower riparian state,⁸⁰ therefore implying that most transboundary situations will result from pollution in the upper riparian state flowing into the lower riparian state (either through the river or the aquifer). Other transboundary impacts, however, could result where the lower riparian state pumps at an accelerated rate thereby increasing the volume of ground water flowing within the cone of depression from the upper riparian state to the lower riparian state. Likewise, excessive pumping in the upper riparian state could result in a localized reversal of ground water flow (from the lower riparian state to the upper riparian state) as well as introduction of any contaminants present in the lower riparian state into the upper riparian state.

In addition, the river's effluent or influent relationship with the underlying aquifer also can result in transboundary consequences. For example, if the river is effluent in the upper riparian state and influent in the lower riparian state, any negative characteristic (such as pollution) found in either aquifer sections in the upper riparian state could flow into the river and then into the aquifer on both sides of the river in the lower riparian state.

3) Model C – An unconfined aquifer that flows across an international border and that is hydraulically linked to a river that flows completely within the territory of one state. An example of this Model is the Mimbres Basin Aquifer traversing northern Mexico and the U.S. state of New Mexico.⁸¹

The transboundary implications of Model C are a factor of the distribution of hydraulic potential and the effluent and influent aquifer-river relationship. For example, where the aquifer-river relationship is effluent, ground water recharged in the non-riparian state could flow through the aquifer to the state containing the river and into the river. If the aquifer-river relationship is

relation to other riparian states, in terms of flow direction of the water in the aquifer or the surface body of water.

80. The presence of a river flowing from State A to State B implies that the State A lies at a higher elevation than State B. Although not always the case, the presumption is that the aquifer slopes in the same general direction as the river.

81. The Mimbres Basin Aquifer is an unconfined aquifer in northern Mexico and the southern portion of New Mexico. It is recharged from the Mimbres River, which flows solely inside the U.S. For more information on the Mimbres Basin Aquifer, see J.W. Hawley, et. al., *TRANS-INTERNATIONAL BOUNDARY AQUIFERS IN SOUTHWESTERN NEW MEXICO* 30-49 (2000) available at <http://wrri.nmsu.edu/publish/otherrpt/swnm/pdf/downl.html> (last visited Oct. 21, 2003). See also E.M. Hebard, *A Focus on a Binational Watershed With A View Toward Fostering A Cross-Border Dialogue*, 40 NAT. RESOURCES J. 281, 289-297 (2000).

influent, the water could flow from the river into the aquifer and reach the part of the aquifer located underneath the non-riparian state. These normal flow conditions, however, could be reversed locally where the state from which the water flows overpumps causing the ground water within the pump's cone of depression to flow toward the pump.

4) Model D – An unconfined aquifer that is completely within the territory of one state but that is linked hydraulically to a river flowing across an international border (in such cases, the aquifer is generally located in the “downstream” State). Examples of this Model include: the Gila River Basin Aquifer underneath parts of Arizona, California, Nevada, and New Mexico in the United States.⁸²

The transboundary implications for this aquifer type are primarily one-sided. Regardless of whether the aquifer is in the upriver or downriver state, the upstream riparian has the singular opportunity and responsibility for ensuring the quantity and condition of water in the transboundary river. In addition, whether the aquifer is effluent or influent will be significant in assessing whether the upriver activities could impact the downriver state.

5) Model E – A confined aquifer,⁸³ unconnected hydraulically with any surface body of water, with a zone of recharge (i.e., in an unconfined portion of the aquifer) that traverses an international boundary or that is located completely in another state.⁸⁴ Examples of this Model include: the series of deep, confined aquifers in the Syr Darya River Basin of Central Asia;⁸⁵ the

82. The Gila River Basin Aquifer is an unconfined aquifer linked to the Gila River, which is a significant contributor to the Colorado River as it flows towards Mexico. For more information on the Gila River Basin Aquifer, see Hawley, *supra* note 81, at 103-06.

83. A “confined” aquifer is an aquifer contained between two impermeable layers – the base or “floor”, and the “ceiling” strata – that subject the stored water to pressure exceeding atmospheric pressure. Price, *supra* note 3, at 10-11. For additional basic information diagramming and describing confined and unconfined aquifers, see Eckstein & Eckstein 2003, *supra* note 3, at 211-13.

84. Such an aquifer would be recharged from precipitation falling in the area of the zone of recharge.

85. The aquifers in the Syr Darya River Basin are recharged primarily in the high mountains of Turkmenistan and Tajikistan and are not linked to the Syr Darya River. For more information on the aquifers of the Syr Darya River Basin, see G.S Sydykov and V.V. Veselov, *Water Ecological Situation Changes of the Aral Sea Basin Under the Influence of Intensive Agricultural Development*, in ENVIRONMENTAL IMPACT OF AGRICULTURAL ACTIVITIES, PROCEEDINGS OF INDUSTRIAL AND AGRICULTURAL IMPACTS ON THE HYDROLOGIC ENVIRONMENT, THE 2ND USA/CIS JOINT CONFERENCE ON ENVIRONMENTAL HYDROLOGY AND

Mountain Aquifer between Israel and the Palestinian Territories;⁸⁶ and the Guarani Aquifer underneath Argentina, Brazil, Paraguay and Uruguay.⁸⁷

Model E describes a solitary aquifer that is unrelated to any other body of water (such as a river or lake). This type of aquifer, however, is still a dynamic component of the hydrologic cycle since it has an exposed zone that allows for recharge from precipitation.

The transboundary implications of this Model are, in large part, a function of the rate of pumping. Any excessive pumping in one or both states could have serious implications for the part of the aquifer along the border between the two countries. Moreover, any negative characteristics found in the aquifer underneath one of the states could flow to the other as a result of natural flow or as a result of a cone of depression locally reversing the natural flow. In addition, where the recharge zone is primarily or entirely in one state, considerable international consequences may result where that state diverts surface runoff from recharging the aquifer or undertakes activities that pollute surface waters in the recharge zone (*i.e.*, agricultural runoff, untreated municipal and industrial waste, etc.).

6) Model F – A transboundary aquifer unrelated to any surface body of water and devoid of any recharge. Examples of this Model

HYDROGEOLOGY 3 (Eckstein and Zaporozec eds., 1993).

86. See H. Gvirtzman, *Groundwater Allocation in Judea and Samaria*, in WATER AND PEACE IN THE MIDDLE EAST, PROCEEDINGS OF THE FIRST ISREALI-PALESTINIAN INTERNATIONAL ACADEMIC CONFERENCE ON WATER: ZURICH, SWITZERLAND 205, 208-212 (Issac & Shuval eds., 1994); Gabriel E. Eckstein and Yoram Eckstein, *Ground Water Resources and International Law in the Middle East Peace Process*, 28 WATER INT'L 154, 159-160 (June 2003). While the international political status of the West Bank and the Palestinian controlled territories may be debatable, the situation provides an interesting example of disputed waters in a political geography that could, at some point in the future, have possible international implications.

87. The Guarani Aquifer is a confined aquifer in 90% of its extent and is recharged primarily through rainfall infiltrating in places where the confining layer is not present. For more information on the Guarani Aquifer, see Eduardo Usunoff, *Web-Based Information for Integrated Water Resources Management of a Multi-National Aquifer: The Global Environmental Facility Project on the Guarani Aquifer*, presentation at the Third Water Information Summit: Status, Challenges, and Future Opportunities of Internet-Based Communications Supporting Sustainable Water Resources Management (Nov. 3-5, 2000), available at http://www.waterweb.org/wis/wis3/presentations/30_Usunoff_pp.pdf (last visited Oct. 21, 2003); United Nations Education, Scientific, and Cultural Organization [UNESCO], *Internationally Shared (transboundary) Aquifer Resources Management: Their Significance and Sustainable Management, A Framework Document*, 44-46, Non-Serial Doc. SC-2001/WS/40 (Shammy Puri ed., 2001) (providing a brief case study of the Guarani Aquifer System).

include: the Nubian Sandstone Aquifer underneath Chad, Egypt, Libya, and Sudan;⁸⁸ the Complex Terminal Aquifer underlying Algeria and Tunisia, and possibly Libya and Morocco;⁸⁹ the Continental Interclaire Aquifer underlying Algeria and Tunisia, and possibly Libya and Morocco;⁹⁰ and the Qa-Disi Aquifer underlying southern Jordan and northern Saudi Arabia.⁹¹

Model F is unique among the other models in that the aquifer is both unrelated to any other body of water (like a stream or lake) and is disconnected from the hydrologic cycle. As such, this aquifer type is non-recharging, contains non-renewable ground water, and cannot be utilized sustainably. Such aquifers contain *paleo* or ancient waters and may be confined or unconfined, as well as fossil or connate.⁹² Where the aquifer is unconfined, a lack of recharge generally implies a location in an arid zone where annual precipitation is inconsequential or non-existent. Moreover, as there is neither a distinct recharge nor discharge zone, the ground water table in this type of aquifer is horizontal and the water is stagnant with little or no perceptible flow.⁹³

88. The Nubian Sandstone Aquifer is a non-renewable aquifer containing ground water unrelated to any other water resource. See Caponera & Alh riti re, *supra* note 9, at 592-94, 590; Gabriel E. Eckstein, Hydrologic Reality: International Water Law and Transboundary Ground-Water Resources, Paper and Lecture presented at the Conference on Water: Dispute Prevention and Development, American University Center for the Global South, Washington, D.C. (Oct. 12 - 13, 1998) available at <http://www.InternationalWaterLaw.org> (follow "Bibliography" hyperlink; then follow "Watercourse Convention" hyperlink; then follow "Eckstein, Gabriel" hyperlink) (last visited Oct. 22, 2003) [hereinafter Eckstein 1998].

89. The Complex Terminal Aquifer is a non-renewable aquifer. See Raj Krishna, & Salman M.A. Salman, *International Groundwater Law and the World Bank Policy for Projects on Transboundary Groundwater*, in GROUNDWATER: LEGAL AND POLICY PERSPECTIVES, PROCEEDINGS OF A WORLD BANK SEMINAR 163, 181 (Salman M.A. Salman ed., 1999).

90. The Continental Interclaire Aquifer is an unrelated, non-renewable aquifer. *Id.*

91. The Qa-Disi Aquifer is a non-renewable aquifer unrelated to any other water resource. See Krishna & Salman, *supra* note 89, at 183-84; Andrew Macoun, & Hazim El Naser, *Groundwater Resources Management in Jordan: Policy and Regulatory Issues*, in GROUNDWATER: LEGAL AND POLICY PERSPECTIVES, PROCEEDINGS OF A WORLD BANK SEMINAR 105, 111 (Salman ed., 1999).

92. A "fossil" aquifer is an aquifer (confined or unconfined) containing water that was buried at the same time as the geologic formation in which it is trapped. The ground water in such aquifers is of the same age as the porous geologic formation in which it is found. A "connate" aquifer describes a confined aquifer that has been completely cut off from any recharge or discharge for an appreciable period of geologic time. In connate aquifers, ground water once flowed freely through the aquifer from a recharge to a discharge zone, but has since become cut off from both and stagnant within the porous geologic formation. See Fetter, *supra* note 20, at 288.

93. See Eckstein & Eckstein 2003, *supra* note 3, at 216 (discussing the characteristics of non-recharging aquifers); J. Barberis, *International Groundwater Resources Law*, in FOOD AND

Due to their unique geologic configuration, the transboundary consequences associated with unconfined non-recharging aquifers are almost exclusively a function of pumping. Where a state begins withdrawing water from such an aquifer, the pumping will generate flow within an ever-expanding cone of depression. If the aquifer is transboundary, the cone of depression will eventually encroach into the portion of aquifer underlying the other aquifer state. Any pumping restrictions implemented by the aquifer states could reduce the rate of the expansion of the cone of depression. Unless pumping is stopped altogether, though, the rate of expansion will continue until the aquifer is fully depleted.

It is noteworthy that such aquifers are uniquely susceptible to pollution because of their stagnant character and lack of recharge. Once an aquifer becomes polluted, it is extremely difficult and expensive to clean. The absence of recharge and flow to and within a non-recharging aquifer further exacerbates the situation by preventing the aquifer's natural cleansing processes from removing contaminants. This can make the aquifer unusable for decades or longer.⁹⁴ Additionally, any flow created by a pumping well could exacerbate the extent of the pollution and transfer the contaminants to other parts of the aquifer.

The above aquifer models represent the vast majority of aquifers with the potential for transboundary consequences found on Earth. They serve as generic scenarios in which ground water resources can exist along and across international borders, or can be hydraulically linked to surface waters that are transboundary. The purpose of these models is to help evaluate the applicability and scientific soundness of proposed and existing rules governing transboundary ground water resources. Through such analyses, it is hoped that the models assist in the development of clear, logical, and appropriate norms of state conduct. It is against these models that the application of the Watercourse Convention to ground water resources will now be assessed.

AGRIC. ORG. LEGIS. STUDY NO. 40, 6 (1986).

94. Cf. Yamada Addendum, *supra* note 65, at 3 (suggesting that a specific legal regime should cover fossil aquifers). This is primarily because of their vulnerability to pollution and inability to cleanse themselves.

IV. GROUND WATER UNDER THE UN WATERCOURSE CONVENTION

The inclusion of “ground waters” in the Watercourse Convention provided significant clarification of the status of ground water under international law. While certainly a progressive development of international law, a more focused analysis of the Watercourse Convention, and in particular, the definition of the term “watercourse,” reveals that the Convention’s principles do not apply to all ground water resources. In fact, the Watercourse Convention sets very strict criteria for determining whether one or another type of ground water is included and consequently excludes numerous aquifers with transboundary implications. In the following, the Convention’s definition of “watercourse” is considered in relation to the six aquifer models discussed above. The goals of this analysis are to determine the extent to which the Convention covers ground water resources, to identify those aquifer types that are included within the scope of the agreement, and to assess the rationale for excluding other aquifer types.

A. Decoding the “Watercourse”

The inclusion of the “system” criterion into the definition of “watercourse” advocates a unitary or comprehensive management scheme of hydraulically connected waters.⁹⁵ While certainly a reasonable and progressive conception, when considered in relation to the rest of the phrase “a system of surface waters and ground waters,” the interpretation of the term places significant and questionable restrictions on the types of aquifers that fall within the scope of the Convention.

In particular, the phraseology restricts the Convention to aquifers that have some type of relationship to surface water, such as a stream or lake.⁹⁶ While the term “system” is not explicitly defined

95. See *supra* notes 44-48, and accompanying text.

96. While not defined in the Convention, the term “surface water” should be understood to mean a surface body of water, such as river, stream, or lake, and other defined bodies of water on the Earth’s surface, and to exclude from its scope surface runoff, water percolating into the ground, and other diffused or unchanneled waters. This understanding coincides with the definition used by geologists, see, e.g., Fetter, *supra* note 20, at 5 (defining surface water as “[w]ater stored in ponds, lakes, rivers, and streams”), and comports with that of the drafters of the Watercourse Convention. For example, early in their deliberations, the ILC limited the scope of their work to defined surface bodies of water when they declined to use the broader “drainage basin” approach as used in the Helsinki Rules. See *supra* note 32-45, and accompanying text. In 1980, in response to the Commission’s difficulties in defining

in the Convention, at the very least it is reasonable to assume that “system” implies an interrelationship between ground and surface water whereby water flows from one to the other resource consistently and in a defined pattern.⁹⁷ This supposition is supported and complemented by the next phrase in the definition of “watercourses” – “constituting by virtue of their physical relationship a unitary whole.” This phraseology establishes that the relationship must be of a “physical” nature. In other words, there must be some actual material connection and interaction between the two bodies of water. In addition, the phraseology strengthens the concept that many surface and ground water resources are interdependent and that “any use of waters of the system may . . . affect waters in another part.”⁹⁸ As noted in the Commentary to the Draft Articles, “[s]o long as these components are interrelated with one another, they form part of the watercourse.”⁹⁹ This forms the practical basis for the requirement that such systems must be

their scope of work, the ILC prepared a working hypothesis of “watercourse” that again reflected the ILC’s focus on defined bodies of water: “A watercourse system is formed of hydrographic components such as rivers, lakes, canals, glaciers and groundwater constituting by virtue of their physical relationship a unitary whole.” See Thirty-Second Session Report, *supra* note 16, at 108, ¶ 90. Thereafter, in 1991, in discussing the hydrographic components of an international watercourse, Rapporteur McCaffrey noted that “a watercourse system will always have certain kinds of components (such as streams, their tributaries, and groundwater) and may have others (such as lakes, reservoirs, and canals) as well.” McCaffrey, *Seventh Report, supra* note 5, at 49, ¶ 11. More specifically, McCaffrey asserted that “[s]urface waters may take several natural forms, including rivers, lakes and ponds, and various artificial forms, such as canals and reservoirs.” *Id.* at 51, ¶ 15.

97. Cf. *Report of the Commission to the General Assembly on the Work of its Forty-Third Session, The Law of the Non-Navigational Uses of International Watercourses*, U.N. Doc. A/46/10, reprinted in [1991] 2(2) Y.B. INTL L. COMM’N 63, 64, ¶ 44; 65, ¶ 48, U.N. Doc. A/CN.4/SER.A/1991/Add.1 [hereinafter Forty-Third Session Report]; *Seventh Report, supra* note 5, at 53, ¶¶ 23-24; at 61, ¶ 70. While not explicit, it is also understood from the ILC’s work that a hydraulic relationship between two surface bodies of water, such as a lake and a connected river, but with no hydraulic connection to any ground water, also would fulfill the “system” criterion. Forty-Third Session Report, *supra* at 65, ¶ 44; McCaffrey *Seventh Report, supra* note 2, at 51, ¶ 15; at 58, ¶¶ 50-70.

98. See Schwebel, *First Report, supra* note 28, at 152, ¶ 39 (noting that “[t]he unity of a watercourse is based upon the hydrologic cycle . . . by which water circulates in a never-ending flow from the land and water surface of the earth to the atmosphere to the earth and back”); Thirty-Second Session Report, *supra* note 16, at 109, ¶ 91 (recognizing that such hydraulic relationships are scientific “fact”).

99. *Report of the Commission to the General Assembly on the Work of its Forty-Sixth Session, The Law of the Non-Navigational Uses of International Watercourses*, U.N. Doc. A/49/10, reprinted in [1994] 2(2) Y.B. INT’L L. COMM’N 88, 90, art. 2, cmt. 4, U.N. Doc. A/CN.4/SER.A/1994/Add.1 (Part 2) [hereinafter Forty-Sixth Session Report].

considered comprehensively as one single water system.¹⁰⁰

B. “Watercourse” and Solitary Aquifers

Considering the criteria discussed above, a question arises whether the systemic relationship itself is necessary for the Convention to apply. In other words, can a solitary transboundary aquifer unrelated to any river or lake, in and of itself, constitute a “system” and fulfill the criteria of “physical relationship” and “constituting . . . a unitary whole”? Of course, the same question can be applied to a solitary transboundary river or lake. However, with the latter question, the answer is most likely in the affirmative since it is inconceivable that a solitary transboundary river, albeit unconnected hydraulically to any other water body, would be excluded from the scope of the Watercourse Convention. Such a scenario would contradict the basis of the Watercourse Convention and the justification for its formulation.¹⁰¹

With regard to the solitary transboundary aquifer, the Watercourse Convention, work of the ILC and comments to the final Draft Articles are fairly clear. Ground water identified as “confined” by the ILC,¹⁰² meaning ground water that is unrelated to

100. See Forty-Third Session Report, *supra* note 97, at 64, ¶ 44 (acknowledging that “only an overall approach to an international watercourse as a system in constant motion could allow for the full implementation of the principle of equitable and reasonable utilization of a watercourse”); Cf. Schwebel, *First Report*, *supra* note 28, at 152, ¶ 41 (asserting that “[t]he areal and functional unity of a drainage basin suggests that this indivisibility is the proper starting point for the development of principles to govern the uses of fresh water moving through international watercourses”).

101. The ILC’s mandate was to “take up the study of the law of the non-navigational uses of international watercourses with a view to its progressive development and codification . . .” G.A. Res. 2669, U.N. GAOR, 25th Sess., Supp. No. 28, at 127, ¶ 1, U.N. Doc. A/8202 (1970). The point of departure for the ILC’s study was a 1963 study prepared by the UN Secretary General entitled “Legal problems relating to the utilization and use of international rivers.” UN Doc. A/5409 (1963), *reprinted in* [1974] 2(2) Y.B. INTL’ L. COMM’N 33, U.N. Doc. A/CN.4/SER.A/1974/Add.1 (Part 2). In that document, the Secretary General noted that the term “international river” refers “to international rivers properly so called” as well as to “any watercourse (river, stream, spring, etc.) running through the territory or along the border of two or more States”. *Id* at 50, ¶ 9. Nowhere in the document are the terms “international river” or “watercourse” limited by reference to the existence of other hydraulically related bodies of water. Likewise, during the ILC’s discussion of the scope of the resulting Convention, while the inclusion of interrelated surface and underground waters was debated, the ILC never restricted the applicability of the treaty to a river or stream hydraulically related to other bodies of water. Rather, the ILC emphasized that the “core” of the concept of a watercourse is “the main stem of a river traversing or forming an international boundary.” Thirty-Second Session Report, *supra* note 16, at 110, ¶ B(1).

102. The Commission applied the term “confined” to mean ground water that has no

hydrological relationship to surface water. See Forty-Sixth Session Report, *supra* note 99, at 90, art. 2, cmt. 4. While the etymology of the Commission's use of the term is uncertain, this definition creates potential confusion when compared to the use of the term by hydrogeologists. See, e.g., Hayton 1992, *supra* note 40, at 38; Ximena Fuentes, *The Utilization of International Groundwater in General International Law*, in *THE REALITY OF INTERNATIONAL LAW: ESSAYS IN HONOR OF IAN BROWNLIE* 177, 180 (Goodwin-Gill & Talmon eds., 1999). As used in hydrogeology, the term "confined" ground water relates to ground water contained and flowing through an aquifer that is under pressure between overlaying and underlain impermeable strata. See Eckstein & Eckstein 2003, *supra* note 3, at 210-14 (providing a basic explanation of confined and unconfined aquifers); PRICE, *supra* note 3, at 10-11 (providing a more technical explanation of confined and unconfined aquifers). Moreover, hydrogeologists know that confined aquifers often are hydraulically connected to and recharged from surface waters in portions of the aquifer that are unconfined, or through lateral flow from higher elevations where the aquifer crops out on the land surface. See Eckstein & Eckstein 2003, *supra* note 3, at 221-22 (discussing recharge of aquifers); PRICE, *supra* note 3, at 73.

Although terms and definitions often vary among disciplines, such differences can result in significant difficulties and misunderstandings, especially where the disciplines focus on the same subject matter. In the context of law, policy, and science, such misunderstandings could lead to more significant problems, such as confusion among those with responsibility for interpreting and implementing the law (like geologists and engineers), and even to misapplication of law. Today, the term "confined, to mean unrelated," can be found in a number of professional publications, in the thesis work of Masters students, and on professional Internet sites. See, e.g., Nikolai Frant, Comment, *Developments in Transboundary Water*, 2002 COLO. J. INT'L ENVTL. L. & POL'Y 91 (2003); Stephen C. McCaffrey, *An Overview of the U.N. Convention on the Law of the Non-Navigational Uses of International Watercourses*, 20 J. LAND RESOURCES & ENVTL. L. 57, 58-59 (2000); A. Dan Tarlock, *Putting Rivers Back in the Landscape: The Revival of Watershed Management in the United States*, 6 HASTINGS W.-N.W. J. ENVTL. L. & POL'Y 167, 180 (2000); Gamal Abouali, *Natural Resources Under Occupation: The Status of Palestinian Water Under International Law*, 10 PACE INT'L L. REV. 411, 544-45 (1998); K. Matsumoto, *Transboundary Groundwater and International Law: Past Practices and Current Implications*, (December 2002) (a research paper submitted in partial fulfillment of the degree of Master of Science, Department of Geosciences, Oregon State University), available at <http://www.transboundarywaters.orst.edu/publications/Matsumoto.pdf> (last visited Mar. 27, 2005); International Water Law Research Institute, University of Dundee at http://www.dundee.ac.uk/law/iwlri/KaR_Annexe.php (last visited Mar. 27, 2005).

One particular example where the use of terms was especially confused is in Rapporteur McCaffrey's recent work, which briefly considers what types of ground water fall within the scope of the Watercourse Convention. See McCaffrey 2001, *supra* note 25, at 429-430. Citing to Barberis's 1986 work in *supra* note 93, in which Barberis offered four case models to demonstrate the various transboundary implications associated with ground water resources, McCaffrey asserts that "[o]f the various possible situations identified by Barberis, it would appear that the only one that would not be covered by the Convention is the first, the case of the so-called 'confined aquifer.'" McCaffrey 2001, *supra* note 25, at 429-430. Barberis's first model is described as "a confined aquifer [that] is intersected by an international boundary, and is not linked hydraulically with other groundwater or surface water, and, as such, it alone constitutes the shared natural resource." Barberis, *supra*, note 93, at 36.

It is entirely likely that McCaffrey focused on the second part of the Barberis description ("not linked hydraulically with other groundwater or surface water") in defining the model as an example of a "confined" aquifer under the ILC's definition. This is somewhat confusing since in Barberis's description of the model, he explicitly uses the term "confined

any surface water resources, is explicitly excluded from the scope of the agreement. The ILC reached this consensus on the basis that ground water unrelated to surface water “should not be included because . . . it lacked a physical relationship with surface water and did not thus form part of a unitary whole.”¹⁰³ Focusing on the concept of “unity” of the system, the Commission also noted that “[i]t follows from the unity of the system that the term ‘watercourse’ does not include [water that is] unrelated to any surface water.”¹⁰⁴ Hence, for the purposes of the Convention, the “system,” “physical relationship,” and “unitary whole” criteria can only be met where a material interrelationship is present between an aquifer and a surface body of water.¹⁰⁵

aquifer” in the classical geologic definition of “confined” and not the one developed by the ILC. Barberis, *supra*, note 93, at 4 (defining “confined aquifer” to mean “a geological formation [that] consists of an entirely impermeable structure, *i.e.*, both floor and roof are impermeable, and [where] the pressure to which the stored water is subjected exceeds atmospheric pressure”). As a result, the reader is left unsure as to which type of aquifer is excluded from the Convention under McCaffrey’s analysis – a confined aquifer in the classical geological sense, or a confined aquifer as defined by the ILC.

It also noteworthy that the term “confined,” meaning ground water with no hydrological connection to surface water, was formally memorialized in the ILC Resolution on Confined Transboundary Ground Water, which accompanied the Commission’s draft of the Watercourse Convention. Forty-Sixth Session Report, *supra* note 99, at 135. Most recently, however, in the ILC’s latest effort to address the international law applicable to transboundary ground water resources, the ILC’s Special Rapporteur for shared natural resources noted the inconsistency in definitions and acknowledged the need to harmonize the terminology. See, Yamada Addendum, *supra* note 65, at 2-3, ¶ 5; *Report of the Commission to the General Assembly on the Work of its Fifty-Fifth Session, The Law of the Non-Navigational Uses of International Watercourses*, [2003] U.N. Doc. A/58/10 (2003), Supp. No. 10, 262, ¶ 380, available at <http://www.un.org/law/ilc/reports/2003/2003report.htm> (follow “Shared Natural Resources” hyperlink, then follow “English” hyperlink) (last visited Mar. 27, 2005).

103. Forty-Third Session Report, *supra* note 97, at 65, ¶ 48. See also reference to the exclusion of so-called “confined” ground water from the scope of the Convention. *Supra* note 102, and accompanying text.

104. Forty-Sixth Session Report, *supra* note 99, at 90, ¶ 222.

105. In his writings subsequent to his service on the ILC, McCaffrey offered an exception to this absolute conclusion. He argues that a solitary transboundary aquifer that is not hydraulically related to any other water body, but which is recharged from precipitation in an area across a political boundary (such as depicted in Model E), would qualify the aquifer as an “international watercourse” under the Convention. See McCaffrey 2001, *supra* note 25, at 429-430. If so, it would support the applicability of the Convention to solitary transboundary aquifers, or, at least, to solitary aquifers with a recharge zone partly or fully across an international boundary.

McCaffrey’s justification for the inclusion of such aquifers within the rubric of the Watercourse Convention, however, is problematic in that his definition of surface water conflicts with that of the ILC. McCaffrey reasons that percolating water and other diffused waters in a recharge zone of an aquifer constitute “surface water” for the purposes of the Convention, and, thereby, create a “system of surface waters and groundwaters.” *Id.* In

In considering whether unrelated aquifers should be subject to the same regulatory regime and principles of law as those that are related to surface water, it is perplexing and shortsighted to question whether the aquifer is hydraulically connected to a surface body of water, or whether the surface water is a stream or lake or merely surface runoff. The more relevant questions are: 1) whether the aquifer is a dynamic part of the hydrologic cycle; and 2) whether the aquifer could have transboundary consequences.

An aquifer that is unconnected hydraulically with any surface body of water, but which has its recharge zone along or across an international border, is still a very dynamic part of the hydrologic cycle.¹⁰⁶ Like the aquifer types described in Models A, B, and D, all of which do fall within the scope of the Watercourse Convention, this aquifer type has the potential for sustainable withdrawal or discharge and has a consistent source of recharge (through the zone of recharge on the surface). Moreover, and possibly more important for the purposes of international law and politics, the transboundary implications arising from such an aquifer are, in most cases, identical to those found with aquifer Models A, B, and D. Those consequences could result from pollution crossing the border due to the natural flow of water within the aquifer, or from a cone of depression locally reversing the natural flow.¹⁰⁷ International and transboundary consequences also are implicated where the state in which the recharge zone is located diverts surface runoff from recharging the aquifer or undertakes activities that pollute surface waters in the recharge zone (i.e., agricultural runoff, untreated municipal and industrial waste, etc.). Excluding such aquifers from the scope of the Convention removes numerous transboundary aquifers of considerable importance, especially in water-stressed and arid regions of the world like the Middle East,

contrast, however, the ILC's use and understanding of the term "surface water" limits it only to surface bodies of water, such as rivers, streams, lakes, canals, and other non-diffused bodies of water on the earth's surface. See *supra* note 96 (discussing in the footnote the definition of "surface water"). Upon reviewing the ILC's consideration of "surface waters" in its deliberations, it is difficult to believe that the Commission would have considered surface runoff, percolating water, or other diffused waters within the scope of "surface water" for the purpose of the Convention.

106. See *supra* note 83-87, and accompanying text (describing such an aquifer in Model E and its connection to the hydrologic cycle); see also Eckstein & Eckstein 2003, *supra* note 3, at 244-46.

107. *Id.*

Northern Africa, Central Asia, and others.¹⁰⁸ Moreover, this exclusion effectively reduces the value and significance of the Watercourse Convention in addressing transboundary ground water concerns.

One important example, the Mountain Aquifer, underlies the foothills bordering the Israeli coastal plain and the Jordan-Dead Sea rift valley. This aquifer is an unrelated recharging aquifer. Beginning as an unconfined aquifer in the highlands of the Judean Mountains, which include the Palestinian Territories of the West Bank, the aquifer is recharged in this region solely from precipitation and runoff.¹⁰⁹ As it slopes westward toward the Mediterranean Sea and underneath Israel, following the downward curvature of the strata, it becomes confined (in the hydrogeological sense) in the lowlands underneath impermeable material. Precipitation falling on the surface, in this area, does not reach the aquifer, making it absolutely reliant on recharge from the highlands.¹¹⁰ Nevertheless, the absence of a systemic relationship to a surface body of water does not negate the very real transboundary implications of this aquifer. Given that the transboundary consequences of this aquifer type are strikingly similar to ground water included within the Watercourse Convention (i.e., Models A, B, and D), there is no logical basis to justify why this aquifer type is excluded from the scope of the Convention.¹¹¹

C. The Transboundary Character of an International Watercourse

Considering the “system” criterion, a second question arises when the definition of “watercourse” is read in concert with the definition provided for “international watercourse,” namely “a

108. For example, aquifers excluded from the Watercourse Convention because of this criterion include: the series of deep, confined aquifers in the Syr Darya River Basin, *see supra* note 85; the Mountain Aquifer between Israel and the Palestinian Territories, *see supra* note 86; and the Guarani Aquifer underneath Argentina, Brazil, Paraguay and Uruguay, *see supra* note 87.

109. *See* Eckstein 1998, *supra* note 88; Gvirtzman, *supra* note 86, at 208-212.

110. *See* Eckstein 1998, *supra* note 88; Gvirtzman, *supra* note 86.

111. Arguably, the UN Convention should not apply to the situation of the Mountain Aquifer given the lack of a defined international boundary between Israel and the Palestinian Territories. Nonetheless, the situation provides an excellent example of disputed water needs and objectives in a political geography that, were it to be construed a transboundary dispute, whether now or in the future, would fall outside of the scope of the UN Convention.

watercourse, parts of which are situated in different States.”¹¹² The question is whether the transboundary character of the system *must* be found in the river, or whether it *may* be found solely in the aquifer. Bearing in mind that transboundary rivers were at the “core” of the ILC’s efforts,¹¹³ it is clear that a system composed of a transboundary river interrelated with a domestic aquifer (such as is depicted in Model D) would fall within the scope of the Convention. Nevertheless, a textual interpretation of the two definitions together suggests that so long as any part of the system (i.e., the river part or the aquifer part) lies across an international boundary, the system would be subject to the Convention. In other words, it should not matter whether it is the river or the interrelated aquifer that is transboundary.

Neither the work of the ILC or of the various Rapporteurs, nor subsequent scholarship, provides any guidance on this question.¹¹⁴ Moreover, the ambiguity was not addressed by the General Assembly Committee that finalized the Convention’s text. McCaffrey, in his writings, offered limited attention to this aquifer type in stating that “the scope of the UN Convention is defined [to mean] that a particular aquifer need not be intersected by a border in order for it to be covered by the Convention’s provisions; it is enough that the aquifer be related to surface water that does cross or flow along a border.”¹¹⁵

To the extent that McCaffrey’s assertion focuses on the river as the transboundary body of water, it supports the supposition that Model D is covered by the Convention. It does not, however, support coverage for the aquifer type described in Model C. Moreover, to the extent that McCaffrey suggests that the

112. Watercourse Convention, *supra* note 13, at art. 2.

113. See Thirty-Second Session Report, *supra* note 16 (asserting that “the main stem of a river traversing or forming an international boundary” is the “core” of a watercourse).

114. This aquifer type was only briefly acknowledged in one Member’s comments during the ILC’s deliberations over the development of the Watercourse Convention. See 115th Meeting, *The Law of the Non-Navigational Uses of International Watercourses*, in Summary of record of the meetings of the thirty-first session, [1979] 1 Y.B. INTL L. COMM’N 117, 119, ¶ 17, U.N. Doc. A/CN.4/SER.A/1979 (reporting on ILC Member Mr. Ushakov’s comments that according to the definition of international drainage basin, “a national watercourse that flowed through the territory of a single State could become an international watercourse if it was fed by underground water originating in the territory of another State”).

115. See S. McCaffrey, *International Ground Water Law: Evolution and Context*, in GROUND WATER: LEGAL AND POLICY PERSPECTIVES, PROCEEDINGS OF A WORLD BANK SEMINAR 139, 155-56 (Salman ed., 1999) (explaining the scope of the Convention in relation to ground water).

transboundary character of an aquifer-river system *must* be found in the river for the Convention to apply, a transboundary aquifer physically linked to a domestic river would be excluded from the Convention.¹¹⁶

The question here, however, should not be whether the transboundary characteristic is found in the river or in the interrelated aquifer. Rather, the more pertinent questions are functionally identical to those proffered above in relation to solitary aquifers: 1) whether the aquifer-river system is a dynamic part of the hydrologic cycle; and 2) whether the aquifer-river system could have transboundary consequences. A domestic aquifer hydraulically related to a transboundary river has the same potential for transboundary consequences as does a transboundary aquifer connected to a purely domestic river. Moreover, they are the same consequences as those associated with Models A, B, and D.

The exclusion of one but not the other aquifer-river system is certainly indefensible. The absence of any state practice or guidance by the ILC or UN General Assembly on this matter, however, will maintain the uncertainty as to the rights and responsibilities of riparians applicable to such a system.

D. The “Common Terminus” Criterion

Another criterion placing limitations on the Convention’s applicability to ground water resources is the phrase “flowing into a common terminus.”¹¹⁷ This criterion suggests that, as required by the “system” restriction, here, too, there must be more than one water resource that is interrelated. In defining “terminus,” the adjective “common” intimates the existence of more than one

116. Such an interpretation would reflect the historical proclivity to focus on the river as the focal point of international law. See McCaffrey 2001, *supra* note 25, at 34 (discussing the historical emphasis placed on rivers and lakes); see also Eckstein & Eckstein 2003, *supra* note 3, at 241-42 (discussion of the international implications of model C). Many of the ILC members, for example, sought to exclude ground water from the scope of the Convention by arguing that the focus of the ILC’s work and the draft articles “dealt primarily with surface water and did not contain provisions that focused on specific characteristics of groundwater.” Forty-Third Session Report, *supra* note 97, at 65, ¶ 50; Forty-Fifth Session Report, *infra* note 119, at 88, ¶¶ 368-370. Moreover, they contended that the uniqueness of ground water merited a separate legal regime, and that consideration of ground water resources would unnecessarily delay the Commission’s work. Forty-Third Session Report, *supra* note 97, at 65, ¶ 50; Forty-Fifth Session Report, *infra* note 119, at 88, ¶¶ 368-370.

117. Watercourse Convention, *supra* note 13, at art. 2.

distinct water resource that flows toward the same end point, which, by definition, would exclude solitary, unrelated aquifers from the scope of the Convention.

This phrase was added to the Convention's definition, in part, because of concerns raised by certain countries that a geographic limitation was necessary.¹¹⁸ In particular, some ILC Members contended that, "In a single State where most of its rivers were connected by canals, the absence of the requirement of common terminus would turn all those rivers into a single system and would create an artificial unity between watercourses."¹¹⁹ By embracing the qualifying phrase "flowing into a common terminus," two different watercourses connected by a canal could not be regarded as a single watercourse for the purposes of the Convention.¹²⁰

The "common terminus" criterion, however, raises considerable concerns in the context of ground water since the directional flow of rivers and lakes is generally described in two dimensions while the directional flow of ground water is illustrated in three dimensions.¹²¹ River flow direction, for example, is described in terms of two points: X and Y. Water in rivers flows from point X to point Y. In the context of the Watercourse Convention, point X is the origin or source of the water and point Y the terminus of the flow.

The flow direction of ground water, however, is far more complex and requires a third dimension to properly illustrate. Ground water flow is a factor of hydraulic potential, which in turn is dependent on gravity, soil permeability, gradient, ambient air pressure, and temperature.¹²² All of these factors vary at different

118. While this terminology was not included in the definition until rather late in the Commission's work, it is not a new standard. The same phrase appears in Article II of the 1966 Helsinki Rules, which defines the scope of the Rules. Helsinki Rules, *supra* note 32, at art. II.

119. *Report of the Commission to the General Assembly on the Work of its Forty-Fifth Session, The Law of the Non-Navigational Uses of International Watercourses*, U.N. Doc. A/48/10, reprinted in [1993] 2(2) Y.B. INTL L. COMM'N 84, 87-88, ¶ 365, U.N. Doc. A/CN.4/SER.A/1993/Add.1 (Part 2) [hereinafter Forty-Fifth Session Report].

120. See Text of Draft Articles 2, 10, 26 to 29 and 32, With Commentaries Thereto, Provisionally Adopted by the Commission at its Forty-Third Session, Commentary (7) to Article 2, in Forty-Third Session Report, *supra* note 97, at 70.

121. See T.C. Winter, et. al., *Ground Water and Surface Water: A Single Resource*, U.S. Geological Circular 1139, 7 (1998), available at <http://water.usgs.gov/pubs/circ/circ1139/index.html> (last visited Jul. 15, 2004) (describing ground water movement).

122. See Eckstein & Eckstein 2003, *supra* note 3; see also Heath, *supra* note 3, at 20-25 (1987) (discussing flow and velocity of ground water flow, methods for charting flow

points in the aquifer and, therefore, can result in varying flow directions. Moreover, while aquifers do sometimes discharge at a single point, such as at a spring, aquifer discharge more often occurs over an extended geographical area along the entire edge of the aquifer. For example, aquifers that discharge into oceans typically discharge along the entire aquifer-ocean interface. Accordingly, to identify a common terminus between a river and interrelated aquifer could be enormously difficult if not impossible.

Furthermore, underground water resources do not always have the same linear flow direction as interrelated surface waters. Because of hydraulic potential, ground water may flow toward a disparate terminal point from that of a related surface body of water.¹²³ For example, surface water in the Danube River, as well as related ground water, generally flows toward a terminus in the Black Sea. In the upper region of the Danube, however, where the river emerges from the Black Forest in Germany, water from the river seeps, on a seasonal basis, into the fractured bedrock underlying the river and travels through the fractures into the Rhine River basin, thus flowing toward a terminus in the North Sea.¹²⁴ Based on the Convention's definition of watercourse, any use or management scheme developed for the upper reaches of the Danube River would not be bound by the Convention's principles with regard to the related ground water flowing toward the Rhine River. While this scenario may raise unique complications, consequences to the Rhine River and other downstream states are not inconceivable.

Nevertheless, the ILC did address this and other similar scenarios by modifying the "flowing to a common terminus" phrase with the prefix "normally." In so doing, the ILC sought a compromise

movement, and noting that gravity is the dominant force affecting ground water movement). The rate or speed of water-flow through the porous media is controlled by the permeability of the soils as well as hydraulic gradient and can range from a few millimeters to thousands of meters per day. Cf. H. Bouwer, *GROUND WATER HYDROLOGY* 38-37, 43, 90-91 (1978) (describing factors affecting ground water flow, and explaining technical aspects of rate and direction of flow in ground water).

123. See Fetter, *supra* note 20, at 9.

124. This very scenario was the subject of a well-known case – *Donauversinkung* – brought by the German states of Württemberg and Prussia against Baden. Württemberg and Prussia v. Baden (The *Donauversinkung* Case), German *Staatsgerichtshof*, June 18, 1927, *Entscheidungen des Reichsgerichts in Zivilsachen*, 116 RGZ, Appendix, at 18-45. For a discussion of this case, see A. McNAIR & H. LAUTERPAHT EDs., *ANNUAL DIGEST OF PUBLIC INTERNATIONAL LAW CASES – YEARS 1927 AND 1928*, at 128; and McCaffrey Seventh Report, *supra* note 5, at 56-57, ¶ 39-43.

between those who argued that the “common terminus” phraseology was hydrologically incorrect, potentially misleading, and could exclude certain important waters, and those who urged the need to maintain some measure of geographic limitation in the application of the Convention.¹²⁵ Accordingly, the term “normally” as a modifier for the phrase “flowing to a common terminus” prevents the application of the term “watercourse” to two distinct drainage basins connected by a canal or by naturally occurring seasonal flow.¹²⁶ Theoretically, it also would preclude such application to the Rhine-Danube situation since the ground water flow was seasonal, as well as to an aquifer and river that are hydraulically related on an intermittent or other less than “normal” basis.

In the context of the six aquifer types, Models E and F would clearly fall outside the scope of the Convention because there can be no possibility for a “common terminus” since the aquifers are solitary. Even in the case of Model E, where the aquifer does flow toward an identifiable end point, because it does not have any interrelated surface water against which to gauge flow toward a common end point, it would be excluded from the Convention. The application of the Convention to the remaining four models, however, would be purely dependent on the directional flow of the two interrelated water resources. If it is determined that an aquifer hydraulically related to a river (as variously described in Models A through D) flows toward an end point common with the end point of the river, then that aquifer would comply with the common terminus criteria. Otherwise, the interrelated aquifer would be excluded from the scope of the Convention. Of course, the hydraulically connected river would be subject to the terms of the Convention regardless of whether the interrelated aquifer is included or excluded.¹²⁷

E. Non-Recharging Aquifers and Non-Renewable Ground Water

A non-recharging aquifer is an aquifer with insignificant or no source of contemporary recharge. It is an aquifer that is detached from the hydrologic cycle and any water found within the aquifer is

125. Forty-Sixth Session Report, *supra* note 99, at 90, ¶ 222, art. 2, comm. (6).

126. *See id.* at 90-91, ¶ 222, art. 2, comm. (6).

127. *See supra* note 104 and accompanying text.

non-renewable.¹²⁸ By definition, such aquifers cannot be utilized sustainably as any withdrawal eventually will exhaust the resource.

As noted above, such aquifer types fall outside the scope of the Watercourse Convention because as solitary aquifers they do not fulfill the criteria of “system”, “physical relationship” and “unitary whole.”¹²⁹ They are also excluded from the Convention because they fall into the Commission’s misnomer of “confined” aquifers.¹³⁰ When considered in relation to the questions proffered above –1) whether the aquifer system is a dynamic part of the hydrologic cycle; and 2) whether the aquifer system could have transboundary consequences – only the second question can be answered in the affirmative. Accordingly, due to their distinctiveness from the other aquifer types, it is unclear whether non-recharging aquifers and non-renewable ground water should be subject to the same principles of law as other aquifer types when located in a transboundary context.

Due to their unique characteristics, non-renewable ground water is sometimes compared to other non-renewable, depletable natural resources, like oil and natural gas deposits.¹³¹ Oil and gas, like non-renewable ground water, are static, fluidic natural resources that once mined are permanently depleted. Proponents of such comparisons suggest that because of the similarities, it may be more appropriate to apply to non-renewable ground water the same rights, allocation, and use regime applied to oil and natural gas deposits.¹³²

Unlike oil and gas, however, water is indispensable for life and has no substitute.¹³³ In contrast to oil and gas, freshwater is often

128. See Eckstein & Eckstein 2003, *supra* note 3, at 215-16 (describing non-recharging aquifers); Fetter, *supra* note 20, at 364.

129. See *supra* note 105.

130. See *supra* note 102.

131. Cf. D.A. Caponera, *Principles of Water Law and Administration: National and International* 247 (1992) (suggesting that the legal regime for non-renewable ground water should be analogous to the law applicable to depletable minerals); see Krishna & Salman, *supra* note 89, at 167.

132. See Eckstein & Eckstein 2003, *supra* note 3, at 251-54 (discussing the arguments for and against application of oil and gas law to non-renewable ground water resources); Forty-Fifth Session Report, *supra* note 119, at 88, ¶ 369. It is noteworthy that in considering what principles of law may be applicable to non-renewable ground water, the law applicable to solid natural resources, like coal and salt, is not informative or pertinent since principles of management and allocation of such minerals are inadequate to deal with the fluidic nature of water. See Krishna & Salman, *supra* note 89, at 167.

133. See generally, WATER FOR PEOPLE, *supra* note 4, at 78 (discussing the imperative of

expressed in terms of a fundamental human necessity and, more recently, in the context of a human right.¹³⁴ Accordingly, regardless of its location, it may not fully comport with traditional economic notions of supply and demand since even the poorest and least privileged must have some water. Moreover, defining water in terms of necessity or rights raises considerable social, ethical, and legal questions of governments' responsibility to their own citizens as well as to those of other nations, thus questioning the appropriateness of an unfettered market for the distribution of freshwater.¹³⁵

In addition, because of the lack of recharge and flow within non-recharging aquifers, such aquifers may require stricter standards of management and protection than that applied to other natural resources. The absence of recharge and stagnant character of the water prevents the aquifer's natural cleansing abilities from diluting or eliminating contaminants.¹³⁶ As a result, such aquifers are particularly susceptible to contamination. They are also extremely difficult, if not impossible, to clean.¹³⁷ Moreover, if pumped, the artificial flow created from the pumping action could transfer contaminants to other parts of the aquifer and aggravate the situation.¹³⁸ Accordingly, the standards applied to oil and natural gas resources may be inadequate and inappropriate to protect such vulnerable water resources.¹³⁹

Notwithstanding this discussion, the status of non-renewable ground water resources under international law is a sorely neglected topic. While there are numerous transboundary aquifers

water for people and populations and asserting on page 5 that "[w]ater is essential for life.").

134. See General Comment No. 15 (2002), *The Right to Water, Substantive Issues Arising in the Implementation of the International Covenant on Economic, Social and Cultural Rights*, U.N. Committee on Economic, Social and Cultural Rights of the Economic and Social Council, U.N. Doc. E/C.12/2000/11, ¶ 1 (2002); see also J. Scanlon, et. al., *Water as a Human Right?*, IUCN Environmental Policy and Law Paper No. 51 (2004), available at <http://www.iucn.org/themes/law/pdffdocuments/EPLP51EN.pdf> (last visited Jul. 19, 2004); P. Gleick, *The Human Right to Water*, 1 *Water Pol'y* 487 (1999), available at www.pacinst.org/gleickrw.pdf (last visited Oct. 20, 2003); M. Barlow, *Globalization of Water as a Commodity is Destroying Resources*, U.S. Water News 9 (Feb. 2003).

135. See Eckstein & Eckstein 2003, *supra* note 3, at 254-56 (discussing the commercial and human rights aspects of marketing water).

136. See *id.* at 247.

137. *Id.* at 247.

138. *Id.* at 248.

139. See Yamada Addendum, *supra* note 65, at 3, ¶ 7; cf. Eckstein & Eckstein 2003, *supra* note 3, at 255-56.

with no or little contemporary recharge,¹⁴⁰ this author has found no scholarship on how such aquifers should be allocated, managed, or protected other than secondary remarks of the possible applicability or inapplicability of mainstream international water law and oil and gas law to such ground water resources.¹⁴¹ Moreover, there are no treaties or other agreements governing non-renewable aquifers to suggest state practice, and the Watercourse Convention offers no guidance since it omits from its scope ground water that is unrelated to surface water, that is not part of a system, and that fails to flow to some common terminus. Non-renewable ground water, by definition, does not fall within any of these criteria.

Given the ambiguity and lack of attention to the subject, more comprehensive and critical consideration is in order. This is especially necessary because many countries rely on transboundary, non-renewable aquifers as a source of freshwater; in some cases, such aquifers represent the only source of freshwater in a given region. As reliance on transboundary ground water continues to grow, nations will need clear guidelines for the management and allocation of such resources so as to achieve cooperation and avoid disputes.

V. CONCLUSION

The long standing preoccupation with surface waters by statesmen and scholars has prevented a more comprehensive approach to international water law that is hydrogeologically sound. This fixation is readily apparent in the Convention's particular focus on the "watercourse" and surface bodies of water, while giving ground water resources a more vague and limited consideration. The consequence is that hydraulically related surface and ground water resources may be governed and managed under very different principles and regimes with the result that

140. Examples include the Nubian Sandstone Aquifer underneath Chad, Egypt, Libya, and Sudan, the Complex Terminal Aquifer underlying Algeria and Tunisia and possibly extending underneath Libya and Morocco, the Continental Interclaire Aquifer underlying Algeria and Tunisia and possibly Libya and Morocco, and the Qa-Disi Aquifer underlying southern Jordan and northern Saudi Arabia. See Eckstein & Eckstein 2003, *supra* note 3, at 216, 248.

141. See, e.g., Caponera, *supra* note 131, at, at 247; Krishna & Salman, *supra* note 89, at 167; see also Eckstein & Eckstein 2003, *supra* note 3, at 251, 256.

such governance and management could conflict. Moreover, it overshadows and effectively inhibits the development of rules and principles for ground water resources, particularly those with transboundary and international characteristics.

Given the significance of ground water as a source of freshwater globally and the implications arising from the management and use of transboundary and international ground water resources, there is a considerable need for further study and consideration of the rules and principles applicable to this precious resource. In particular, the applicability of surface water law to ground water resources must be examined carefully keeping in mind the similarities and differences of surface and ground water, the relationship between the two resources, and the science of water.¹⁴²

In addition, greater attention must be focused on the particular qualities of ground water – e.g., slow flow or stagnant state of the water, susceptibility to pollution, availability or absence of recharge, rate of recharge – and considered with regard to whether the existing rules of international water law should be applied more strictly to ground water, whether additional standards are needed, or whether a completely different regulatory and management regime is called for.¹⁴³ For example, specific guidelines or rules may be necessary to address: land-based activities in or around an

142. There is still considerable debate on whether the regime applicable to transboundary surface water resources can and should be applied to surface and ground water, and whether it is already applicable under customary international law. Compare, e.g., Caponera & Alh riti re, *supra* note 9, at 619; Caponera, *supra* note 131, at 254-55; Eckstein 1995, *supra* note 25, at 71, 84-89, 93, and 94 (1995); E. Benvenisti, *Collective Action in the Utilization of Shared Freshwater: The Challenges of International Water Resources Law*, 90 A.J.I.L. 384, 398-99 (1996); see also the *Donauversinkung* Case, The Annual Digest of Public International Law Cases, *supra* note 124, at 128; Int'l Law Ass'n, *The Seoul Rules on International Groundwaters*, Report of the Sixty-Second Conference 251 (1987), available at http://www.internationalwaterlaw.org/IntlDocs/Seoul_Rules.htm (last visited July 23, 2004), at Article I; with Fuentes, *supra* note, 193-94, 198 (questioning the existence of customary international law applicable to transboundary ground water resources); J.W. Dellapenna, *The Evolving International Law of Transnational Aquifers*, Management of Shared Groundwater Resources: An Israeli-Palestinian Case with an International Perspective 209 (Feitelson & Haddad eds., 2001) (questioning the application of international water law principles to transboundary aquifers).

143. McCaffrey 2001, *supra* note 25, at 430-31, 433; Forty-Sixth Session Report, *supra* note 99, at 90. The best guidance currently available are soft law documents: the International Law Association's Seoul Rules, and the ILC's Resolution on Confined Transboundary Groundwater, Forty-Sixth Session Report, *supra* note 99, at 135, both of which take the position that the principles and rules applicable to renewable ground water resources are equally applicable to non-renewable ground water.

aquifer's recharge zone that could impact the aquifer; situations where activities related to a surface body of water affect an aquifer, and visa versa; artificial recharge of aquifers; and the status of non-renewable ground water resources under international law.

Ultimately, while development of the Watercourse Convention greatly increased international attention on global ground water resources, there is still a great deal of misunderstanding of the subject. For example, the ILC's use of the term "confined" ground water to describe ground water that is unrelated to surface water is troubling for its potential to generate considerable misunderstanding.¹⁴⁴ Although terms and definitions often vary among disciplines, the use of different terminology for formulating principles of law in a subject requiring thorough scientific understanding is a significant concern. In the least, it suggests a misunderstanding of the science underlying the subject of water law. At worse, it could serve as the basis for the formulation of rules and legal principles with little scientific underpinning, as well as the management and protection of this vital natural resource. As science develops and operates on the frontiers of knowledge, the law must keep apace and must continually adapt to new scientific discoveries and developments.¹⁴⁵ Only through the full understanding of the various legal, policy *and* scientific issues involved will states be able to use, manage and protect their shared resources appropriately, effectively, and in such a way that the resources suffice for present needs and are preserved for future generations.

It is noteworthy that toward this end, there is now a new effort by the ILC to explore these issues in a study that focuses specifically on transboundary ground water resources, and which in addition to the legal and political aspects, considers the scientific, environmental, and societal facets of the topic.¹⁴⁶ At its fifty-fourth session in 2002, the ILC appointed Ambassador Chusei Yamada of Japan Special Rapporteur for the subject of shared natural resources.¹⁴⁷ As part of his mandate, Ambassador Yamada is

144. See *supra* note 102.

145. See Eckstein 1998, *supra* note 88 (discussing the need of legislatures, policymakers, and the law, in general, to keep pace with the level of scientific knowledge).

146. For a review of the issues being considered by the ILC in its present effort, see G. Eckstein, *Protecting a Hidden Treasure: The U.N. International Law Commission and the International Law of Transboundary Ground Water Resources*, 1 SUST. DEVEL. L. & POL'Y 5 (2005).

147. *Report of the Commission to the General Assembly on the Work of its Fifty-Fourth Session*,

presently concentrating his efforts on transboundary ground water resources with the goal of delineating and articulating basic principles or guidelines applicable to such water resources. To his great credit, the Special Rapporteur has arranged through UNESCO to organize an interdisciplinary panel of specialists to advise him in this task. In addition to international legal experts, the panel is composed of scientists, academics, and other experts, including the present author. Through this effort, it is hoped that the Special Rapporteur and the ILC will consider all of the relevant aspects of the subject matter and articulate guidelines and principles that are not only politically sound and judicious, but also scientifically sensible.