[Nebraska Law Review](https://digitalcommons.unl.edu/nlr)

Volume 57 | Issue 3 Article 3

1978

International Groundwater Management: The Case of The U.S.-Mexican Frontier

Albert E. Utton
University of New Mexico School of Law

By Albert E. Utton*

International Groundwater Management: The Case of The U.S.-Mexican Frontier

> *The general picture is one of more recent resort to ground water. . . without an adequate understanding of the physics of the resource and without regard, generally speaking, for the future.*[1]

I. THE LEGAL CONTEXT

The heaviest groundwater users in the United States are the states which are contiguous to Mexico,[2] and yet, paradoxically, the law and institutions of the border states are woefully inadequate to control the exploitation of their groundwater resources.[3] In addition, international competence over aquifers divided by the frontier is largely undefined;[4] it is fair to say that the legal and institutional situation is chaotic .

It has been suggested that none of the border states has

> adequate legislation or regulations for the protection and management of diminishing supplies within the state and along the border areas. New Mexico has the only public control system, but regulations under it do not contemplate joint controls in the area of the border. Arizona and Texas have virtually no controls except voluntary ones, and the California law is beholden to similar rules of capture which do little to discourage excessive pumping and waste.[5]

In contrast to the legal situation on the United States side of

---

* Professor of Law, University of New Mexico. B.A. (Hons.) 1953, University of New Mexico; B.A. (Juris.) (Hons.) Oxon 1956; M.A. (Juris.) Oxon 1959.

1. Hayton, *The Ground Water Legal Regime as Instrument of Policy Objectives and Management Requirements*, in 2 ANNALES JURIS AQUARUM 272, 275 (2d Int'l Conf. on Water Law & Admin., Caracas, Venezuela Feb. 8-14, 1976).
2. Clark, *Institutional Alternatives for Managing Groundwater Resources: Notes for a Proposal*, 18 NAT. RESOURCES J. 153, 155 (1978).
3. Burman & Cornish, *Needed: a Ground-water Treaty Between the United States and Mexico*, 15 NAT. RESOURCES J. 385, 388-91 (1975).
4. *See* note 11 and accompanying text *infra*. It must be noted, however, that the International Boundary and Water Commission has done a remarkable job of resolving groundwater problems with a minimum of treaty mandate or international practice as precedent.
5. Clark, *supra* note 2, at 155-56.

the frontier, Mexico does have legal authority to control groundwater withdrawals. The national government can regulate extraction through the Secretariat of Water Resources, and the Secretary, on his own initiative, can establish prohibited groundwater zones if existing developments or the aquifer are in danger of being adversely affected,[6] or if it is otherwise in the public interest.

Coincident with the near legal vacuum, significant population increases are projected on both sides of the border, making it reasonable to anticipate that there will be increasing investment in groundwater facilities and accelerating demand placed on groundwater resources bisected by the international boundary between the two countries.[7] These two factors could be described as on a collision course. With increased demand for a limited resource, combined with a striking absence of institutions for either resolving disputes or managing the resource, the potential for dispute between the two countries has to be something more than imaginary.[8]

---

6. Teclaff, *Abstraction and Use of Water: A Comparison of Legal Regimes*, U.N. Doc. ST/ECH/154 62 (1972). *See* CONSTITUCIÓN POLÍTICA art. 27 (Mexico).
7. *See* Alba, *Condiciones y Políticas Económicas en la Frontera Norte de México*, 17 NAT. RESOURCES J. 571 (1977); Bradley & DeCook, *Ground Water Occurrence and Utilization in the Arizona-Sonora Border Regions*, 18 NAT. RESOURCES J. 29 (1978); Day, *International Aquifier Management: The Hueco Bolson on the Rio Grande River*, 18 NAT. RESOURCES J. 163 (1978).
8. Three examples will serve to illustrate the possibilities for conflict over United States-Mexican groundwater resources:
    1. Near San Luis, Sonora, a well field was put into operation in 1972. The field contains 63 wells with pumps and concrete lined laterals. The water is collected in a canal flowing westerly to San Luis for irrigation. This pumping by Mexico from the underground reservoir tends to deplete groundwater underlying both the United States and Mexico. The groundwater basin is straddled by the international boundary. Further, the water pumped on the Mexican side came originally from the Colorado River, in that the water used to irrigate the mesa lands in the Yuma area was diverted from the Colorado. After being placed on the fields in Arizona, it gradually percolated down, forming a mound of groundwater. Since Mexico was pumping water from this underground base, it was really taking Colorado River water which was not charged against the Mexican allocation under the Treaty of 1944, "since underground flow across the border is not considered as 'deliveries in satisfaction of the Treaty.'" Bradley & DeCook, *supra* note 7, at 37. *See* Treaty Respecting Utilization of Waters of the Colorado and Tijuana Rivers and of the Rio Grande, Feb. 3, 1944, 59 Stat. 1291, T.S. No. 944 (effective Nov. 8, 1945). In order to avoid a "pumping war" between the two countries, the governments of the United States and Mexico agreed to limit to 160,000 acre feet annually pumping of groundwaters within five miles of the Arizona-Sonora boundary near San Luis.
    2. In the Nogales region, the municipal and industrial uses of both the city of Nogales, Sonora, and the city of Nogales, Arizona, are sup-

The situation of a near legal vacuum is not unique to the United States-Mexican frontier, since only recently has much attention been directed to groundwater resources. Hayton observed that "traditionally there has been a failure to focus on the regulation and management of ground water in most legal systems."[9] Professor Clark added that, "Legislative attention to the physical relationship between surface and ground-water sources is scarcely older than the concern for pollution."[10] It has been, in fact, a question of being out of sight and out of mind. The primary attention of domestic water law has been focused on surface water, and there is an almost complete lack of groundwater practice at the international level. There are some treaties, such as the agreement between Poland and the USSR, signed at Warsaw on July 17, 1964,[11] which refer to groundwaters. That treaty came into force on February 16, 1965, through an exchange of the instruments of ratification at Moscow, and in a general way includes groundwaters "intersected by the State frontier" in frontier waters.[12] There is also Minute 242 between the United States and Mexico, which limits pumping on both sides of the frontier in the Yuma area,[13] and the Interna-

---

plied by groundwater. On the Mexican side, there are well fields along the Santa Cruz River to supply the city of Nogales, Sonora. On the Arizona side, five wells supply the city of Nogales, Arizona. The Santa Cruz River, which rises in Arizona, flows into Sonora and then loops back into Arizona so that the city of Nogales, Sonora, is in fact upstream from the city of Nogales, Arizona. The wells of the city of Nogales, Arizona, show an immediate response to river flows in the Santa Cruz, so that the depth of water in the city's wells fluctuates from thirty to eighty feet. Thus, with both cities looking to the same limited water supplies for their survival there is potential for conflict between the two countries as population continues to grow on both sides of the international boundary. Bradley & DeCook, *supra* note 7, *passim*.

3. The metropolitan area of Ciudad Juarez, Chihuahua, and El Paso, Texas, has nearly one million inhabitants. Both cities depend largely on shared groundwater reservoirs for their municipal water supplies. Studies indicate that both sides are now pumping water at a rate faster than the groundwater reservoir is being recharged. *See* Day, *supra* note 7, at 168-69.

9. Hayton, *supra* note 1, at 275.
10. Clark, *Western Ground-Water Law*, in 5 WATERS AND WATER RIGHTS § 440, at 411 (R. Clark ed. 1972). *See also* Fischer, *Management of Interstate Groundwater*, 7 NAT. RESOURCES LAW. 521, 523 (1974); Harnsberger, *Nebraska Ground Water Problems*, 42 NEB. L. REV. 721 (1963); Moses, *The Law of Ground Water—Does Modern Buried Treasure Create a New Breed of Pirates?*, 11 ROCKY MTN. MINERAL L. INST. 277 (1966); Teclaff, *supra* note 6, at 57.
11. Agreement concerning the use of Water Resources in Frontier Waters, July 17, 1964, Poland-U.S.S.R., No. 8054, 552 U.N.T.S. 188 (1966).
12. *Id.* art. 2, n.2.
13. *Text of IBWC Minute No. 242*, 69 DEPT. STATE BULL. 395, 396, res. 5 (1973), *reprinted in* 15 NAT. RESOURCES J. 2, 6 (1975).

tional Boundary and Water Commission (IBWC) has dealt successfully with groundwater problems on a pragmatic, ad hoc basis; but, by and large, groundwaters have not been a matter of concern at the international level. As in the case of groundwaters generally, "[i]t is more a case of non-management than one of mismanagement."[14]

Teclaff points out that frequently groundwater has not been included in the established surface water law regime: "[I]t was thought quite adequate to treat groundwater either as part of the land . . . or as a commodity, susceptible of ownership through the act of capturing it by sinking a well."[15] For example, under Spanish law, which has influenced the groundwater law in Latin America and the Philippines, "ground waters have traditionally belonged to the owner of the superjacent land."[16] English common law has also given absolute ownership to groundwaters to the superjacent property owner. For example, Wells Hutchins states that the English common law doctrine

> [i]n its original form . . . accords exclusive property rights in the water to the landowner; *it gives him the right to pump out the water at any time and in any quantity*, for any legitimate enterprise, either on or off the overlying land. . . . But if the effect of heavy pumping by a landowner, while engaged in any legitimate enterprise, . . . is to exhaust the ground-water supply of his neighbor by drawing all the water from the substrata of the latter's tract into his own heavily pumped well, it cannot become the ground of an action.[17]

Texas follows the English common law doctrine, and the Texas law of groundwater has been summarized as "you can steal your neighbor's water, but you can't pollute his well."[18]

It has been suggested that "the problem, then, for water lawyers and administrators, is to fashion a legal regime and a management machinery"[19] which will be integrated in order to achieve the optimum sustained yield of a nation's, or a region's, total water resources.

The purpose of this article is to suggest possible legal regimes and management machinery to manage the groundwater resources intersected by the United States-Mexican frontier.

---

14. Hayton, *supra* note 1, at 284.
15. Teclaff, *supra* note 6, at 57.
16. Hayton, *supra* note 1, at 278.
17. Hutchins, *Reasonable Beneficial Use in the Development of Ground Water Law in the West*, in GROUND WATER ECONOMICS AND THE LAW 24 (Western Agric. Econ. Res. Council Comm. on Econ. of Water Resources Dev., Rep. No. 5, 1956) (emphasis added).
18. Tyler, *Underground Water Regulation in Texas*, 39 TEX. B. J. 532, 533 (1976).
19. Hayton, *supra* note 1, at 293.

II. THE ECONOMIC CONTEXT

Under the common law doctrine, each owner's right to the water itself, or the right to use the water, is insecure because other pumpers may take possession of the mobile resource at any time.[20] Accordingly, the individual surface owner is encouraged to exploit the groundwater resource as quickly as possible, so that the fluid and mobile water resource will not be captured by others:

> [The d]efinite property rights belong only to those who are in possession—that is, who get there "fustest with the mostest." Every user tries to protect himself against others by acquiring ownership through capture in the fastest possible way. Deferred use is always subject to great uncertainty; others may capture the resource in the meantime.[21]

It has also been noted that

> in the absence of effective social institutions to guide resource use, private groundwater use can be predicted eventually to generate excessive investment and extraction costs; induce a pumping rate which is greater than socially optimal, and which may lead to irreversible depletion; dissipate economic rent or producer surplus, and in general create economic waste and resource inefficiency.[22]

This situation thus leads to great insecurity for all existing users of water from an aquifer, although the concepts of "security" and "flexibility" are essential criteria for an adequate water rights system.[23] Underlying the concept of physical security is the premise that holders of groundwater rights must have a reasonable degree of certainty—the supply of water must not be unreasonably uncertain. Ordinarily, the physical supply of groundwater is more secure than surface water, since the aquifer frequently stores water in seasons and years of heavy rain and above average recharge. This stored water can then be used in seasons and years of lower rain fall and lower recharge.

In addition, however, there is the factor of "tenure security."[24] Tenure security does not refer to reliability of supply, but to the effect of human actions on the reliability of supply, that is, the security of the land owner from the unreasonable use or export of groundwater by his neighbor. The common law rule of absolute ownership obviously increases tenure insecurity because it countenances the unrestrained right of one's neighbor

20. *See* S. CIRIACY-WANTRUP, RESOURCE CONSERVATION, ECONOMICS AND POLICIES, 141-45 (3d ed. 1968).
21. *Id.* at 142.
22. Veeman, *Water Policy and Water Institutions in Northern India: The Case of Ground Water Rights*, 18 NAT. RESOURCES J. n.p. (1978).
23. Ciriacy-Wantrup, *Concepts Used as Economic Criteria for a System of Water Rights*, in ECONOMICS AND PUBLIC POLICY IN WATER RESOURCE DEVELOPMENT 251-71 (S. Smith & E. Castle eds. 1964).
24. *Id.* at 253.

to pump all the water he may need, without restraint or liability to other overlying owners for any adverse effects of his pumping. This has the economic effect of stimulating investment in groundwater development because of the uncertainty of one's property right over this "fugitive resource."[25] There is an incentive to each land owner to protect himself against his neighbor's lawful acts by capturing as much of the resource as quickly as possible. Therefore, there is an economic incentive for overinvestment and for depletion, rather than for conservation of the resource.

This conceptual approach has been elaborated on by Kelso, Martin, and Mack:

> Two aspects of water rights most significant for an understanding of men's behavior relative to water and to one another over water are: (1) . . . that whatever rights they hold to water and its use will be stable and dependable over time, and (2) the flexibility permitted to them to effect changes in use and location of use of the water covered by their rights, and to acquire and transfer water rights from and to others. . . . Security and flexibility are the twin essences of socially efficient property relations.[26]

Thus, the twin concepts of flexibility and security require that owners of groundwater rights have security in their use and that groundwater rights be readily transferable between uses and users. As Veeman points out, "the indefiniteness of property rights associated with a fugitive resource such as groundwater leads to its rapid development and, perhaps, depletion."[27]

Specifically, in regard to the situation along the United States-Mexican border, it cannot be said that water users have security in their expectations, nor can it be said that whatever rights they hold to water and its use will be stable and dependable over time. Quite the contrary, there are (1) projections for growing population along both sides of the border, (2) a situation in which no state north of the border (with the exception of New Mexico) has legal institutions adequate to control pumping, and (3) no international control except at Yuma under the interim arrangement of Resolution 5 of Minute 242,[28] which can prevent either nation from "stealing its neighbor's water."[29] Therefore, a situation exists which encourages each nation to outdo its neighbor by developing its groundwater resources as

25. *Id.* at 258-60.
26. M. KELSO, W. MARTIN & L. MACK, WATER SUPPLIES AND ECONOMIC GROWTH IN AN ARID ENVIRONMENT: AN ARIZONA CASE STUDY 52, 54 (1973).
27. Veeman, *supra* note 22, at 20.
28. *Text of IBWC Minute No. 242*, *supra* note 13, at 396, res. 5.
29. Tyler, *supra* note 18, at 532.

rapidly as possible, perhaps even to the point of depletion of the groundwater resource.

The legal situation encourages overdevelopment; overdevelopment results in over investment in developing the resource and, therefore, both economic waste and resource waste are likely due to the insecurity arising from inadequate institutional controls. Moreover, the increase in use by one pumper can lead to increasing the marginal costs of the second pumper. In cases in which overdraft occurs,

> the private pumper who, through extraction of water, causes drawdown in nearby wells, bears only his private costs of additional withdrawal. Part of the cost of additional pumping is imposed on neighboring users whose conditions of pumping are adversely affected. In these circumstances, the private marginal costs of pumping by the individual user are less than the social marginal cost—a classic case of technological external diseconomy.[30]

In addition to the depletion of the aquifer, the extraction of groundwater can affect the quality of the water by lowering the water table or hydrostatic pressure "so as to allow adjoining, contaminated waters to flow into the reservoir."[31] The following possible economic ramifications of deteriorating groundwater conditions have been projected:

> Crop yields will decrease; there will be efforts to shift to other crops or activities in the zone, and abandonment of formerly productive economic activity. There will be increased costs to industry to treat water prior to use, or it will be necessary to bring in acceptable water from elsewhere. As the water table is lowered, there is increased consumption of energy for the additional lifting by pumps, and wells will need to be deepened, or new wells sunk, to tap the same aquifer. Outmigration of the affected population and changes in gainful activities will result in dislocations affecting economic planning . . . . Finally, it is likely that there will be important impacts on the development and conservation of other resources resulting from deteriorated ground water conditions, where dependence on that source for water is significant.[32]

The history of groundwater development presents a "general picture . . . of more recent resort to ground water . . . without an adequate understanding of the physics of the resource and without regard, generally speaking, for the future."[33]

III. ALTERNATIVE INSTITUTIONAL OPPORTUNITIES

In suggesting possible institutional arrangements for the management of transboundary resources between the United

30. Veeman, *supra* note 22, at 24.
31. Fischer, *supra* note 10, at 522.
32. Hayton, *supra* note 1, at 286.
33. *Id.* at 275.

States and Mexico, it is necessary to consider in addition to the twin criteria of security and flexibility, the goal of avoiding conflict between the two countries, and the fundamental goal of the public interest in providing "for an orderly development of ground-water supplies, in the interest of the best utilization of this natural resource."[34]

A system should be devised which will reduce the likelihood of water users on one side of the international boundary adversely affecting water users on the other side of the boundary, thereby causing conflict between the two countries.

IV. POSSIBLE MANAGEMENT OPTIONS

A. Option 1: The Status Quo Ante

The first option would be to leave the situation largely as it is, following the essentially laissez-faire English common law doctrine allowing each country on each side of the boundary to use and exploit the groundwater resources on its respective side as it sees fit, without regard to its neighbor. This would lead to (1) neither of the water users having security in that resource, (2) uneconomic development of the resource by encouraging overly rapid development, (3) increased marginal cost to all exploiters of the resource, and (4) encouragement of the depletion of the resource. It, therefore, would not provide the security essential to a good groundwater system. Further, at some point it inevitably would lead to conflict between the two countries which, if not settled amicably by agreement, might be taken to the International Court of Justice or an arbitral tribunal. This scenario is not an attractive one. Friction between the two countries and potential for conflict would be raised to undesirable levels, and the economic waste caused by over-rapid development would already have occurred, as well as undoubtedly substantial damage to the groundwater resources due to excessive withdrawals. In addition, it is always hard to assess the perils and uncertainties of resort to litigation.

B. Option 2: Correlative Rights

Another possible approach would be to establish the doctrine of correlative rights over transboundary aquifers, but this, too, has serious drawbacks. The correlative rights doctrine may be viewed as a limitation on the common law rule,[35] in that, as used in California, the landowner has the right to make use of

---

34. W. HUTCHINS, SELECTED PROBLEMS IN THE LAW OF WATER RIGHTS IN THE WEST 178 (U.S. Dept. Agric. Misc. Pub. No. 418, 1942).

35. Clark, *supra* note 10, § 441, at 413.

the waters underlying his lands subject to the co-extensive and co-equal rights existing in adjoining landowners. Thus, a surface owner's right to use the underlying waters is not unlimited as under the common law rule, but limited by co-extensive and co-equal rights of adjoining landowners.[36]

The formula for prorationing an aquifer has been expressed as follows: "[I]n a time of water shortage each landowner is said to have a share of the underlying water in proportion to the amount of land he owns as compared with the total area supplied by the common water source."[37] This prorationing of the overall pool contemplates that the total pie can be cut into smaller and smaller pieces, so that one individual piece of the pie at the time of development and investment can be reduced to the point of inefficiency. This means that the traditional correlative rights doctrine contains a large element of insecurity in that there is no limit on the number of pumpers that can begin pumping at any time, since the right to exploit the water is not lost by failure to appropriate, abandonment, or disuse. The New Mexico Supreme Court, in *Yeo v. Tweedy*,[38] stated:

> According to the "correlative rights" doctrine, each overlying owner would have the same right—the right to use whenever he saw fit. The right does not arise from any appropriation to beneficial use, which develops the resources of the state. It is not lost or impaired by nonuse. Regardless of the improvements and investments of the pioneers, later comers or later developers may claim their rights. The exercise of those rights which have been in abeyance will frequently destroy or impair existing improvements, and may so reduce the rights of all that none are longer of practical value, and that the whole district is reduced to a condition of nonproductiveness. The preventive for such unfortunate and uneconomic results is found in the recognition of the superior rights of prior appropriators. Invested capital and improvements are thus protected. New appropriations may thus be made only from a supply not already in beneficial use. Nonuse involves forfeiture. A great natural public resource is thus both utilized and conserved.[39]

The correlative rights doctrine has been referred to as one of "equalitarian rigidity" which "provides little assurance to developers unfamiliar with the hydrologic data necessary to estimate long range water supply and takes no account of the relative values of different uses to the community."[40] Moreover, it is argued that the correlative rights theory does not

---

36. 2 W. HUTCHINS, WATER RIGHTS LAWS IN THE NINETEEN WESTERN STATES 670 (completed by H. Ellis & P. DeBral, U.S. Dept. Agric. Misc Pub. No. 1206, 1974).
37. M. MCDOUGAL & D. HABER, PROPERTY, WEALTH, LAND 993 (1948).
38. 34 N.M. 611, 286 P. 970 (1929).
39. *Id.* at 620, 286 P. at 974.
40. M. MCDOUGAL & D. HABER, *supra* note 37, at 993.

"succeed in removing the basic drawbacks of judicial administration of groundwater distribution. The hydrologic data required . . . are difficult to obtain and the courts do not have adequate staffs to do the necessary fact gathering job"[41] to provide continuing supervision. It might be postulated that an international agency such as the International Boundary and Water Commission (IBWC) could supervise a correlative rights approach and make the necessary calculations and technical and engineering studies in order to assure that correlative rights are diminished equally as new appropriators begin to exploit the water under their land. However, the security of existing water uses would still be inadequately protected, and the flexibility of transfer would also be inadequate unless the traditional doctrine were significantly modified.[42]

C. Option 3: Management

1. *Variation A (Equitable Apportionment)*

There is a spectrum of possible variations on the option of establishing institutional mechanisms for managing the resource. One would be to grant the IBWC the following powers:

1. jurisdiction over groundwaters intersected by the international boundary;
2. comprehensive authority to make the engineering studies

---

41. *Id.* The development of the law and management of oil and gas provides some historic parallels. William Onorato traces this development and points out that the early law of unregulated production or unrestricted capture gave way to the doctrine of correlative rights and duties between owners in a common source. The doctrine of correlative rights in turn has been replaced by rules

> requiring cooperative development of a shared petroleum resource pool. . . . The laws of a majority of oil-producing nations specifically provide that when an oil-bearing structure is located in two or more tracts belonging to two or more different owners and thus the source of dispute between them as to apportionment, the interested parties are obliged to adopt a unitised plan of development under which competition is now altogether eliminated and co-operation is required on co-ordinating such points as number and spacing of wells tapping the common source.

Onorato, *Apportionment of an International Common Petroleum Deposit*, 17 INT'L & COMP. L.Q. 85, 92 (1968).

42. There is nothing sacrosanct about a particular doctrine which should make it immutable. For example, there is nothing inherent in the doctrine of correlative rights which would make it impossible to limit the total number of water users, or provide for forfeiture or abandonment, but unfortunately it seems that "[a] doctrinal label brings an automatically prepackaged assortment of rules." C. CORKER, GROUNDWATER LAW, MANAGEMENT AND ADMINISTRATION 112 (Nat'l Water Comm'n 1971).

necessary to determine such information as the area, depth to water, aquifer thickness, volume, quality, quantity, anticipated yields, transmissibility and recharge rate of an aquifer. IBWC could determine allowable levels of withdrawal in order to maintain a sustained yield from the aquifer or a calculated mining plan. It should be noted that the IBWC is already gathering this type of data;[43]

3. responsibility to identify and declare designated international groundwater areas which have reasonably ascertainable boundaries; and
4. authority to apportion the waters of the aquifer and close the area to withdrawals beyond the allowable as determined by the physical criteria of the aquifer.

This approach would follow roughly the current practice of the state of New Mexico, in which the State Engineer has jurisdiction over declared basins that have "reasonably ascertainable boundaries,"[44] and has power to close these declared basins to further withdrawals.[45] The IBWC, rather than waiting for development to reach the point at which a safe yield of the aquifer were threatened, could apportion in advance the groundwaters intersected by the boundary on its own initiative. Various alternative methods conceivably could be suggested as guidelines in calculating the division: (1) the amount of water that each nation would receive could be based upon the amount of recoverable water underlying each nation; or (2) the amount of water could be based upon the relative surface areas of each nation overlying the water—each nation would receive the proportionate share of the groundwater that its surface area reflected in proportion to the total surface area overlying the aquifer. Both of these approaches would require much more

43. Interview with government officials (Feb. 1978). *See* Day, *supra* note 7, at 176.

44. N.M. STAT. ANN. § 75-11-1 (1968). This proposal is not unlike the 1973 Oklahoma statute, OKLA. STAT. ANN. tit. 82, § 1020.5 (West Supp. 1977), which

> proposes to assign each landowner a specific quantity of water based on a percentage of the hydrologically determined yield of the basin. His allocation is to be measured, acre for acre, by the relationship his ownership bears to the total acreage overlying the basin. . . . Under this system each landowner receives a quota, as it were, which he can retain or dispose of and which will exhaust his interest.

Clark, *The Role of State Legislation in Ground Water Management*, 10 CREIGHTON L. REV. 469, 482 (1977).

45. For further discussion, see Clark, *New Mexico Water Law Since 1955*, 2 NAT. RESOURCES J. 484, 496 (1962).

study.[46] There is, in fact, some international practice in apportioning shared petroleum resources.[47]

---

46. The formula for division might be a variation of the correlative rights prorationing formula: each country would have a share of the underlying water in proportion to the amount of its land supplied by the groundwater source within the designated groundwater area as compared to the total area supplied by the groundwater source. This approach is designed for agricultural uses, and does not comfortably suit an urban situation or mixed agricultural-urban context.

A corrolary formula might be that each country would have a share of the underlying water in proportion to the amount of water presently being beneficially used by it as compared with the water being beneficially used by the other country. This would appear to have serious objections in that it would freeze the future use patterns in conformance to existing patterns. The division could also be based upon the guidelines of the Helsinki Rules regarding surface waters. *See* note 60 and accompanying text *infra*.

If the parties were unable to reach agreement on the division of the water, it might be useful to borrow a lead from the last best offer concept of labor relations. Under this concept, each nation could choose one member of an arbitration panel, and then those two would select a third arbitrator with the power to choose the proposal he or she considered most equitable, each nation submitting a proposal of what it considered to be an equitable division of the aquifer. The presiding arbitrator would determine which offer he or she considered most fair, but would not be able to amend the offer, or to compromise between the two offers, thereby assuring that each nation would be motivated to present as reasonable an offer as possible. The proposals of the two nations would thus be brought relatively close to each other because an unreasonable or extreme offer would stand no chance of being accepted.

47. Two of these binational agreements are

> the agreement between the Federal Republic of Germany and the Kingdom of the Netherlands on apportioning common petroleum deposits in the Ems River estuary, and the agreement between Austria and Czechoslovakia co-ordinating exploitation of a common field of natural gas in the Zwernsdorf-Vysoka frontier region between the two countries. . . .
>
> The former agreement between Germany and Holland provides for joint development of any common petroleum fields found to exist in the frontier area of the Ems River estuary. The agreement clearly provides that concessionaires of each contracting State shall be entitled to equal shares of the produce of extraction. Under provisions of the agreement possession gained by actual extraction by either party is irrelevant to determining the apportionment of the reserve. Regardless of disproportionate production by either German or Dutch interest-holders, the total volume of crude oil extracted is pooled and divided equally between them as are the costs of such extraction. . . . In effect the agreement creates a form of international unitised production aimed at the primary goal of insuring maximum production gained by efficient and co-ordinated programming of exploitation schemes.
>
> The agreement between Austria and Czechoslovakia over division of common gas fields lying in the Zwernsdorf-Vysoka frontier area . . . provides for the establishment of a joint commission composed equally of representatives of each of the contracting States. The commission receives the reports of a panel of petroleum geologists and experts and from them calculates the reserves in the deposit, fixes the production rate and allocates production quotas to each State. The commission also approves of and regu-

Once the division of the groundwater was made, regardless of the method followed in arriving at the division determination, the internal administrative water machinery of each nation would be responsible for allocating that nation's share of the aquifer according to its water laws and administrative procedures. This would have the advantage of providing security for investment in water resources on each side of the border. It would prevent the possibility of pumping wars, since each side would know with certainty the amount of water to which it was entitled. Further, the resource would not be threatened through uncontrolled exploitation, and the potential for conflict between the two countries would be reduced.

In addition, ideally there should be flexibility for transfers of water rights from one use to another, and from one user to another, including transfers of water rights across the boundary. This, perhaps, could be accomplished by term sale arrangements, somewhat akin to a lease, so that if there were a surplus which was going unused in the allocation of one country, and the other country had an excess of demand over its allocation, it would be possible to buy the water from the other country's allocation and use the water on the other side of the border. However, realistically, one would have to suggest that not only would such a transfer be politically impossible, but also probably legally impossible under existing law which would have to be preempted by a treaty. For example, New Mexico law prohibits such transfers.[48]

2. *Variation B (Case-by-Case Negotiation)*

Granting the IBWC the power to identify and declare "designated international groundwater areas" and the authority to apportion the waters of such designated aquifers will be controversial and undoubtedly strongly opposed. The difficulty in obtaining such a treaty cannot be overestimated. Therefore, a

---

> lates all exploitation procedures employed by either side. In fixing the production rate so far the commission has favoured Austria in a ratio of 14:1 on the basis, it appears, of such technical considerations as reserves in place under each State's territory and the relative cost/profit ratios that would otherwise obtain if the deposit was being worked individually instead of co-operatively under an international joint commission.

Onorato, *supra* note 41, at 97-98.

48. "No person shall withdraw water from any underground source in New Mexico for use in any other state . . . ." N.M. STAT. ANN. § 75-11-20 (1968). *See also* Comment, *"It's Our Water"—Can Wyoming Constitutionally Prohibit the Exportation of State Waters?*, 10 LAND & WATER L. REV. 119 (1975). In some jurisdictions, such as Switzerland and Turkey, neighbors are obligated to share surplus waters. *See* Teclaff, *supra* note 6, at 185.

less far-reaching option would be a case by case or aquifer by aquifer approach. Individual agreements would be negotiated for each groundwater area as problems arose using a variety of engineering and legal measures, including the negotiated apportionment of the waters of the aquifer. This approach would very possibly vary from basin to basin and agreements, therefore, would have to be reached by treaty on a basin to basin basis. This could be termed the pragmatic, case by case approach—pragmatic both politically and technically. This is in fact a description of the present state of affairs. For example, pumping in the Yuma area was dealt with in Minute 242 which limited pumping within five miles of the border to 160,000 acre feet per year.[49] The IBWC is carrying on a data exchange program and an aerial surveillance program to identify groundwater developments and potential trouble spots. The IBWC is keenly aware of possible stress points such as in Ciudad Juarez-El Paso, Nogales, and the Colorado Delta areas.[50]

The problem with such a basin to basin and treaty to treaty approach is that problems such as these are so difficult to get on the national agenda that they tend to be shelved until a crisis is reached. If it were politically possible, it would be desirable to give the IBWC continuing authority to designate groundwater areas and, therefore, control withdrawals before the crisis point is reached.

3. *Variation C (Comprehensive Management)*

A third variation of the management option would be to give the IBWC the complete spectrum of administrative powers from investigation and planning to rule making and enforcement. This would put it not only into the investigative, engineering, and planning functions, but also into the regulatory and enforcement end of the administrative process. This, perhaps, would be the ideal approach, but the least likely to be accepted. It would empower the IBWC to control withdrawals, and thereby preserve the resource, providing security to water users at the time. It would also allow the IBWC to plan for and carry out policies which would be responsive to changing conditions. Undoubtedly this would be objected to as the creation of a super agency, and would expose the IBWC to the criticism and controversy caused by an international agency being placed in the business of enforcement inside the domestic boundaries of a sovereign nation.

---

49. *Text of IBWC Minute 242, supra* note 13, at 395-96, res. 5.
50. Interview with government officials (Feb. 1978).

D. Option 4: International Litigation

Whichever of the above options, or combinations of options, might be chosen, it would undoubtedly be better for the two countries to reach agreement on a binational basis rather than allowing the problem to become so intense as to require litigation before the International Court of Justice or a tribunal of arbitration,[51] with all of the perils, uncertainties, and delay that litigation entails.[52]

The problem, succinctly stated, is that there is a limited supply of groundwater along this international frontier, and that both the United States and Mexico are facing the prospect of greater demand because of increased population. It would be highly desirable that the nations involved be rational enough to anticipate the situation before it reaches crisis proportions. The United States and Mexico should, by agreement, establish the means for managing the resource and avoiding damaging disputes between the two countries. Resolution 5 of Minute 242 contemplates such an agreement.[53]

The courts, too, undoubtedly, would prefer that the parties settle the matter between themselves, rather than resorting to litigation. A recent example of this judicial attitude is the North Sea controversy, in which the International Court of Justice remanded the dispute to the parties for negotiation and agree-

---

51. The Inter-American Arbitration Treaty was developed at the Havana Conference in 1929, and ratified by the Senate of the United States in 1935. It provides in part:

> The High Contracting Parties bind themselves to submit to arbitration all differences of an international character which have arisen or may arise between them by virtue of a claim of right made by one against the other under treaty or otherwise, which it has not been possible to adjust by diplomacy and which are juridical in their nature by reason of being susceptible of decision by application of the principles of law.
>
> There shall be considered as included among questions of a juridical character:
> a) The interpretation of a treaty;
> b) Any question of international law;
> c) The existence of any fact which, if established, would constitute, a breach of an international obligation;
> d) The nature and extent of the reparation to be made for the breach of an international obligation.

Inter-American Arbitration Treaty With Other American Republics, Jan. 5, 1929, 49 Stat. 3153, 3158, T.S. No. 886, at 6 (effective April 16, 1935). For a discussion of the agreement, see Meyers & Noble, *The Colorado River: The Treaty with Mexico*, 19 STAN. L. REV. 367, 400-02 (1967).

52. For a comprehensive discussion of dispute settlements ranging from "referral to government" to arbitration and the International Court of Justice, see *Management of International Water Resources: Institutional and Legal Aspects*, U.N. Doc. ST/ESA/5 144 (1975).

53. *Text of IBWC Minute No. 242, supra* note 13, at 396, res. 5.

ment on their maritime boundaries in the North Sea.[54] The United States Supreme Court made the point clearly in a water quality case when it stated: "We cannot withhold the suggestion . . . that the grave problem of sewage disposal . . . is one more likely to be wisely solved by cooperative study and by conference and mutual concession on the part of representatives of the States so vitally interested in it than by proceedings in any court however constituted."[55] The Court, in *Colorado v. Kansas*,[56] further elaborated:

> The reason for judicial caution in adjudicating the relative rights of States in such cases is that . . . they involve the interests of quasi-sovereigns, . . . of interstate differences of a like nature, that such *mutual accommodation and agreement should, if possible, be the medium of settlement, instead of the invocation of our adjudicatory power*.[57]

Ward Fischer concludes that, in regard to interstate groundwater problems in the United States, there are "two apparently viable alternatives . . . : [t]he interstate compact, and litigation between the states."[58] However, he is pessimistic in his assessment of the likelihood of the states reaching agreement before the crisis point is reached and resort to the courts is necessary:

> Our conclusion must be that the interstate compact is by far the most effective, most sound, most flexible, and over-all most satisfactory approach that can be recommended. Regrettably, our conclusions must also be that, between these two alternatives, it is also the less likely; that litigation between the states resulting in equitable apportionment of available ground waters can be expected, unless there is an unprecedented awakening to responsibility and to reality among the water users and water administrators of the affected states.[59]

54. *North Sea Continental Shelf Cases*, 63 AM. J. INT'L L. 591 (1969).
55. New York v. New Jersey, 256 U.S. 296, 313 (1921).
56. 320 U.S. 383 (1943).
57. *Id.* at 392 (emphasis added).
58. Fischer, *supra* note 10, at 546.
59. *Id.* The discussion in the United States has been going on for some time. In 1961, the Senate Committee's final report commented that "[i]t is possible that where underground aquifers cross State boundaries consideration will have to be given to interstate compacts to control ground water withdrawals, to prevent one State from exhausting water supplies used by another State." S. REP. No. 29, 87th Cong., 1st Sess. 58 (1961). *See also* J. MUYS, INTERSTATE WATER COMPACTS (1971).

In fact, the more modern interstate compacts are now expressly dealing with groundwaters to some degree. For example, the 1969 Niobara River Compact between Wyoming and Nebraska recognizes that groundwater withdrawals may affect the depletion of the Niobrara. Act of Aug. 4, 1969, Pub. L. No. 91-52, 83 Stat. 86. The Blue River Compact of 1971 between Kansas and Nebraska includes groundwater infiltration as part of the natural flow of the stream. Act of June 2, 1972, Pub. L. No. 92-308, 86 Stat. 193. The Delaware River Basin Compact (Delaware, Pennsylvania, New Jersey, New York, and the United States 1965) recognizes the interrelation-

The record of dealing with joint water problems between the United States and Mexico is a good one, and leaves some room for hope, perhaps even optimism, that Mexico and the United States may be able to handle the problem in advance by agreement rather than by resort to international litigation. "In any event, we must expect that our international conflicts will not be limited to surface waters, but rather that, sooner or later, we must grapple with the depletion and pollution of international underground waters."[60]

In the event a groundwater question between Mexico and the United States resulted in litigation, the court undoubtedly would conclude that a nation does not have absolute territorial sovereignty and that it cannot act in disregard of its neighbor.[61]

In the interstate water litigation between Wyoming and Colorado, the United States Supreme Court reached an analogous conclusion:

> The contention of Colorado that she, as a State rightfully may divert and use, as she may choose, the waters flowing within her boundaries in this interstate stream, regardless of any prejudice that this may work to others having rights in the stream below her boundary, can not be maintained. The river throughout its course in both States is but a single stream, wherein each State has an interest which should be respected by the other.[62]

The International Court, if given the case by agreement of the parties, would no doubt also look with favor upon the language of the Supreme Court[63] in a suit by Kansas against Colorado for equitable apportionment of the Arkansas River:

ship of ground and surface waters and declares that "'Water resources' shall include water and related national resources in, on, under, or above the ground, including related uses of land, which are subject to beneficial use, ownership or control." Act of Sept. 27, 1961, Pub. L. No. 87-328, 75 Stat. 688, 690. *See also* Hayton, *Institutional Alternatives for Mexico-U.S. Groundwater Management*, 18 NAT. RESOURCES J. 201 (1978).

60. Fischer, *supra* note 10, at 545.

61. *See* Utton, *International Streams and Lakes*, in 2 WATERS AND WATER RIGHTS 422 (R. Clark ed. 1967).

62. Wyoming v. Colorado, 259 U.S. 419, 466 (1922). *See* Wyoming v. Colorado, 286 U.S. 494 (1952).

63. In the Trial Smelter international arbitration, which involved transboundary air pollution, the Tribunal, by agreement of the parties, relied heavily on U.S. interstate decisions:

> There are, however, as regards, both air pollution and water pollution, certain decisions of the Supreme Court of the United States which may legitimately be taken as a guide in this field of international law, for it is reasonable to follow by analogy, in international cases, precedents established by that court in dealing with controversies between States of the Union or with other controversies concerning the quasi-sovereign rights of such States, where no contrary rule prevails in international law and no reason for rejecting such precedents can be adduced from the limitations of sovereignty inherent in the Constitution of the United States.

Trail Smelter Arbitral Decision, 35 AM. J. INT'L L. 684, 714 (1941).

> Whenever . . . the action of one State reaches through the agency of natural laws into the territory of another State, the question of the extent and the limitations of the rights of the two States becomes a matter of justiciable dispute between them, and this court is called upon to settle that dispute in such a way as will recognize the equal rights of both and at the same time establish justice between them.[64]

The much quoted *International Trail Smelter* case, although dealing with air pollution, would also be relevant for it states

> that, under the principles of international law, . . . no State has the right to use or permit the use of its territory in such a manner as to cause injury by fumes in or to the territory of another . . . when the case is of serious consequence and the injury is established by clear and convincing evidence.[65]

Thus, an international tribunal undoubtedly would reject the international law equivalent of the common law doctrine—absolute territorial sovereignty. It would, instead, look to the Helsinki Rules for guidance in settling a case on the basis of equitable utilization.[66] The Helsinki Rules were promulgated in 1966 by the International Law Association to govern the use of international water resources. They provide in Article V:

> (2) Relevant factors which are to be considered include, but are not limited to:
> (a) The geography of the basin, including in particular the extent of the drainage area in the territory of each basin State;
> (b) The hydrology of the basin, including in particular the contribution of water by each basin State;
> (c) The climate affecting the basin;
> (d) The past utilization of the waters of the basin, including in particular existing utilization;
> (e) The economic and social needs of each basin State;
> (f) The population dependent on the waters of the basin in each basin State;
> (g) The comparative costs of alternative means of satisfying the economic and social needs of each basin State;
> (h) The availability of other resources;
> (i) The avoidance of unnecessary waste in the utilization of waters of the basin;
> (j) The practicability of compensation to one or more of the co-basin States as a means of adjusting conflicts among uses; and
> (k) The degree to which the needs of a basin State may be satisfied, without causing substantial injury to a co-basin State.
> (3) The weight to be given to each factor is to be determined by its importance in comparison with that of other relevant factors. In determining what is a reasonable and equitable share, all relevant factors are to be considered together with a conclusion reached on the basis of the whole.[67]

---

64. Kansas v. Colorado, 206 U.S. 46, 97-98 (1907).
65. *Trail Smelter Arbitral Decision*, *supra* note 63, at 716.
66. Utton, *supra* note 61, at 422.
67. The Helsinki Rules on the Uses of the Waters of Int'l Rivers, art. 5, in *Management of International Water Resources: Institutional and Legal Aspects*, U.N. Doc. ST/ESA/5 188-89 (1975).

Similarly, the United States Supreme Court has said that equitable apportionment

> calls for the exercise of an informed judgment on a consideration of many factors. Priority of appropriation is the guiding principle. But physical and climatic conditions, the consumptive use of water in several sections of the river, the character and rate of return flows, the extent of established uses, the availability of storage water, the practical effect of wasteful uses on downstream areas, the damage to upstream areas as compared to the benefits to downstream areas if a limitation is imposed on the former—these are all relevant factors. They are merely an illustrative, not an exhaustive, catalogue. They indicate the nature of the problem of apportionment and the delicate adjustment of interests which must be made.[68]

The problem with litigation is that the question is referred to the court as a last resort when the crisis has already been reached. The courts deal in a case by case, after-the-fact manner, and are not in a position to anticipate the problem, and to engage in the long term planning and management of the resource that is desirable if optimum use is to be achieved.

Further doubts about leaving groundwater questions to the courts were raised some years ago:

> The hydrologic data required for adequate information about supply, evaporation and movement of groundwater are difficult to obtain and the courts do not have adequate staffs to do the necessary fact gathering job. Consequently, the parties must supply the experts at great expense. . . . Moreover, the courts . . . have a long record of ignoring scientific development in this field and are certainly not expert agencies from an engineering perspective. . . .[69]

However, the most important shortcoming of the courts is the after-the-fact, ad hoc nature of their jurisdiction. Tribunals are not equipped to provide the continuing investigative and administrative machinery required to manage the resource.

As the Supreme Court said in *Colorado v. Kansas*,[70] water cases "present complicated and delicate questions, and, due to the possibility of future change of conditions, necessite expert administration rather than judicial imposition of a hard and fast rule."[71]

E. Conclusions

Of the various alternatives, perhaps the option most likely to be accepted would be a compromise position between the utopian international commission, with the complete panoply of powers from investigation and planning to regulation and en-

68. Nebraska v. Wyoming, 325 U.S. 589, 618 (1945).
69. M. McDougal and D. Haber, *supra* note 35, at 993.
70. 320 U.S. 383 (1943).
71. *Id.* at 392.

forcement, and the existing *status quo* of inactivity awaiting the crisis.

A relatively objective and, therefore, perhaps acceptable approach would be one that provided the means for an equitable apportionment of transboundary groundwaters, leaving the actual planning, distribution, regulations, and enforcement of each country's share to that country.

Ward Fischer, in discussing interstate compacts, has stated that one of the basic decisions

> required in the development of any particular compact is that between allocation v. management. Should the compact provide that each state is allocated a specific quantity of water? Or, on the other hand, should the states agree that the water resource is one that should be subject to year-to-year to decade-to-decade management, without specific quantities of water allocated to the participating states? Allocation in absolute quantities or in percentages, is the simplest solution. Management is no doubt the best, allowing, for example, planned recharging of the underground water resource for the ultimate greater benefit of all of the states.[72]

The allocation option is likely to be the simplest for international groundwaters as well. Specifically, this has been the model followed in the case of surface waters shared by the United States and Mexico where the waters of the Rio Grande and the Colorado have been divided by quantity, leaving the actual administration of each country's amount to each respective country.[73]

It is possible to develop the following skeletal outline of an allocation procedure:

1. The IBWC should be empowered to declare any groundwater resource that is divided by the international boundary to be a "designated international groundwater area" when in its judgment (a) demand is likely to exceed recharge so as to endanger sustained yield or water quality due to salt water intrusion, (b) groundwater withdrawals are likely to affect or be interrelated with surface waters previously allocated by treaty,[74] or (c)

---

72. Fischer, *supra* note 10, at 532.
73. N. HUNDLEY, DIVIDING THE WATERS (1966); C. SEPULVEDA, LA FRONTERA NORTE DE MÉXICO (1976); Meyers, *The Colorado Basin*, in THE LAW OF INTERNATIONAL DRAINAGE BASINS 486-607 (A. Garretson, R. Hayton & C. Olmstead eds. 1967); Utton, *supra* note 61, § 152.2.
74. This language is intended to avoid the complexities developed in the water law of the western United States by classifications such as "tributary" and "non-tributary" waters, "percolating waters," "subterranean streams flowing through definite channels," and "underflow of streams," while recognizing "the interrelationship between many surface and groundwater sources." Clark, *supra* note 10, § 441, at 415.

prudent management of the groundwater resource including the decision to mine groundwater makes such designation desirable.[75]

2. Upon declaring a "designated international groundwater area" and after carrying on the necessary engineering studies, the IBWC should equitably apportion the designated area between the two countries using established engineering criteria. The IBWC should first obtain information concerning aquifer thickness, saturated thickness, depths, area, quantity, and quality of the area, as well as transmissibility, permeability, recharge rates, and other pertinent hydrologic data, before apportioning the waters of the designated area.

Using this data, the IBWC should then apportion the water, bearing in mind the following:

1. the geography of the area, including each nation's proportion of total surface area overlying the designated international groundwater area;
2. the hydrology of the area including, (a) each nation's proportion of the total volume of the water in the designated international groundwater area which lies within that nation's territory, (b) the contribution of recharge by each nation, and (c) other relevant hydrologic considerations;
3. pre-existing utilization by each state;
4. in the event of prolonged drought which in the judgment of the IBWC significantly affects recharge, the IBWC should be authorized to reduce the total allowable withdrawal from the designated international groundwater area for so long as the IBWC deems necessary, and each nation's withdrawal shall be accordingly reduced proportionally.[76]

Each of these items can be determined with a reasonable

75. This is a general provision designed to give the IBWC flexibility in anticipating potential problem areas and exercising its judgment as hydrologic data is developed through its own initiative or the activity of others.

76. *See* 1974 Water Utilization Act, United Republic of Tanzania, *reported in* Hayton, *supra* note 1, at 281-82. Article 10 of the 1944 Colorado River Treaty provides that "[i]n the event of extraordinary drought. . . the water allotted to Mexico . . . will be reduced in the same proportion as consumptive uses in the United States are reduced." Treaty respecting Utilization of Waters of the Colorado and Tijuana Rivers and of the Rio Grande, Feb. 3, 1944, art. 10, 59 Stat. 1219, 1237-38 (1946), T.S. No. 994 (effective Nov. 8, 1945). *See also* Sepulveda, *Instituciónes Para la Solución de Problemas de Aguas de Superficie Entre México y los Estados Unidos*, 18 NAT. RESOURCES J. 131 (1978).

degree of certainty and would provide an objective basis for apportionment. They incorporate some of the central concepts of the Helsinki Rules and avoid the complexities of some of the more subjective criteria of the Helsinki Rules such as

> (e) The economic and social needs of each basin state; . . .
>
> . . . .
>
> (i) The avoidance of unnecessary waste in the utilization of waters of the basin; . . .
>
> . . . .
>
> (k) The degree to which the needs of a basin State may be satisfied, without causing substantial injury to a co-basin State.[77]

However, in making the decision whether to mine or not to mine, it would be necessary, certainly, to consider the economic and social needs of the countries.[78]

V. GENERAL CONSIDERATIONS

A. The Interrelationship of Surface and Groundwaters

In the management of international groundwaters, it is essential to recognize the interrelationships between surface and groundwaters, which frequently are interconnected.

Contrary to hydrologic reality, the law frequently has made distinctions which separate surface waters from underground waters and "percolating waters" from definite underground channels. These distinctions fail to recognize the interrelationships between surface and underground waters and have been characterized as attempts to restate the "physical universe."[79]

Scientists have criticized themselves and the law on this subject:

> *Man has coped with the complexity of water by trying to compartmentalize it. The partition committed by hydrologists . . . is as nothing compared with that which has been promulgated by the legal profession*, which has on occasion borrowed from the criminal code to term some waters "fugitive" and others "a common enemy." The legal classification of water includes "percolating waters," "defined underground streams," "underflow of surface streams," "watercourses," and "diffuse surface waters;" all these waters are actually interrelated and interdependent, yet in many jurisdictions unrelated water rights rest upon this classification.[80]

In view of the agreed upon allocations of surface waters for the Rio Grande and Colorado and the example of the Santa Cruz River upon which both Nogales, Sonora, and Nogales,

77. The Helsinki Rules, *supra* note 67, art. 5, at 189.
78. *See* text accompanying note 93 *infra*.
79. C. CORKER, *supra* note 42, at 146-47.
80. Thomas & Leopold, *Ground Water in North America*, 143 SCI. 1001, 1003 (1964) (emphasis added).

Arizona, depend,[81] it is absolutely essential that the interrelationship between surface and groundwaters be recognized.[82]

> We have been discussing ground water more or less as if it were separate and distinct from the rest of the hydrologic cycle. Such segregation has been common among hydrologists as well as the general public, and is reflected in legislation, in the division of responsibility among government agencies, in development and regulation. Yet it is clear that this isolation can be maintained only when and where water is being mined from underground storage. Any water pumped from wells under equilibrium conditions is necessarily diverted into the aquifer from somewhere else, perhaps from other aquifers, perhaps from streams or lakes, perhaps from wetlands—ideally, but not necessarily, from places where it was of no use to anyone. There are enough examples of streamflow depletion by ground-water development, and of ground-water pollution from wastes released into surface waters, to attest to the close though variable relation between surface water and ground water.[83]

Thus, the IBWC will undoubtedly have to treat differently two major classifications of groundwaters: (1) those that are tributary to surface water flows, or more precisely, those which are interrelated to surface water flows (which would include, for example, the Santa Cruz, which is tributary to the groundwater supply); and (2) those which are not connected hydrologically with any identifiable surface stream or lake.[84]

In fact, the Rio Grande itself has already provided extensive hydrologic and institutional experience concerning the interrelationships between surface flows and the associated alluvial groundwater system. Hydrologic studies have shown

> an intimate hydraulic relationship between the Rio Grande and the adjacent groundwater reservoirs. There are extensive sedimentary rocks along the main stem of the Rio Grande, and these rocks form the principal aquifer adjacent to the river. This aquifer is recharged directly by precipitation, by lateral underflow of water from adjacent formations, by seepage of water from Rio Grande tributaries, and in some areas by seepage from the Rio Grande main stem.[85]

Pumping from groundwater flows thus can have direct effects on surface water flows which can be calculated once the characteristics of the aquifer are known. Using the formula devised by C.V. Theis,[86] the State Engineer of New Mexico has

---

81. *See* Bradley & DeCook, *supra* note 7.
82. *See* NATIONAL WATER COMMISSION, WATER POLICIES FOR THE FUTURE 230 (1973); Clark, *Groundwater Management: Law and Local Response*, 6 ARIZ. L. REV. 178, 189 (1965); Hayton, *supra* note 59.
83. Thomas & Leopold, *supra* note 80, at 1003.
84. Flint, *Ground Water Law and Administration: A New Mexico Viewpoint*, 14 ROCKY MTN. MINERAL L. INST. 545, 551 (1968).
85. *Id.* at 552.
86. Theis, *The Effect of a Well on the Flow of a Nearby Stream*, in 22 AM. GEOPHYSICAL UNION TRANSACTIONS 734-38 (pt. II 1941).

devised a system of administration which allows new appropriations of groundwater in the Rio Grande basin in New Mexico only "under the condition that the appropriator acquire and retire from usage surface-water rights in amounts sufficient, at each point in time, to compensate for the increasing effects of his pumping on the stream."[87] This conjunctive administration of surface and groundwaters protects prior users of both, and has been upheld by the Supreme Court of New Mexico.[88]

B. The Concept of Safe Yield

As Professor Clark succinctly points out, "[a]ll water being pumped from below the earth's surface is either being replaced at measurable, or discernible, rates, or it is not."[89] Where withdrawal exceeds recharge, the water is being mined and "[t]hus all ground water pumped is either 'mined,' *i.e.*, extracted for certain purposes over a relatively short period of time, or it is being withdrawn as 'milked' from nature's aquifers with some view to continued use for a long or indefinite period . . . ."[90] The term "safe yield," although often criticized, has been used in this article and elsewhere to indicate generally the "milking" of underground water at rates which would allow for continued use in the future.

The following provides a good definition of safe yield or sustained yield: "The practical sustained yield is the amount of water which can be withdrawn annually without producing undesirable effects. The practical sustained yield may be limited to an amount less than recharge but cannot exceed the long-term mean annual recharge."[91] The term safe yield is often criticized and frequently avoided in the hydrologic literature because of its uncertainty. "[I]t has come to be recognized that the quantity of water which can be extracted annually from a reservoir—surface or underground—depends on both hydrologic and non-hydrologic factors, and that neither hydrologic nor non-hydrologic factors can be determined or predicted precisely."[92] Non-hydrologic factors include economic and legal considerations, such as prior water rights.[93]

87. Flint, *supra* note 84, at 553.
88. City of Albuquerque v. Reynolds, 71 N.M. 428, 379 P.2d 73 (1962).
89. Clark, *supra* note 82, at 189-90.
90. *Id.*
91. W. WALTON, GROUNDWATER RESOURCE EVALUATION 608 (1970).
92. C. CORKER, *supra* note 42, at 169-70. Clark concludes that the " 'safe yield' concept is properly discredited . . . and should be discarded by lawyers." Clark, *supra* note 44, at 483 n.75.
93. W. WALTON, *supra* note 91, at 608-09.

C. Flow Versus Stock Resources

A useful concept is the distinction between flow and stock resources. Flow resources are self-replenishing, and would include those groundwaters which are being recharged on a continuing basis as part of the hydrologic cycle of precipitation and evaporation. It is these groundwaters which would be used on a sustained yield basis.

However, there are aquifers with small recharge, but with a large amount of water in underground storage which "for all practical purposes . . . has been sidetracked from the hydrologic cycle and is no longer in transit. In human time, at least, it is not a self-replenishing, but an exhaustible resource, similar to petroleum and other minerals."[94]

These non-replenishing groundwaters are, for all practical purposes, exhaustible stock resources; they are not being replenished. Thus continued extraction will lead in time to their complete exhaustion. When exhaustion occurs, or when further mining becomes impractical, the economic activities and other uses dependent upon that supply must turn to other sources or be abandoned:

> With a *stock resource* the decisions to be made are whether and when to use it. A property rights doctrine should recognize that rights to such resources do not involve a perpetual supply. It should permit a decision to hold the stock for use at a later time if it is so desired.
>
> In a *flow resource* the problem is to make the best use of the supply which is continuously available though not necessarily, and in the case of water ordinarily not, at a constant rate.[95]

Thus, the concept of sustained yield is useful for aquifers recharging on a continuing basis, and the concept of mining is appropriate for stock resource underground waters which are not receiving significant recharge.

D. Management of Groundwater Mining

A number of considerations are involved in making a rational decision to mine groundwaters in appropriate circumstances.

It has been postulated that a principal purpose of groundwater law should be "to provide for an orderly development of ground-water supplies, in the interest of the best utilization of this natural resource"[96] and that these laws ordinarily, therefore, do not sanction diversions that would adversely affect the

94. Bagley, *Water Rights Law and Public Policies Relating to Ground Water "Mining" in the Southwestern States*, 4 J. L. & ECON. 144, 147 (1961).
95. *Id.* at 153 (emphasis added).
96. W. HUTCHINS, *supra* note 34, at 178.

"complete development of the safe yield found to exist in the area"[97] in order to preserve the water supply in perpetuity. This is an admirable statement when related to flow groundwaters; but what of stock groundwaters?

It must not be overlooked that in some situations, as a matter of policy,

> the mining of water can be justified in the same way as the mining of non-renewable mineral resources such as uranium, oil, or coal. It is not practical to operate a groundwater basin on a continuous yield basis when the amount of water in storage is very large compared to the annual recharge.[98]

Thus, the decision with respect to stock groundwaters is "whether and when to use"[99] them, in that they are not a replenishing, perpetual supply. In order not to oversimplify, it must be pointed out that flow resource groundwaters can be mined too—

---

97. *Id.*
98. The complete text follows:

> It is desirable, of course, that the ground-water resources be available to future generations in perpetuity; however, the mining of water can be justified as readily as the mining of any of our other mineral resources such as uranium, oil, or coal. It is not practical to operate a ground water basin on a continuous-yield basis when the amount of water in storage is very large compared with the average annual recharge. An example is the Lea County Basin in southeastern New Mexico where the average annual recharge is 29,000 acre-feet per year and the permitted withdrawals will average about 440,000 acre-feet per year. The great value of the approximately 27 million acre-feet in storage in the basin when pumping began can be realized only by mining. Furthermore, to justify the marketing, storage, and transportation facilities essential to a competent agricultural economy in the area it is necessary for the withdrawals to exceed the recharge.
>
> While it is possible to justify the mining of ground-water resources, the practice will make it necessary to face serious water supply problems in the future. In some instances it will be possible to meet these problems only by complete readjustment of the economy of the area. While long range predictions of the value of water in various uses are dangerous, it appears likely that it will not be, in general, economically feasible to import water over appreciable distances for agricultural purposes when the local ground-water resources have been mined out. However, when reduced well yields or excessive lifts make pumping for agricultural purposes uneconomic, the residual water may well supply the municipal and industrial needs of a vigorous non-agricultural economy for many years.
>
> In Lea County pumping for irrigation will probably be uneconomic when about two-thirds of the aquifer is dewatered. At that time there will probably remain substantial valuable reserves of oil and gas in the area. To produce and process those reserves it will be necessary to use numerous low-production wells to pump the residual fresh water, and it may also be necessary to desalinize the abundant brackish waters and brines that occur in the area.

Clark, *supra* note 82, at 190 n.48 (statement of S.E. Reynolds, State Eng'r, Santa Fe, N.M., Sept. 30, 1959).

99. Bagley, *supra* note 94, at 153.

that is, when withdrawals exceed recharge—and this frequent practice is what actually gave rise to the conservation concept of sustained yield.

There may be situations in which it is advisable to "mine" water in basins in which there is significant but inadequate recharge to meet water needs. However, such decisions should be made consciously and with knowledge of the economic and social consequences, and an appreciation of the fact that the options of future generations will be limited.

It has been argued that sustained yield should not be a sacred principle, that the decision to mine can be a rational alternative, but that " '[S]afe yield'—if a proper term can be discovered, or if the old term can be acceptably defined—should be the basis of operation of every groundwater resource"[100] until the decision to mine is made consciously and with full knowledge of its implications.

Such decisions have to be made after thorough investigation and consideration, and the development has to be in an orderly, rational manner; this is particularly so where the groundwater resource is divided by an international boundary, in view of the fact that depletion of the resource and the consequent damage to the other country cannot easily be corrected by natural recharge and, at least stock groundwaters, "once removed, are, for all practical purposes, gone forever."[101]

Such considerations as the spacing of wells, the rate of draw-down, and the portion for each country need to be carried out according to a reasoned development plan.[102]

The New Mexico Supreme Court has recognized the validity of mining groundwaters for reasoned policy goals and, at the same time, recognized the need for careful management of such mining:

> The administration of a non-rechargeable basin, if the waters therein are to be applied to a beneficial use, requires giving to the stock or supply of water a time dimension, or, to state it otherwise, requires the fixing of a rate of withdrawal which will result in a determination of the economic life of the basin at a selected time.
>
> The very nature of the finite stock of water in a non-rechargeable basin compels a modification of the traditional concept of appropriable supply under the appropriation doctrine. Each appropriation

100. C. CORKER, *supra* note 42, at 174.
101. Fischer, *supra* note 10, at 524.
102. As Professor Clark suggests: "A plan should be developed to control future uses, irrespective of whether the aquifer is stabilized or must of necessity be mined." Clark, *supra* note 82, at 818.

> from a limited supply of non-replaceable water of necessity reduces the supply in quantity and shortens the time of use to something less than perpetuity. Each appropriator, subsequent to the initial appropriation, reduces in amount, and in time of use, the supply of water available to all prior appropriators, with the consequent decline of the water table, higher pumping costs, and lower yields.[103]

In areas declared to be "designated international groundwater areas" by the IBWC, the commission should apportion the waters and rate of withdrawal, since the "time dimension"[104] is an essential aspect of the apportioned water right.[105] Particularly in closed or non-tributary areas, the capability to plan depletion over a calculated period is essential. Often the hydrologic and economic considerations are quite complicated. As an example of the type of factors that must be considered, the State Engineer of New Mexico suggests that if it were determined to set

> a fixed "life" for the basin and then apportion the water by fixing the annual rates for each nation, deferral of development would be discouraged and there would be a race to achieve the allowed rate of withdrawal at the earliest time to maximize the quantity that could be taken within the "life" of the basin. On the other hand, if there is no limitation on the annual rate, that nation which takes its allocated quantum at a slower rate will have greater pumping lifts and possibly a worse quality of water; this could be mitigated by imposing a reasonable limitation on the annual rate of withdrawal as well as specifying the quantum allocated to each nation. In most situations, it probably would also be useful to require some areal distribution of withdrawals to insure that one country does not damage the other (and perhaps itself) by concentrating its withdrawals along the international boundary.[106]

Fortunately, the IBWC has that capability. It has the staff, resources, and experience to call on various disciplines for input.

> [A]s war is too important to be left to the generals, water law is too important to be left to water lawyers (or the engineers or the economists) alone. Initial inputs and along-the-way review . . . should be elicited from each of the relevant disciplines, to insure the economic, engineering, and administrative soundness . . . [of the decision].[107]

In addition, contributions from those most affected by the decision would appear to be appropriate through a hearing process.

---

103. Mathers v. Texaco, Inc., 77 N.M. 239, 243-44, 421 P.2d 771, 775 (1966).
104. Flint, *supra* note 84, at 568. *See also* Bagley, *supra* note 94, at 154-55.
105. *See* Fundingsland v. Colorado Ground Water Comm'n, 171 Colo. 487, 468 P.2d 835 (1970). The court approved a rate of depletion based on a 25 year period.
106. Letter from S.E. Reynolds, State Eng'r, Sante Fe, N.M., to Albert Utton (Aug. 29, 1977). *See* Bagley, *supra* note 94, at 154; Clark, *supra* note 2, at 159.
107. Hayton, *supra* note 1, at 288.

E. Criticism of Equitable Apportionment

The equitable apportionment approach to dividing groundwaters does not place a comprehensive planning power in an international agency and, therefore, can be criticized for not striving for "optimum utilization."[108] This is a valid criticism. Rather than optimum utilization, this option seeks equitable apportionment, a quantitative division of available supply. Such a division of the waters is simpler and, perhaps, politically possible. Even this will be a difficult achievement.[109] Equitable apportionment between the United States and Mexico would have the following advantages:

1. Certainty would be increased. Through quantification each nation would know its entitlement and could plan, grow, and develop accordingly. As one commentator has said, "[m]aximum development of water resources depends in large measure upon the principle of certainty . . . ."[110]
2. Political accountability would be enhanced. Within each nation there would be control over the decision as to how that nation's share should be allocated and used. Thus, the decision-making process would be subject to the ordinary political process of each country.[111]
3. The strength and reputation of the IBWC would be protected from the abrasions that would be incurred by periodic adjustments, not to mention day-to-day water administration within the boundaries of the sovereign nations.
4. The potential for dispute between the two countries would be reduced greatly.
5. And, of course, of elemental importance, equitable apportionment just might be politically possible; proposing anything more would border on utopian unreality.

F. The Need for Flexibility

Perhaps the major shortcoming of an equitable apportionment immutably enshrined by a decision of the IBWC, for ex-

108. Utton, *International Water Quality Law*, 13 NAT. RESOURCES J. 282, 309 (1973).
109. *See generally* LaMarquand, *Politics of International River Basin Cooperation and Management*, 16 NAT. RESOURCES J. 883 (1976).
110. Flint, *supra* note 84, at 570.
111. Fox, *Institutions for Water Management in a Changing World*, 16 NAT. RESOURCES J. 743 (1976); Ingram, *The Political Economy of Regional Water Institutions*, 55 AM. J. AGRIC. ECON. 10 (1973).

ample, is that of inflexibility. As new information becomes known, determinations such as the boundaries and recharge sources of a particular aquifer, or rate of recharge or sustained yield may need to be adjusted. "It is seldom that any single value of practical sustained yield can be correct for an extended time, in part due to changing economic conditions."[112]

In order to be responsive to changing conditions and new knowledge, it would be desirable to provide the IBWC with authority for periodic review and adjustment. Reopening for further consideration decisions previously made has the potential for being disruptive—often it is better to let sleeping dogs lie—but the complexity of the hydrologic and economic factors indicates the need for some periodic review and the power to make adjustments, even at the expense of certainty and political tranquility. It would appear that basic apportionment decisions should not be tampered with except in extraordinary circumstances, but determinations concerning sustained yield and decisions whether to mine or not, and at what rate, could well be adjusted with changing conditions and information.

G. Necessary Preliminary Action

In order to obtain the hydrologic and geographic data necessary for the declaration of designated international groundwater areas, specific actions need to be taken. Professor Clark suggests:

> 1. The International Boundary and Water Commission . . . [carry out] a joint research program which would include an inventory of ground water supplies, detailing the areas of availability and present uses. The program should include the study of nontributary sources and of other surface and ground waters that are interdependent. . . .
>
> . . . .
>
> 3. This program coordinated on both sides of the border should include the drilling of strategic test wells, well metering, and record keeping which will encompass water quality matters. Selected areas of heavy demand and diminishing supplies should be studied first, particularly in the heavily populated areas . . . .[113]

In fact the IBWC is carrying on an inventory of groundwater supplies and is exchanging data between the United States and Mexican sections of the IBWC.[114]

112. W. WALTON, *supra* note 91, at 608-09.
113. Clark, *supra* note 2, at 160 (footnotes omitted).
114. Interview with government officials (Feb. 1978). *See* Day, *supra* note 7, at 176.

Included in the inventory of groundwater supplies and present uses should be the identification and registration of all existing wells. Ideally, there should be compulsory metering and testing of all wells exceeding a specified capacity. All registered wells should be certified by data, volume, and location.[115] With this inventory of existing uses and demand, combined with the hydrologic inventory of groundwater supply and quality, the safe yield could be projected or a "calculated program of mining the water supply developed."[116] The IBWC could then declare a designated international groundwater area, apportion the resource between the nations, and so control withdrawals according to the apportionment and the projected yields or calculated depletion program.

In areas in which there is inadequate data, the IBWC would await the development of data from other sources and the completion of its own studies. This would allow the IBWC to phase its activities with the development along the border, utilization of the resource, and availability of information.

As the physical resources of each area become understood, the IBWC could declare additional designated international groundwater areas in order to ensure the prudent utilization of the groundwater resources divided by the international boundary.

H. Enforcement

The actual allocation, administration, and enforcement of water rights within each nation's portion of water in a designated international groundwater area would be within the national jurisdiction of that nation and its appropriate political subdivisions.

In addition, there should be a generally overriding, supervisory enforcement power lodged in the IBWC, to ensure that each nation lives within the total water budget allocated to it by the basic apportionment. "The designated international agency must implement administrative authority which is broad enough to carry out the policies of the two countries; this authority must be strong enough to enforce policies designed for particular ground water areas along and near the border."[117] Basic to the monitoring process of the IBWC is the continuing acquisition of information obtained from the metering of wells. "There must be a system of measurement of withdrawals from

115. Clark, *supra* note 102, at 816-17.
116. *Id.* at 817.
117. Clark, *supra* note 2, at 159.

wells. . . . Records must be kept of withdrawals over a period of time,"[118] and the IBWC must be able to assure that withdrawals do not exceed allocated amounts in the designated international groundwater areas which are based on calculated mining programs or determined safe yield in terms of water quality and water quantity—specifically the prevention of salt water intrusion.

The IBWC's existing treaty authority and established diplomatic channels could be looked to to settle disputes that might arise with respect to the interpretation or application of the treaty.[119]

---

118. *Id.*
119. The Commission is authorized "to settle all differences that may arise between the two governments with respect to the interpretation or application of the treaty, subject to the approval of the two governments." Treaty Respecting Utilization of Waters of the Colorado and Tijuana Rivers and of the Rio Grande, Feb. 3, 1944, 59 Stat. 1291, T.S. No. 944 (effective Nov. 8, 1945).