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Ludwik A. Teclaff

Eileen Teclaff

TRANSBOUNDARY GROUND WATER POLLUTION: SURVEY AND TRENDS IN TREATY LAW

LUDWIK A. TECLAFF* and EILEEN TECLAFF**

There is an old Chinese saying that a city can be moved, but not a well.[1] This may not seem very relevant to ground water pollution, but in fact it goes to the heart of the problem. The well, or the aquifer, is a receptacle, a fixed resource and, unlike air or flowing surface water, one that is often virtually nonrenewable in terms of quality. If it becomes too badly polluted it must be abandoned. There is not so much pure ground water left that nations can afford to lose it by contamination.

The ground water that is accessible is already endangered and poses a threat to public health in parts of the United States and Europe, especially through pollution by toxic substances, hydrocarbons, and nitrates.[2] For instance, in some areas of England where nitrate concentrations in water bearing strata have reached unacceptable amounts, it has become necessary to supply bottled water for babies.[3] Awareness of the problem already has reached international levels. A draft directive submitted by the Commission of the European Economic Community (EEC) in January 1978 refers to the "urgent need for action to protect the groundwater of the Community from pollution, particularly that caused by certain toxic, persistent and bioaccumulable substances."[4]

Ground water accounts for an overall seventy percent of the drinking water in the member states of the EEC, even more than that in Denmark, the Federal Republic of Germany, and the Benelux countries, and an astonishing ninety-three percent in Italy.[5] In the United States, according to the Environmental Protection Agency (EPA), half of all drinking water is supplied from underground sources.[6] Large cities around the world are increasingly dependent on ground

*Professor of Law, Fordham University School of Law.

**Free lance writer on environmental subjects.

1. I Ching: Book of Changes 164-65 (paperback ed. 1969).

2. *See, e.g.*, statements by the U.S. Environmental Protection Agency and by experts of the European Common Market Commission. 43 Fed. Reg. 58948 (1978); BNA INT'L ENV'TAL RPTR., CURR. REPT. 27 (1978).

3. BNA INT'L ENV. RPTR., CURR. REPT. 291 (1978).

4. Draft EEC Council of Ministers Directive to the Member States on Protection of Groundwater Against Pollution, submitted to the Council by the Commission, 24 January 1978, COM (78) 3 final, full text in BNA INT'L ENV. RPTR., CURR. REPT. 46 (1978).

5. EEC estimate. *See* BNA INT'L ENV. RPTR., CURR. REPT. 27 (1978).

6. 43 Fed. Reg. 58948 (1978).

water for public supply because of the pollution of surface bodies and the aquifers around cities such as London, Copenhagan, Hamburg, Basel and Vienna, to mention only a few. These waters have become severely depleted as extraction exceeds the rate of natural replenishment.[7] There is no question, then, why it has become so necessary to conserve and protect (and if possible reclaim) the remaining accessible ground water resources. The only question is how this should be done. This is where moving the city comes in—not in a literal sense, but in the sense of *re*-moving, controlling and regulating all the activities of our urbanized, industrialized society that endanger the purity of ground waters. Where these waters underlie a frontier zone the problem becomes one of international concern and negotiation.

PATHWAYS OF CONTAMINATION

Ground water is polluted when pollutants are discharged into an aquifer's intake or recharge area (land surface), into wells tapping the aquifer, or into surface streams that feed aquifers (influent streams). Polluted ground water may in turn contaminate surface water through streams that are fed by aquifers (effluent streams). A surface body of water may feed an aquifer at one part of its course and be fed from an aquifer at another. In many areas the major aquifer is the alluvium underlying a river valley or lake basin.[8] Hence, there is hardly an international river or lake anywhere in the world that is not somehow connected with an underground water resource. Because of the extensive pollution of surface bodies of water (natural and man-made), therefore, aquifers interconnected with them are generally more likely to be subject to or to create pollution problems than aquifers which have no connection with surface waters and whose recharge is very slow.

The manner in which ground waters become polluted is described in recent guidelines and regulations of the EPA:

> In general, when contaminants leach into groundwater, they form a plume of contaminated water which extends downgradient from the contaminated source. The shape and size of a plume depends upon the local geology, the groundwater flow, the type and concentration of contaminants, and the continuity of waste disposal. Any modifications of the groundwater system made by human activities, such as well pumping from a point source, will cause the plume to become

7. *See* TECLAFF, ABSTRACTION AND USE OF WATER: A COMPARISON OF LEGAL REGIMES 3, U.N. Doc. ST/ECA/154 (1972).

8. *See generally* on this subject D. TODD, GROUND WATER HYDROLOGY (1959) and R. KAZMANN, MODERN HYDROLOGY (1965).

> elongated. Where the flow is low, contamination will tend to spread more laterally to form a somewhat wider plume. Irregular plumes can be created by local influence such as location of pumping wells and variations in permeability.[9]

Among the many sources of ground water pollution (agricultural, industrial, domestic and municipal) are the following: irrigation return flows containing heavy concentrations of minerals (especially a problem in arid areas); concentrations of nitrates from fertilizer applications, animal feedlots, and the use of sewage for irrigation; pesticide and herbicide application; discharge of industrial wastes into surface streams; deep well disposal of toxic substances; unintentional recharge of aquifers from settling ponds for industrial wastes; oil field brines; contamination from the laying of pipes and from storage tanks; effluent from hospitals, pharmaceutical manufacture, etc., which may include toxic chemicals and radioactive wastes; septic tanks and cesspools (both in active use and abandoned); discharge of sewage into surface waters connected with groundwater aquifers; settling ponds in sewage purification plants; cemeteries and solid waste landfills. There is a very close connection between the overexploitation of ground water resources and their contamination. This often results in salt water intrusion, now a significant problem in forty-two of fifty states of the United States.[10] The development of water-works—dams, canals, drainage ditches and pipes, and works for hydroelectric power production—in itself may be a cause of ground water pollution. Other causes of pollution are the diversion of surface waters and the recharge of aquifers with surface water of poor quality.[11]

One of the aspects unique to ground water pollution is that the injury may be at least partially self induced. If A pumps ground water at a rate appreciably faster than the natural recharge, a cone of depression is formed into which polluted ground water from B infiltrates. A uses its wells for municipal supply, B does not. In a boundary zone, if A did not over pump, the contaminated ground water would remain on B's side of the frontier and remain a domestic rather than international problem. Suppose the people of A have a high standard of living and a cultural heritage from more humid areas: they use much water of potable quality for air conditioning, lawn watering, and washing cars, whereas the people of B are poor

9. 43 Fed. Reg. 58946, 58953 (1978).

10. U.S. GENERAL ACCOUNTING OFFICE REPORT, GROUND WATER: AN OVERVIEW, GAO Report CED-77-69 (1977).

11. *See* TECLAFF, LEGAL AND INSTITUTIONAL RESPONSES TO GROWING WATER DEMAND 36-37 (FAO Legislative Study No. 14, 1977).

farmers with a per capita consumption of water only a fraction of their neighbor's. The A's are outraged by the pollution of their water supply, though they are victims of their own excessive consumption. The B's blame the A's for lowering the water table over the entire area and drying up their surface streams and wells; they see no necessity for the A's to have beautiful gardens while the crops in B are dying. Both parties feel aggrieved and both are partially to blame.[12]

There are important differences between surface and ground water pollution. Ground waters store pollution and the process is often irreversible, whereas surface flowing waters have some capability for self-purification. Measures of control and prevention that are appropriate for surface waters, therefore, may not be relevant for ground water pollution or may be difficult to enforce unless the exact course of the pollutant can be traced and the polluter positively identified. The cleaning and retrieval of ground water, once polluted, is difficult and costly. Even in the ordinary course of aquifer recharge, it has been estimated that it takes 100 days' residence time for infiltrated surface water to correspond in quality to natural ground water, and minor changes could still be observed after 300 days.[13]

It may take as many as one hundred years of constant recharging with clean water before a polluted aquifer is again capable of discharging potable water, assuming that the contaminant can be degraded.[14] A pollutant which is not readily degraded or absorbed underground can persist indefinitely, since the *average* residence time of ground water is of the order of two hundred years.[15] The effort needed to clean up pollution is illustrated by the water supply crisis which developed in 1978 in Provincetown, Massachusetts, when a ruptured underground gasoline tank contaminated the community's well field. Reclamation, which may not be successful, involves pumping out as much of the gasoline as possible and the injection of nutrients into the soil to induce the multiplication of bacteria to consume the remaining hydrocarbons. This relatively small-scale project will cost a quarter of a million dollars.[16]

12. Most of the elements of this hypothetical situation are in fact present in the ground water pollution problem of the El Paso-Juarez area on the U.S.-Mexico border, except that the latter concerns two urban populations, not an urban and a rural one. *See* Day, *Urban Water Management of an International River: the Case of El Paso-Juarez,* 15 NAT. RES. J. 454 (1975).

13. H. HYDEN & G. WINGVIST, ARTIFICIAL RECHARGE OF GROUNDWATER, United Nations Water Conference, Mar del Plata, Argentina, 14-25 March 1977, Doc. No. E/CONF.70/TP 71, at 4.

14. Haaze, *The interrelationship of ground and surface water: an enigma to western water law,* 10 Sw. Nev. L. Rev. 2069, 2079 (1978).

15. EPA estimate. 43 Fed. Reg. 58953 (1978).

16. New York Times, Nov. 19, 1978, at 76, col. 3.

Sometimes it is difficult or impossible to find a remedy which does not create a worse problem or affect a wider public. The dilemma is epitomized in *Cabrera v. Municipality of Bayamon,*[17] in which owners of property below a new municipal dump that was polluting their surface and underground water supply and endangering themselves and their animals sought to enjoin the dump's operation and have it removed elsewhere, or force the municipality to buy them out by condemnation. Quoting from the court's opinion:

> [T]he Court . . . has found [it] almost impossible to arrive at a remedy to discontinue the irreparable damages being caused to plaintiffs by defendants. . . .
>
> . . .
>
> When the case . . . was finally submitted to the Court for decision, the dump site was practically full. Layers of garbage and sand have been compacted almost all over the area, at a rate of 400 tons per day for approximately two years. And the water that emanates from the spring and becomes polluted with the everyday more decayed matter contained in the garbage continues to pollute the once clear water of the stream and wells of the plaintiffs.
>
> . . .
>
> The Court cannot please the plaintiffs one way or the other. As to the possibility of ordering condemnation procedures, we fail to see any authority in the law that could warrant such an extreme action. As to the possibility of removing hundreds of thousands of tons of decayed matter and moving it through the public highways, the Court feels that it would be a very risky, if not an altogether impossible maneuver that would endanger the public health of a whole community, trying to remedy a much smaller health hazard to a few citizens . . .[18]

The problems are not limited to current storage or disposal of pollutants and polluting wastes—some of them are decades-old nightmares returning or resurfacing to haunt us like skeletons arisen from a tomb. The Love Canal landfill situation on the Niagara frontier is only one of many such cases now being unearthed or that may develop (EPA officials admit that there is no nationwide inventory of such dump sites). Only the width of the Niagara River prevented a transfrontier pollution incident. The toxic chemicals which in 1976 began leaching to the surface were from rusted storage drums buried some three decades ago in accordance with the existing regulations and technology.[19] Similarly, an unknown amount of ground water

17. 370 F. Supp. 859 (1974).
18. *Id.* at 870.
19. BNA ENV. RPTR, CURR. DEV. 581 (1978).

in various parts of the world may have been polluted by oil field brines through the exercise of techniques used in the oil and gas industry for many decades. As late as the 1950's and 1960's, oil companies in the United States defended themselves against charges of having contaminated farm ground water irrevocably and permanently by claiming that the use of methods universal in the industry has absolved them from any obligation to use a better or more developed technology, such as leakproof storage tanks.[20]

Long abandoned mine operations are another source of current pollution. In *Pittsburgh Coal Co. v. Sanitary Water Board*,[21] it was disclosed that an underground pool covering 23,780 acres and estimated to contain anywhere from 100 to 350 billion gallons of polluted water had formed as the result of abandoned workings, and was flowing at the rate of 2.7 million gallons per day into the one deep mine still operating in the area. The solution proposed illustrates one difficulty likely to arise in transfrontier ground water pollution situations, especially where boundary changes have occurred: who is responsible for remedying an environmental injury that may have taken place decades previously, and to what extent? In the Pittsburgh Coal Company case, the Pennsylvania Sanitary Water Board had ordered the coal company to cease operating the mine and denied a permit to drain the mine and discharge the effluent into surface waters. Reversing the Board's order, the lower court pinpointed the problem of responsibility: "It [the Sanitary Water Board] now seeks to place the burden of remedying this pollutional problem upon an unfortunate victim of this water's course who is faced with an impractical task in order to realize any use and enjoyment of his land."[22] Similarly, in *Philadelphia Chewing Gum Corp. v. Commonwealth of Pennsylvania Department of Environmental Resources*,[23] the facts revealed that the polluting condition which the four appellants were ordered to correct was created more than two decades ago by a previous occupant of the land as part of its wood preservative business. The discharge ceased in 1956 and none of the four appellants, including the subsequent owner and occupier of the land, actually has discharged any industrial waste into ground or surface waters. Indeed, one of the appellants had willy-nilly

20. *See* Brown v. Lundell, 334 S.W.2d 616 (Tex. Ct. App. 1960); Gulf Oil Corp. v. Alexander, 291 S.W.2d 792 (Tex. Ct. App. 1956).

21. 4 Pa. Commw. Ct. 407, 286 A.2d 459 (1972).

22. *Id.* at 466, n. 8.

23. 35 Pa. Commw. Ct. 443, 387 A.2d 142 (1978), concerning the disposal via a well of pentachlorphenol mixed with oil, a fungicide, herbicide and wood preservative.

"acquired" the contaminant due to the downward slope of the water table from the disposal well.

A new spectrum of problems in ground water protection has sprung up now that disposal of pollutants into surface waters is more stringently regulated. Many different parts of the industrialized world are protesting the manner of disposal and storage of hazardous wastes. In January 1979 an angry crowd in a North Carolina county bordering Virginia raged against the state's application for a federal permit to bury soil contaminated with PCB's (polychlorinated biphenyls) at a site within seven feet of the ground water table. The problem of disposal originally arose when three men from out of state, unable to discharge the toxic substance legally into surface waters, used a tank truck to spray it secretly by night along the verges of some 200 miles of the state's back roads.[24] There was a public outcry in West Germany when it was discovered that 150 tons of the deadly insecticide Kepone, shipped from the United States (where its use is now banned), was stored under permit in the State of Hesse near the East German frontier in salt caves which already contain more than 200,000 tons of toxic and hazardous materials.[25] For years the Dutch have been protesting the discharge of chlorides from French potash mines in Alsace into the Rhine; now that a plan has been conceived for disposing of the wastes by pipeline into underground reservoirs in Alsace where they might pollute local water supplies, it is the French who are in an uproar.[26] Nuclear wastes constitute another appalling hazard to the safety of underground waters and, through them, to the environment generally. The U.S. Atomic Energy Commission, for instance, had long planned to dispose of these wastes by burying them deep in abandoned salt mines, but the possibility of their migration and escape through radioactive contamination of hitherto unsuspected bodies of water caused the first two chosen sites to be rejected and it cast doubts upon the entire project.[27] The Italian government is protesting vigorously a Swiss proposal to bury radioactive wastes in caves on the southern slopes of the Alps from which the leachate allegedly could pollute not only ground water but "all the rivers of northern Italy."[28]

24. New York Times, Jan. 6, 1979, at 6, col. 1.
25. 1 BNA INT'L ENV. RPTR., CURR. REPT. 412 (1978).
26. *Id.*, 410-11.
27. *See* Natural Resources Defense Council v. U.S. Nuclear Regulatory Commission, 547 F.2d 633, 648 n. 46 (D.C. Cir., 1976), citing Boffey, *Radioactive Waste Site Search Gets into Deep Water,* 190 SCIENCE 361 (1975).
28. 1 BNA INT'L ENV. RPTR., CURR. REPT. 209-10 (1978).

EARLY FRONTIER WATERS TREATIES INDIRECTLY PROTECTING GROUND WATERS

Because ground water pollution is out of sight it is also out of mind. Concern about it may come slowly, only after a realization that a single well or group of wells is contaminated. Not until the damage is widespread and pollution can be traced over a wide area is it apparent that an entire aquifer has been affected. This is probably why transboundary ground water pollution hitherto has not been recognized as a serious problem. The frontier area affected may be very localized—a group of farmers, a single border community, may experience trouble with well water supply. Perhaps the same difficulty has cropped up many miles away, either in the frontier zone or deep within national territory. The matter is not worth an international fuss and, in any case, the two problems are not considered to be connected. Only when the pollution is serious and affects important interests and many people does it become an issue of international significance. Other reasons why ground water did not feature in treaties until quite recently are first, ground water in most jurisdictions has been the private property of the owner of the overlying land and therefore of no concern to the state; and second, the behavior of ground water and its interrelationships with surface waters were not well or widely understood.[29]

Nevertheless, from the beginning of the 19th century, national proximity has forced states to conclude treaties which limited their free use of transboundary waters in the frontier zone. These treaties place a heavy obligation on maintaining surface boundary waters in a natural condition and preventing any alteration in the flow, bed or banks (including diversion of water) without consent of the governments concerned. Some prohibit change in the natural course of the

29. It is true that centuries ago some individual observers, such as the French philosopher, Bernard Palissy (1510-1589), had a remarkably clear conception of how ground water behaved. G. P. MARSH, MAN AND NATURE 379 (1965). It is also true that, even in an age which recognized landowners' rights to the hilt, they were held not to extend to pollution. In Ballard v. Tomlinson, Lord Justice Lindley carefully distinguished the nature of the offense as follows:

> The right to foul water is not the same as the right to get it. . . . Prima facie every man has a right to get from his own land water which is naturally found there, but it frequently happens that he cannot do this without diminishing his neighbour's supply. In such a case the neighbour must submit to the inconvenience. But prima facie no man has a right to use his own land in such a way as to be a nuisance to his neighbour, and whether the nuisance is effected by sending filth on to his neighbour's land, or by putting poisonous matter on his own land and allowing it to escape on his neighbour's land, or whether the nuisance is effected by poisoning the air which his neighbour breathes, or the water which he drinks, appears to me wholly immaterial.

29 Ch. D. 115-CA (Eng. 1885).

rivers or require the mutual consent of both parties for diversion of surface waters.[30] Others place on their signatories the obligation to ensure that any works undertaken do not substantially impair the flow of water.[31] There is a heavy obligation to maintain frontier rivers in their natural state laid on the participating governments in the Additional Act to the Treaty of Bayonne and in the Belgium-Luxembourg treaty of 1843.[32] The Belgium-Netherlands treaties regulating the abstraction of water from the Meuse stipulate precise quantities of water to be taken from the river at certain seasons.[33] Another early boundary treaty, between the Netherlands and Germany (Hanover) of 1824, gives technical directions on flow and limits the amount of water that may be diverted to Hanoverian territory. A Franco-Swiss treaty of the same year, dividing the waters of the Doubs between the two parties, contains provisions for maintaining the volume and rate of flow.[34]

Because of political fragmentation and the large number of boundary streams involved, these early treaties must have been a potent factor in maintaining aquifers connected with transboundary surface waters in a more natural state than would have been the case if only one political unit were involved. As time went on, boundary water treaties began to include more specific provisions to help maintain a steady volume and rate of flow in surface waters.[35] Although the

30. Prussia-Netherlands, Oct. 7, 1816 (Treaty of Aachen), text in U.N. LEG. SER., LEGISLATIVE TEXTS AND TREATY PROVISIONS CONCERNING THE UTILIZATION OF INTERNATIONAL RIVERS FOR OTHER PURPOSES THAN NAVIGATION, ST/LEG./SER.B/12 (1963), at 737 [hereinafter cited as U.N. LEG. SER.]; Belgium-Luxembourg boundary convention, Aug. 7, 1843, *id.* at 535; Belgium Netherlands, treaty regulating the regime of abstraction of water from the Meuse, May 12, 1863, *id.* at 550.

31. Switzerland-Baden, agreement concerning navigation of the Rhine, May 10, 1879, *id.* at 776.

32. France-Spain, Additional Act to the Treaty of Bayonne, May 26, 1866, *id.* at 672, art. XI; Belgium-Luxembourg, boundary convention, *supra* note 30, art. 30.

33. Belgium-Netherlands, treaties regulating the regime of abstraction of water from the Meuse, May 12, 1863, *supra* note 30, arts. 4 and 7; and Jan. 11, 1874, U.N. LEG. SER. 552, Declaration, art. 1.

34. Netherlands-Germany (Hanover), frontier treaty, July 2, 1824, U.N. LEG. SER. 740, art. 34; France-Switzerland (Canton of Neufchatel), proces-verbal of delimitation, Nov. 4, 1824, *id.* at 700, art. 5.

35. E.g., France-Germany, frontier delimitation treaty, Aug. 14, 1925, U.N. LEG. SER. 657, arts. 13 and 14; Portugal-Spain, treaty on hydropower development of the Douro, Aug. 11, 1927, *id.* at 911, arts. 8 and 18; Norway-Sweden, convention on certain questions relating to the law on watercourses, May 11, 1929, *id.* at 871, arts. 1 and 2; France-Switzerland, convention concerning the Chute du Châtelot concession on the Doubs, Nov. 19, 1930, *id.* at 713, art. 4. Also France-United Kingdom, convention on certain points connected with the mandates for Syria, the Lebanon, Palestine and Mesopotamia, Dec. 23, 1920, *id.* at 286, art. 3; Iran-USSR, frontier rivers and waters convention, Feb. 20, 1926, *id.* at 371, arts. XV and XVI; Egypt-United Kingdom, exchange of notes on use of R. Nile waters for irrigation, May 7, 1929, *id.* at 100, art. 4; Belgium-United Kingdom, agreement regarding water rights on the boundary between Tanganyika and Ruanda, Nov. 22, 1934, *id.* at 97, art. 1.

interrelationship between ground and surface waters was not even hinted at,[36] these provisions did minimize or prohibit activities which could have adverse effects on interrelated ground waters. Among the most significant provisions are those which require that a minimum flow be maintained for surface waters. These requirements help lessen the concentration of pollutants in surface waters and, by maintaining the ground water level in valley and lake basin alluvium, hinder the infiltration of pollutants into underlying aquifers. One of the oldest treaties containing such a provision is that between Austria (Bohemia) and Bavaria of 1862, which requires that diversions from frontier brooks be maintained so that "the bed of the brook may always be covered with water."[37] Almost 90 years later a very similar requirement was included in the Austria-Germany (Bavaria) agreement of 1950 to ensure the maintenance of a "sufficient volume of water in the Isar bed."[38] Minimum flow provisions also were included in the Czech-Hungarian agreement of 1954 (Art. 29 (1) states that the parties agree to furnish the necessary reciprocal information on the influence of works located outside frontier sections on the maximum and minimum flow of frontier watercourses);[39] the Austrian-Czech agreement of 1928 (Art. 29 requires the parties to exercise care in granting new rights so that they do not affect the volume of water necessary for the supply of muddy water for irrigation of adjacent land during drought periods--essentially a minimum flow provision);[40] and in the multilateral agreement of 1959 between the U.S.S.R., Norway, and Finland concerning the regulation of Lake Inari, Annex 3 of which contains detailed regulations on maximum

36. There is one interesting early exception in the exchange of notes between Italy and the United Kingdom in June 1925, concerning utilization of the waters of the River Gash by Eritrea and the Sudan, and quoting from a joint report of experts which states that:

> The works of Tessenei will not, so far as the barrage itself is concerned, have any influence on the wells of Kassala, which are fed by inundation and not by subsoil flow. So far as concerns the extraction of the water, according to the project of Nobile, the interests of Kassala will not be injured during the periods of normal flood. But . . . during certain periods of prolonged scarcity, the water remaining below the dam might not be sufficient for the needs of Kassala if a discharge of 10 cubic metres per second were taken continuously from the river as provided for in the project in question.

U.N. LEG. SER. 128, at 130-31.

37. Austria-Bavaria, agreement concerning regime of the frontier line, June 24, 1862; U.N. LEG. SER. 468, art. 58 (3).

38. Austria-Germany (Bavaria), agreement concerning diversion of water, Oct. 16, 1950, U.N. LEG. SER. 469, art. 2(d).

39. Czechoslovakia-Hungary, frontier waters agreement, Apr. 16, 1954, U.N. LEG. SER. 564.

40. Austria-Czechoslovakia, treaty regarding the settlement of frontier legal questions, December 13, 1928, U.N. LEG. SER. 452.

and minimum lake levels.[41] It may be noted that the first of these treaties (Czech-Hungary of 1954) also takes account of the effect of works outside the frontier sections on transboundary waters.

TREATIES RECOGNIZING EFFECTS OF SURFACE WATER DEVELOPMENT ON GROUND WATER

A further step toward recognition of the interrelationship between surface and ground waters and of the need to protect the latter is represented by those treaties which explicitly concern themselves with the effect of surface water utilization upon ground waters, and vice-versa. Four of these are between the German Federal Republic (or its political subdivisions) and neighboring Luxembourg and France, and some date back to the 1950's. Those with Luxembourg concern hydropower plant construction. The treaty of April 25, 1950, between Luxembourg and the Land Rhineland-Palatinate, provides in Art. 10:

> (1) In the event of damage caused by a rise or fall in the groundwater on the left side of the Sauer (Sure) in consequence of the construction of the dam, the Government of the Grand Duchy of Luxembourg undertakes to rectify such damage or pay appropriate compensation.
> (2) Before and during construction of the dam and after it has been put into operation, the power-plant undertaking shall with the aid of suitable experts, ascertain the nature of groundwater conditions in the German areas affected by the dam.[42]

Eight years later, a similar agreement between Luxembourg and the Land Rhineland-Palatinate, concerning hydropower installations on the River Our, declared in Annex II, Art. 4:

> Where any parcel of land, even though not directly affected, suffers impairment—e.g., through an adverse change in the ground-water level—the impairment shall be prevented or so far as possible limited by such measures as are possible. Where the cost of such measures is greater than the damage incurred or where the measures are otherwise economically unsound, suitable monetary compensation shall be made.[43]

The agreements between the German Federal Republic and France

41. USSR-Norway-Finland, agreement concerning the regulation of Lake Inari, April 29, 1959, U.N. LEG. SER. 434.
42. U.N. LEG. SER. 721.
43. Luxembourg-Land Rhineland-Palatinate, agreement of July 10, 1958, U.N. LEG. SER. 726.

relate to measures for the regulation and joint development of the upper course of the Rhine. That of 1956 obligates each of the parties to be responsible within its territory for the measures necessary to avert on its bank any damage caused by variation in the ground water table.[44] The 1970 convention, concerning the area between Strasbourg/Kehl and Lauterbourg/Neuburgweier, establishes as one of the conditions for development of the river that it shall not cause "any adverse change in the present water-table" and that the interests of water supply shall be preserved.[45]

A more systematic approach to the interrelationship between surface and ground water is contained in the procès-verbal between Yugoslavia and Greece of 1957, concerning a plan of collaboration for hydroeconomic studies of the drainage basin of Lake Dojran.[46] One of the necessary studies listed is observation of ground water levels in relation to different levels of lake waters, and Section B (II) of the procès-verbal states:

> The two Delegations are agreed that the study of the groundwater level is useful and that each country organize and execute this study on its own territory over an area which will permit obtaining sufficient data on the influence of ground waters on the level of the lake and vice versa.[47]

Thus, at long last treaty law has begun to acknowledge that ground waters can be adversely affected by surface water development, that they merit independent investigation, and that they fall within the scope of agreements pertaining to international drainage basins.

PROTECTION OF SURFACE WATERS AT THE EXPENSE OF GROUND WATER

Whereas surface water treaties restricting frontier-zone activities and providing for minimum flows were at least indirectly protective of ground waters, the earlier treaties on control of surface water pollution probably were not very much help in preventing the contamination of interrelated ground waters. Indeed, they may even have been detrimental. The Paris Convention of March 9, 1904, between France and Switzerland, regulating fishing in boundary waters states in Art. 6:

44. Germany (Federal Republic)-France, convention on the regulation of the upper course of the Rhine between Basle and Strasbourg, Oct. 27, 1956, U.N. LEG. SER. 660, art. 4(2).

45. Germany (Federal Republic)-France, convention concerning development of the Rhine between Strasbourg/Kehl and Lauterbourg/Neuburgweier, 760 U.N.T.S. 346 (1970).

46. U.N. LEG. SER. 813.

47. *Id.* at 816.

> Factories, mills and other establishments located in the vicinity of the Lake (of Geneva) are prohibited from discharging into the waters waste or substances injurious to fish. Such establishments are under the obligation to ensure at their own cost *that such substances are discharged into the soil* (Emphasis added).[48]

These wastes presumably filtered, perhaps harmlessly, perhaps not, into the underlying aquifer and eventually into the lake. In those days the use of deep wells, soak pits, etc., for disposal of effluents into the ground was perhaps the only way to comply with the absolute prohibition in many treaties on pollutant discharge into surface waters.[49]

The situation is not much better in the modern era of water standards, effluent standards, effluent charges and the panoply of measures designed to clean up surface waters. Wastes, particularly toxic wastes, must be disposed of somewhere. With the exception of recycling of water and recovery of solids, there is little choice but to dispose of them in the ground. So, for example, the remedy proposed in the 1976 Rhine Convention[50] for the problem of pollution from the Alsace potash mines was to require the French to bury the wastes on their territory instead of spilling them into an international river. Not unnaturally the French have balked at this solution because of the potential threat to ground water resources.

The Convention requires that the discharge of chloride ions into the Rhine eventually be reduced by at least 60 kilograms per second dry salt equivalent, annual average, and initially by 20 kilograms per second.[51] To realize this goal, the French Government must install a system for the injection of saline water from the Alsace mines into deep limestone strata southwest of Mulhouse using wells sunk to a depth of 1500 to 2000 meters. The saline water is to be concentrated at a brine manufacturing plant located at the mine, capable of supplying a volume of brine equivalent to 20kg/s of chloride ions, annual average. One network of pipes will conduct the concentrated brine from the storage area to the injection wells over a distance of some 10 kilometers; another will carry the extracted waste water over approximately 20 kilometers to a collecting basin for such efflu-

48. U.N. LEG. SER. 701.

49. Such generalized prohibitions on pollution of any kind or in any amount occur, e.g., in the Boundary Waters Treaty of Jan. 11, 1909, between the United States and the United Kingdom (Canada), 36 Stat. 2448, T.S. No. 548, art. I; and in the Danish-German frontier waters agreement of Apr. 10, 1922, U.N. LEG. SER. 588, art. 29.

50. Convention on the Protection of the Rhine Against Pollution by Chlorides, Dec. 3, 1976, text in 1 BNA INT'L ENV. RPTR., Reference File [hereinafter cited as BNA-IEF] 121:0521.

51. *Id.*, art. 2.

ent.[52] France is a signatory to this Convention but has not ratified it because of intense opposition from constituencies in the area affected.[53]

The attitude of those concerned is understandable. The technical conditions imposed by the Convention raise problems similar to those posed by the burial of radioactive wastes and by the transport of oil by pipeline. The Convention recognized that ground water pollution may result from the saline injection system, but required France to take steps immediately to remedy the situation, and to resume the injection or resorption process as soon as the danger is past.[54] These conditions are stringent indeed. A pipeline break can be mended, but damage to the water table already will have resulted and may not be easy to remedy. As for leakage from the storage basins or the wells, the remote control monitoring network described in the Annex may take care of that—or it may not. Pollution seems to accord with the old army adage: if something can go wrong, it will. Thus the 1976 Convention may succeed merely in shifting the injury from a transnational victim, the Dutch, to domestic victims, the French communities within the area of the injection system installations. An alternative, of course, would be to require that the potash mines be closed down altogether.

GROUND WATERS AND POLLUTION IN TREATIES

The next stage in the development of international measures for the protection of ground water against pollution is formed by a group of treaties which specifically mention or include the problem. There are not many of these and they all are quite recent (within the past quarter century). Nevertheless they do make provision, for the first time, for the inclusion of ground water pollution control within the jurisdiction of boundary commissions and boundary water institutions. Several of the treaties are between the socialist countries of eastern Europe; e.g., Yugoslavia-Hungary (1955), Yugoslavia-Albania (1956), Yugoslavia-Bulgaria (1958), Poland-Czechoslovakia (1958), and Poland-USSR (1964).[55] There is also the 1972 agreement between Finland and Sweden concerning frontier rivers, the Swiss-Italian convention of the same year concerning the protection of the

52. *Id.*, Annex I.

53. 1 BNA INT'L ENV. RPTR., CURR. REPT. 174-75 (1978).

54. Convention, *supra* note 50, art. 4.

55. Yugoslavia-Hungary, Aug. 8, 1955, U.N. LEG. SER. 830; Yugoslavia-Albania, Dec. 5, 1956, *id.* at 441; Yugoslavia-Bulgaria, Apr. 4, 1958, *id.* at 558; Poland-Czechoslovakia, Mar. 21, 1958, 538 U.N.T.S. 108, No. 7811; Poland-USSR, July 17, 1964, 552 U.N.T.S. 175.

Italo-Swiss waters, and the U.S.-Mexico agreement (Minute 242) of 1973.[5 6]

The Italian-Swiss convention is the only one concerned solely with pollution. In most of the other treaties the extent of protection of ground water quality can be ascertained only by construing together separate references to ground water, frontier waters, and water quality generally.

In the Yugoslav agreements these references are included within the broader context of the expressions "water economy" and "water systems." The first paragraph of the first Article in all three agreements contains identical wording as to water economy and water quality: "The Contracting Parties undertake . . . to examine and resolve all questions of water economy, including measures and works which may affect the quantity and quality of the waters and which are of interest to both or either of the Contracting Parties."[5 7]

The expression "water system intersected by the State frontier" is used to bring ground water and protection against pollution within the purview of the agreements as separate items in a long list of water economy questions: "The provisions of this Agreement shall . . . apply to all water economy questions, measures, and works on . . . water systems intersected by the State frontier, and in particular to: . . . ."[5 8]

"Water system" is defined as "all watercourses (surface or underground, natural or artificial), installations, measures and works which may affect watercourses from the standpoint of water economy, and installations forming or intersected by the State frontier."[5 9] The use of the words "watercourses . . . underground" raises the question whether percolating ground water, as distinct from underground streams, really comes within the scope of these agreements. The Czech-Polish agreement of 1958 also is somewhat ambiguous as to whether it refers to underground streams or percolating waters. Article 2(1)(b) defines frontier ground waters merely as ". . . ground

56. Finland-Sweden, agreement concerning frontier rivers, Dec. 15, 1971, 825 U.N.T.S. 272; Italy-Switzerland, convention of Apr. 20, 1972, text in Rev. Gen. de Droit Int'l Publ. 265 (1975); Mexico-United States, Agreement of Aug. 30, 1973, on a Permanent and Definitive Solution to the International Problems of Salinity of the Colorado River, Minute No. 242, International Boundary & Water Commission, text in 69 DEPT. STATE BULL. 395 (1973).

57. U.N. LEG. SER. 441 (Yugoslavia-Albania), 558 (Yugoslavia-Bulgaria), 830 (Yugoslavia-Hungary).

58. Art. 1 (2) in the treaties between Yugoslavia-Bulgaria and Yugoslavia-Hungary, U.N. LEG. SER. 558 and 831.

59. Art. 1 (3) of the agreements between Yugoslavia-Albania and Yugoslavia-Hungary, U.N. LEG. SER. 442 and 831.

waters *flowing* from the territory of one State to the territory of the other, *at those places where they are intersected by the State* frontier" (emphasis added). If strictly interpreted, this definition is narrow indeed.[60]

By contrast the Polish-Soviet treaty of 1964 contains broader definitions and is explicit. Article 2(3) defines frontier waters as including "ground waters intersected by the state frontier" and Article 3(7), which refers to the protection of surface "and ground waters" against depletion and pollution, definitely includes protection of transboundary aquifers as part of the subject matter of the agreement.[61] The 1972 convention between Italy and Switzerland also leaves no doubt as to whether pollution protection for ground waters comes within its scope, although its enumeration of shared waters lists only surface bodies.[62]

The Finnish-Swedish agreement contains no preambular statement or definition specifically referring to ground waters.[63] Article 1 of Chapter 3 states the provisions concerning hydraulic construction works also apply to measures taken in any waters "which may affect ground water conditions." There is nothing to distinguish this clause from provisions of surface water treaties previously mentioned relating to the effect on ground waters of works carried out in surface waters. However, the agreement's Chapter 6 with Annex C is concerned solely with pollution control and if the term "waters" can be broadly construed as pertaining also to ground water, then the treaty must be considered quite advanced in this respect. Annex C contains a long list of polluting operations which may not be carried on without permission, including mining, agricultural activities, metal works, and solid waste disposal. Part 7 of the Annex, dealing with solid waste disposal, applies to the "piling up of solid substances in such a way that waters may be polluted." This leaves room at least for the protection of ground water quality in the frontier zone.

The agreement between Mexico and the United States of August 30, 1973, known as Minute 242, is concerned primarily with the quality of Colorado River waters delivered to Mexico on the basis of the 1944 treaty, and only secondarily with pollution of ground waters in the border zone.[64] Its importance lies in the fact that it is a

60. 538 U.N.T.S. 108.

61. 552 U.N.T.S. 175.

62. Italy-Switzerland, convention of Apr. 20, 1972, *supra* note 56, art. 1. The waters listed are Lakes Maggioro and Lugano and the watercourses of the Doveria, Melezza, Giona, Tresa, Breggia, Maira, Poschiavino, and Spöl.

63. 825 U.N.T.S. 272.

64. Minute 242, *see* note 56 *supra*; 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.

prelude to a comprehensive settlement, for which negotiations already are in progress, of U.S.-Mexico boundary water questions, including the preservation of ground water quality. Since Minute 242 addressed the salinization problem that had arisen because of overpumping of ground water and leaching of irrigation return flows, the provisions for correcting the situation include a curtailment of pumping, the substitution of clean water, and limitations on land development. In other words, Minute 242 is an interim measure designed to enable the United States to fulfill its obligations under the 1944 treaty, relating to allocation of surface waters to Mexico. However, there may be read into this agreement a recognition of the principle *neminem laedere* as far as the pollution of waters, including ground water is concerned.

Most of the treaties discussed here envisage a survey of ground waters in boundary areas, either as part of a general study of frontier waters or as a separate study. The Polish-Soviet agreement of 1964, Art. 3(9) states:

> The purpose of this Agreement is to ensure co-operation between the Contracting Parties in economic, scientific and technical activities relating to the use of water resources in frontier waters, including in particular: . . . .
> (9) The study of frontier waters for the purpose of determining their quantity and quality. . . .

On the other hand, the Yugoslav-Bulgarian agreement of 1958 in Art. 1(2)(f) refers to the study and utilization of ground water.[65] Provisions for a general exchange of physical data are contained in the three Yugoslav instruments and the Polish-Soviet agreement of 1964. The latter specifically includes ground water information: Art. 8(1) provides that the parties "shall establish principles of cooperation governing the regular exchange of hydrological, hydrometeorological and *hydrogeological* information . . ." (emphasis added).[66] The three Yugoslav treaties go further and mandate the exchange of plans, or information about plans—a general provision which may be construed again as applying to ground water. The wording in all three is identical, it is contained in Art. 1(2), the "shopping list" article on

For an exhaustive discussion of Minute 242 and further developments toward the regulation of international ground water resources along the Mexico-U.S. border, *see generally,* International Symposium on Salinity of the Colorado River, 15 NAT. RES. J. 2 *et seq.* (1975), and Symposium on U.S.-Mexican Transboundary Resources, Parts I and II, the work of the U.S.-Mexico Transboundary Resources Study Group, in Vols. 17, No. 4 and 18, No. 1 of the Natural Resources Journal.

65. 552 U.N.T.S. 175; U.N. LEG. SER. 558.

66. U.N.T.S. 8054.

water economy questions and refers to all other items on the list.[67]

The obligations of treaty parties in adopting measures to prevent pollution of ground waters range from very general to quite specific. In the Yugoslav group of treaties, a general duty to prevent contamination of frontier waters can be inferred to extend to transboundary ground waters only by construing together (as noted above) separate references to ground waters and pollution prevention, which are in the list of water economy questions deemed of particular interest to the contracting parties. The Polish-Soviet agreement expresses the duty both more specifically and in more detail. Arts. 2(3) and 3(7) bring ground water within the definition of frontier waters and the purview of pollution prevention. Art. 4(2), which otherwise appears to be a typical surface water pollution provision, defines protection of water quality as:

> . . . protection against the introduction into the waters, directly or indirectly, of solid, liquid or gaseous substances and heat in such quantities as may cause physical, chemical and biological changes which limit or prevent the normal utilization of the said waters for communal, industrial, agricultural, fishery or other purposes.[68]

This potentially covers not only the contamination of ground waters by, for example, injection of liquid effluent which requires control of direct pollution sources, but it also covers such matters as leaching of wastes from landfills and dump sites. In the former case pollution control would require direct control of the pollution sources, which in the latter control would require land use regulation. Art. 9.4 requires approval of the contracting parties in each case for the discharge of sewage and other water into frontier waters. Art. 10 obligates the parties to conduct joint measurements with regard to frontier waters pollution, to work out common standards and norms on water purity, and if necessary to establish joint procedures for controlling pollution. Finally Art. 11, somewhat redundantly proclaims that: "The Contracting Parties shall endeavour to keep frontier waters clean, shall employ appropriate procedures for suitably purifying sewage and rendering it harmless, and shall not discharge any sewage which may cause harmful pollution of frontier waters."[69]

The agreement between Poland and Czechoslovakia of 1958 is considerably narrower in scope. As previously noted, its application to ground waters is restricted to those "flowing from the territory of

67. U.N. LEG. SER. 441 at 442, 558 at 559, 830 & 831.
68. U.N.T.S. 8054.
69. *Id.*

one State to the territory of the other, at those places where they are intersected by the State frontier," (Art. 2(1)(b)) and it contains no definition of pollution. Art. 3(2) requires the parties to reach agreement concerning the discharge of waste water. Subsection 4 of Art. 3 states: "The Contracting Parties have agreed to abate the pollution of frontier waters and to keep them clean to such extent as is specifically determined in each particular case in accordance with the economic and technical possibilities and requirements of the Contracting Parties . . ." and subsection 5 merely requires that when installations discharging polluted water into frontier waters are constructed or reconstructed the waste water is to be treated.[70]

Examination of this meager international practice demonstrates that ground water pollution and activities which may lead to it are treated as part (for that matter, a minor part) of surface water quality management, not as a separate problem necessitating separate provisions. The wording of the treaties lacks precision regarding the occurrence of ground water, the pathways of its contamination, or the means which might be used to control, prevent and remedy such contamination. On the other hand, they are replete with loophole expressions such as "harmful" pollution, "if necessary, to establish procedures," and "in accordance with the economic and technical possibilities and requirement of the contracting parties," expressions which lend themselves to varied interpretations.[71] Only one of them attempts to define pollution or to prescribe common standards.[72] Nevertheless, these treaties represent the beginnings of an international law on groundwater pollution.

INSTITUTIONS AND AREA UNITS FOR GROUND WATER PROTECTION

The administration and implementation of these treaty provisions nearly always is entrusted to joint commisions. In all three of the Yugoslav treaties these are "water economy" commissions, in the Finnish-Swedish agreement there is a "frontier river" commission, and in the Italian-Swiss convention a "mixed" commission. The Polish-Soviet and Polish-Czech agreements make no provision for a permanent entity of this nature but require each of the contracting parties to appoint a government plenipotentiary and deputies, to be "where necessary" to hold discussions alternately in each party's

70. 538 U.N.T.S. 108, 110.

71. Poland-USSR, frontier waters agreement of July 17, 1964, 552 U.N.T.S. 175, arts. 10 and 11; and Poland-Czechoslovakia, frontier waters agreement of Mar. 21, 1958, 538 U.N.T.S. 108, No. 7811, art. 3 (4).

72. The Polish-Soviet agreement, 552 U.N.T.S. 175, art. 10.

territory.[73] The powers and duties of the commissions and plenipotentiaries with regard to control of ground water pollution are not precisely defined. The Italian-Swiss antipollution convention accords its mixed commission the authority merely to examine pollution problems, undertake research, "make use of the information so obtained," and propose to the contracting parties measures and projects for prevention and control of contamination,[74] but even this delegation does not afford a clear definition of duties with regard to ground water.

This lack of defined powers should not be surprising when we consider the weakness of the administrative machinery set up for surface water bodies and especially for some of the major rivers. It has taken the International Commission for the Protection of the Rhine Against Pollution the better part of two decades to come up with a workable solution to the problem of chloride pollution, and agreement is not yet in sight.[75] The Commission is largely advisory in nature; it can carry out research and analysis, but has no independent authority to act. Understandably, a group of Dutch horticulturists, hard hit by the chloride pollution, preferred to institute proceedings directly against the French company responsible rather than to await the relief to be afforded by the 1976 Rhine Convention which has not been ratified by the French Government.[76]

The same applies to the Danube and its tributaries, perhaps with even more force. The CMEA states (Hungary, Rumania, and Czechoslovakia) cooperate with each other, but because Austria contributes a considerable amount to the pollution downstream it has not been possible to achieve pollution control for the river as a whole through the auspices of the Danube Commission.[77]

Nor do the existing international river basin commissions offer much hope for a problem like that of ground water pollution where any reasonably effective ground water pollution control measures imply considerable encroachment upon national sovereignty. Commissions are primarily consultative bodies, with weak future planning machinery and no power to make binding decisions.[78] There are two

73. *Id.*, arts. 12 (1) and 13 (1), and Polish-Czech agreement, *supra* note 71, art. 9.

74. Italy-Switzerland, convention of Apr. 20, 1972, *supra* note 56, art. 3.

75. The Commission operates under the Convention of Apr. 29, 1963, between France, the Federal Republic of Germany, Luxembourg, the Netherlands, and Switzerland, which entered into force on May 1, 1965; text in [1974] Beiträge zur Umweltgestaltung B7, Internationales Umweltrecht-Multilaterale Verträge, No. 963: 31/1.

76. 1 BNA INT'L ENV. RPTR. CURR. REPT. 38-39 (1978).

77. *See* Utton, *International Water Quality Law,* in INTERNATIONAL ENVIRONMENTAL LAW 173 (1974).

78. *See* L. TECLAFF, THE RIVER BASIN IN HISTORY AND LAW, ch. 6 and especially 178-79 (1967).

exceptions to this rule, however, among the entities established by interprovincial agreement. They are the Delaware and Susquehanna River Basin Commissions, and the scope of their existing and potential authority with regard to ground water pollution merits analysis.

Art. 1.2(i) of the Delaware River Basin Compact of 1961 defines water resources as including "water and related natural resources in, on, under, or above the ground, *including related uses of land,* which are subject to beneficial use, ownership or control" (emphasis added).[79] The Basin Commission established by Art. 2 has power to act not only within the basin but also outside it (Art. 2.7, "in its discretion" and "upon the consent of the state in which it proposes to act"); to carry out ground water research, forecasting, and other investigations (Art. 3.6); to acquire, operate and control projects and facilities for regulation of supplies of ground waters and, *inter alia,* for "dilution and abatement of pollution, the prevention of undue salinity and other purposes" (Art. 4.2(a)). Art. 5, dealing with pollution control, contains no specific mention of ground water contamination as such, but it does give the Commission jurisdiction to control pollution. The Commission may classify the waters of the basin and establish standards of waste treatment, including allowance for the variable factors of ground waters such as movement, location, character, self-purification, and usage (Art. 5.2). It can issue orders to cease discharges that violate its rules and regulations, and these orders are reviewable and enforceable in any court of competent jurisdiction of the party states (Art. 5.4). Using its authority under the Compact, the Commission has dealt, by individual docket and by informal cooperative arrangements negotiated orally or by correspondence, with a wide variety of problems. These include the removal of contaminants from ground water, the storage of potentially polluting substances in underground caverns, the approval of landfill projects, and the establishment of procedures to prevent raising the water temperature in an aquifer through recharge.

Similar powers have been granted to the Susquehanna River Basin Commission.[80] It can act outside the basin where necessary (Art. 2.7), an important factor in the case of aquifers whose boundaries extend beyond the surface drainage area; it can plan, construct, and operate facilities; establish standards of design and operation for all operations and facilities affecting water resources, including ground water recharge operation (Art. 3.4); and in regard to water quality

79. Delaware River Basin Compact, 1961, Penna. Stats. Ann., tit. 2, §815.101 *et seq.* (Purdon 1967).

80. Susquehanna River Basin Compact, 1968, Penna. Stats. Ann., tit. 2, §820.1 *et seq.* (Purdon Supp. 1978).

management, it can recommend standards to the party states and adopt them itself (Art. 5.2). In August 1978 the Susquehanna Commission published standards specifically governing ground water development.[81] These regulations require ground water developers to meter withdrawals, monitor water table levels, develop a water conservation program, and report water quality information. The water quality analyses must be submitted every three years after the initial application and must include twenty-two measurements (conductance, pH, hardness, and dissolved solids, plus eighteen minerals actually or potentially harmful). If the ground water is to be used for drinking purposes additional sampling and analyses are required. The regulations apply to any project sponsor proposing to withdraw ground water from a well or well field, or proposing to increase an existing withdrawal in excess of 100,000 gallons per day.

It must be emphasized that the foregoing international and interprovincial agreements provide for ground water pollution control basically within areal units of surface water management, whether these are artificial units comprising narrow frontier zones or natural ecosystems comprising huge river basins. International law has not yet matured to the point where it can create institutions to manage large transboundary regional aquifers, although there are promising developments in that direction.[82] One of these developments has arisen from the worldwide struggle to combat desertification, and in particular from a United Nations feasibility study on transnational cooperation in the shared use and management of large aquifers in northeast Africa and the Arabian Peninsula.[83] That study noted a growing ground water pollution problem on the eastern side of the Arabian Peninsula caused by intrusion of saline waters of the Arabian (Persian) Gulf, aggravated by the common petroleum industry practice of injecting sea water or brackish water into oil fields to the detriment of fresh water in the limestone aquifer in the several countries bordering the Gulf. One of the four pilot aquifer projects proposed by the study, and the only one which concerns pollution, would concentrate on management of this limestone aquifer.[84] As for the institutional framework in the preparatory phase of transnational cooperation (this applies to all four projects), the study proposes:

81. 43 Fed. Reg. 34127 (Aug. 3, 1978).

82. Especially on the U.S.-Mexico frontier. *See* Hayton, *Institutional Alternatives for Mexico-U.S. Groundwater Management*, 18 NAT. RES. J. 201 (1978).

83. U.N. Conference on Desertification, Aug. 29-Sept. 9, 1977, Nairobi. Background Document and Feasibility Study, Transnational Project: The Management of the Major Regional Aquifers in North-east Africa and the Arabian Peninsula, A/CONF.74, 24.

84. *Id.* at 17.

(a) a technical committee (or a single technical specialist) at the country level;
(b) a technical steering committee at the regional level, which would include one representative from each country and would designate a regional representative to assist in coordinating the activities at the regional level; and
(c) an Interregional Coordinating Office for the Management of the Major Regional Aquifers in North East Africa and the Arabian Peninsula (ICOMRA), to be established as a project of the United Nations system. This office would be directed by an international expert as coordinator, assisted by the two regional representatives (Northeast Africa and Arabian Peninsula), consultants and other required experts.[85]

GUIDELINES FOR GROUND WATER POLLUTION CONTROL: TRANSNATIONAL AND DOMESTIC

Beyond the proposal for an institutional framework based on the aquifer and the region, however, the U.N. feasibility study is hardly more specific in its recommendations for international ground water management and ground water pollution control than the treaties discussed previously. It has remained for international organizations in the region most severely threatened: western Europe—to come up with specific formulations aimed at controlling and preventing pollution through harmonization of national laws. So far this appears to be the most feasible approach, given the basic difficulty of reconciling land use regulation (which is crucial to the success of any ground water pollution abatement program) with the preservation of national sovereignty. The European Economic Community is progressing steadily in the direction of a comprehensive set of rules for protection of ground water. Its program of action includes the following specific elements within the general goal of protecting all water:

—gradually restricting the use of certain underground waters to human consumption as much as is compatible with a rational management of resources;
—protecting the quality of ground water and its abstraction points against pollution and against any ecologically unacceptable deterioration in the ground water system.[86]

The action program also alludes to the possibility that tipping or dumping on the ground as a means of waste disposal may well in-

85. *Id.*
86. BNA IEF 131:0318 (1978).

crease as a result of anti-pollution measures to prevent disposal into surface streams.[87]

The EEC documents which relate most directly to ground water quality are the directives or proposed directives on drinking water,[88] disposal of waste oils,[89] discharge of dangerous substances into the aquatic environment,[90] titanium dioxide waste,[91] toxic and dangerous waste,[92] and protection of ground water against pollution caused by certain dangerous substances.[93] Of these, by far the most important and wide reaching is the last. The lack of any regulation of discharges from agricultural activities has been much criticized in view of the large concentrations of nitrates from fertilizer percolating down to aquifers, especially from arable land. However, the EEC is reported to be preparing a separate draft directive on agricultural pollution.[94]

The EEC groups pollutants according to their toxicity into "black" lists for those considered most dangerous and "grey" lists for those which are deleterious but which can be discharged in controlled quantities, usually under permit. Such lists have been for some time now a standard feature of conventions on the marine environment—for example, the Oslo and London dumping conventions[95]—and their somewhat tardy introduction into ground water protection measures illustrates the position of ground water as a

87. *Id.*

88. Council of European Communities Proposed Directive on Drinking Water, July 31, 1975 (OJ C 214, Sept. 18, 1975), text in BNA IEF 151:3101. Art. 2 makes particular reference to private wells and drill-holes in its definition of water for human consumption. Art. 4 requires member states to take steps to ensure that such water conforms to values to be fixed for all the parameters given in Annex I of the directive, this goal to be achieved by regular monitoring according to procedures set down in Annexes II and III (art. 6).

89. Council of European Communities Directive on Disposal of Waste Oils, June 16, 1975 (75/439/EEC-OJ 194, July 25, 1975), text in BNA IEF 181:0201. This directive obligates member states to take the "necessary" measures to ensure the prohibition of discharge of waste oils into ground water (art. 4) and requires a permit (art. 6), but is not specific as to the means to be used.

90. Council of European Communities Directive on the Discharge of Dangerous Substances into the Aquatic Environment, May 4, 1976 (76/464/EEC-OJ L 129, May 18, 1976), text in BNA IEF 151:1201.

91. Council of European Communities Directive on Titanium Dioxide Industry Waste, Feb. 20, 1978 (78/176/EEC-OJ L 54, Feb. 25, 1978), text in BNA IEF 151:1401.

92. Council of European Communities Directive on Toxic and Dangerous Waste, Mar. 20, 1978 (78/319/EEC-OJ L 84, Mar. 31, 1978), text in BNA IEF 161:1201.

93. Draft EEC Council of Ministers Directive to the Member States on Protection of Groundwater Against Pollution Caused by Certain Dangerous Substances, Jan. 24, 1978 (COM (78) 3 final), text in 1 BNA INT'L ENV. RPTR., CURR. REPT 46-48 (1978).

94. 1 BNA INT'L ENV. RPTR., CURR. REPT. 290 (1978).

95. Oslo Convention for the Prevention of Marine Pollution by Dumping from Ships and Aircraft, Feb. 15, 1972, text in 11 Int'l Leg. Mat. 262 (1972); London Convention on Prevention of Marine Pollution by Dumping of Waste and Other Matter, Dec. 29, 1972, text in 11 Int'l Leg. Mat. 1291 (1972).

stepchild of international environmental concern. In these directives the EEC also moves, albeit somewhat tentatively, into land-use regulation by means of controls on the indirect discharge of contaminants, i.e., the introduction of substances into ground water after passage through the ground. A third major feature of the guidelines is the stress, especially in the latest directives, on monitoring and recording the disposal of hazardous pollutants because of their toxicity and long life. This entire approach, if not coupled with too many expectations, seems a most promising way of dealing with ground water contamination.

The May 1976 EEC directive on pollution caused by dangerous substances discharged into the aquatic environment[96] is aimed primarily at surface water and applies to ground water only until the draft directive of January 1978,[97] or a similarly specific set of rules, takes effect. The May directive calls for the establishment of two lists of pollutants and requires member states to apply a system of zero-emission to discharges into ground water of substances within List I, the "black" list. The March 1978 directive on disposal of toxic and dangerous waste[98] encompasses substances and materials listed in the Annex as requiring priority consideration. It requires member states to ensure that toxic or dangerous waste is disposed of without risk to water, to prohibit its abandonment and uncontrolled discharge, to ensure the recording of each disposal and disposal site, to control by authorization the storage, treatment and/or deposit of wastes, including precautions to be taken and methods of disposal, and to require that records be kept of such wastes from their origin to their disposal.[99] The directive specifically excludes wastes covered by previous Community rules, such as titanium dioxide, which is covered with similar provisions.[100]

The draft directive of January 24, 1978, on protection of underground waters[101] resembles other EEC directives in its inclusion of a

96. *Supra* note 90.

97. *Supra* note 93.

98. *Supra* note 92.

99. *Id.* arts. 5 (1), 5 (2), 7, and 9 respectively.

100. *Supra* note 91. This directive applies to disposal directly by discharge into ground water as well as by other means, such as storage, which may affect ground water indirectly (art. 1 (c)). It requires prior authorization not only by the member states in whose territory the waste is produced, but also by the member state in whose territory the waste is disposed of (art. 4), a provision which evidently takes account of the export of waste. It also requires monitoring of the waste, to be carried out by a jointly appointed body in the case of transfrontier pollution (art. 7 and Annex II). When wastes are stored on land or injected into the ground the monitoring must include tests to ensure that ground waters are not contaminated (Annex II, B).

101. *Supra* note 93.

primary or "black" list of seven groups of substances whose direct discharge or injection underground would be prohibited altogether (with certain specific exceptions). Also included is a secondary or "grey" list of less toxic substances whose discharge, whether directly or indirectly, would be governed by authorization. The exceptions to and exclusions from the provisions of this directive are significant and some of them have sparked a good deal of controversy within the Community. *Direct* discharge into ground water of the substances on List I is prohibited.[102] But member states may make exceptions under a system of prior authorization, *inter alia,* for discharges into aquifers which are isolated from the biosphere and unusable for any purpose. This includes domestic or agricultural discharges; discharges caused by re-injection into the same aquifers of waters used for geothermal purposes, water pumped out of mines and quarries, or water pumped out for civil engineering purposes; discharges caused by the injection of waste water used in exploring for and working resources contained in the ground, and finally, discharges caused by the exploitation of these resources.[103] Moreover, *indirect* discharge is permitted for substances on List I, under a system of prior authorization.[104]

Member states may grant the authorizations only after consideration of the hydrogeological conditions of the area concerned, and on the condition that no significant risk of pollution exists.[105] The authorizations must specify the place and method of discharge, individual precautions to be taken in each case and, where necessary, maximum permissible concentrations and quantities over time.[106] Member states are required to keep an inventory of authorizations granted for direct or indirect discharge of substances in List I[107] and upon request by the Commission are to provide information on hydrogeological conditions, details of authorizations granted, results of monitoring and inspection, and results of the inventory.[108]

Predictably, most of the objections to the directive as being too stringent have come from Great Britain which is far less dependent upon ground water than most other Community members, and does not have to worry about transfrontier pollution. Britain objects to the complete ban on direct discharge of List I substances as unneces-

102. *Id.*, art. 3 (1).
103. *Id.*, art. 3 (2) (a, b and c).
104. *Id.*, art. 4.
105. *Id.*, art. 5.
106. *Id.*, art. 6.
107. *Id.*, art. 9. This is not required in the case of substances on List II.
108. *Id.*, art. 10 (1).

sary, impractical, and imprecisely defined, inasmuch as the substances banned under Art. 3 are not necessarily all the substances on List I.[109] They also consider the controls over indirect discharge unnecessary if waste disposal is carried out according to existing Community measures (e.g., the directive on toxic and dangerous waste) and believe it impracticable to monitor and control some kinds of discharges, such as leachate from waste disposal sites. Indeed, they would propose to exempt properly authorized waste sites from the scope of the directive altogether.[110] By contrast, an influential body of opinion in Europe regards the draft directive as not sufficiently stringent. In November 1978 the European Parliament adopted a resolution proposed by its Committee on the Environment, Public Health and Consumer Protection urging that the draft directive be tightened. It also proposed that karst zone waters in limestone caverns be given special protection, and expressed concern over the loophole in the ban on List I discharges afforded by the permission to discharge under prior authorization.[111]

It may be useful at this point quickly to review the situation in the United States, where in recent years stringent and detailed measures to protect ground water quality have also developed. The trends emerging appear to run parallel to those in the European Communities and offer the hope that appropriate measures in municipal law (especially in large federal states) will percolate at an accelerating pace into international law.

The major U.S. measures for ground water protection include the Safe Drinking Water Act of 1974,[112] especially its provisions for underground injection practices and "sole source" aquifers; the regulations under that Act promulgated by the EPA in October 1978;[113] and the EPA's proposed regulations, published in December 1978, on the handling and disposal of hazardous wastes.[114]

The relevant portion of the Safe Drinking Water Act is Part C, Sec. 1421 *et seq.*, which concern the protection of underground sources of drinking water. Section 1424(e) provides for the designation of an entire aquifer as a "sole source" if it is the sole or principal drinking

109. *See* 1 BNA INT'L ENV. RPTR., CURR. REPT. 290-91 (1978) for a summary of criticisms contained in a report from the House of Lords Select Committee on the European Communities.

110. In order to avoid conflict between the directive and the provisions of the Control of Pollution Act (1974), which regulates waste disposal sites in Great Britain. 1 BNA INT'L ENV. RPTR., CURR. REPT. 453-54 (1978).

111. 1 BNA INT'L ENV. RPTR., CURR. REPT. 421 (1978).

112. 42 U.S.C. §300f *et seq.* (1976).

113. 43 Feb. Reg. 47130 (1978).

114. 43 Feb. Reg. 58946 (1978).

water source for an area and if it permits the withholding of federal government assistance for any project which might contaminate such an aquifer:

> If the Administrator determines, on his own initiative or upon petition that an area has an aquifer which is the sole or principal drinking water source for the area and which, if contaminated, would create a significant hazard to public health, he shall publish notice of that determination in the Federal Register. After the publication of any such notice, no commitment for Federal financial assistance (through a grant, contract, loan guarantee, or otherwise) may be entered into for any project which the Administrator determines may contaminate such aquifer through a recharge zone so as to create a significant hazard to public health, but a commitment for Federal financial assistance may, if authorized under another provision of law, be entered into the plan or design the project to assure that it will not so contaminate the aquifer.

Moreover, under Section 1424(a)(1), any person may petition the EPA Administrator to have an area of a state or states designated as an area in which no new underground injection well may be operated without an EPA permit, until a state underground injection control program comes into effect. The Administrator may so designate an area within a state if he finds that it has one aquifer which is the sole or principal drinking water source. To date only a few "sole source" designations have been made, but interestingly one of these is for an interstate aquifer, the Spokane Valley-Rathdrum Prairie aquifer extending from Washington into Idaho.[115] No provision designating an entire aquifer for protection has been made as yet in the EEC directives.

The above examples of direct federal intervention, aside the Safe Drinking Water Act creates an underground injection control program based on state activity. The Act specifies the issue of permits and primary enforcement are to be the responsibility of the states, with federal aid from EPA. The EPA is required to issue regulations specifying eligibility requirements and grant procedures and explaining criteria for evaluation of programs when states apply for grants to develop and administer injection control programs.[116] It should be noted that the 1976 Rhine Convention provides for financial aid to France, through contributions from the other contracting parties, to provide 70 percent of the cost of the chloride injection and storage system mandated in the treaty.[117] The Organization for Economic

115. *See* 42 Fed. Reg. 5749 (1977).
116. Safe Drinking Water Act of 1974, sec. 1450, 42 U.S.C. §300j-9 (1976).
117. Convention on the Protection of the Rhine Against Pollution by Chlorides, *supra* note 50, art. 7.

Co-Operation and Development (OECD) also has addressed some elements of the question of financial assistance for costly pollution control projects in the Annex to its Recommendation for Strengthening International Co-Operation on Environmental Protection in Frontier Regions, adopted September 31, 1978.[118] It urges countries to make no distinction, in granting support for an environmental protection undertaking, as to whether the action will protect their own or their neighbor's environment, and to ensure that regional and local entities in adjacent frontier regions enjoy financial facilities for a joint environmental action equivalent to those which they would be able to obtain for similar joint action with a regional or local entity in comparable zones within national territory.

According to EPA regulations and guidelines issued on October 12, 1978,[119] the basis for the allotment of grants is to be as follows: the population of each state in proportion to the total population of all states (given a weight factor of 10%); the area of each state in proportion to the total area of all states (also given a factor of 10%); and the number of injection practices in a given state in proportion to the total number of injection practices in all states (given a weight factor of 80%).[120] There have been criticisms that EPA did not include in the basis for grant allotment a factor for the volume of fluids injected, or a factor based on the extent of reliance on ground water as a sole source of water supply. EPA contended it did not have sufficient data from the states for the former, and that in the latter case EPA believed that the *absolute* number of persons rather than the percentage potentially affected by ground water pollution was more relevant as an indicator of need for the control program.[121] EPA's aid program for the states gives due weight to the seriousness of the pollution, but if densely populated areas with a large number of injection wells receive proportionately more financial aid, the result might be not unlike that which has resulted from application of the "polluter pays" principle in some parts of Europe. In those situations the regional entities in heavily industrialized districts have developed "constituencies" of polluters and an almost vested interest in the perpetuation of pollution activities because of the funds derived thereby.[122] In a transboundary context, therefore, the financing of pollution control programs needs to be evaluated carefully before it becomes enshrined in an agreement.

EPA's regulations also identify elements to be included in protec-

118. Final text in 17 Int'l Leg. Mat. 1530 (Nov. 1978).
119. 43 Fed. Reg. 47130 (1978).
120. *Id.* at 47132.
121. *Id.* at 47131.
122. *See* Harrison & Derrick Sewell, *La reorganisation economique et regionale de la gestion des eaux en France*, 20 CAHIERS DE GEOGRAPHIE DE QUEBEC 127 (1976).

tion programs. These include: inventories and assessment of underground injection facilities; administration and program development (including development and evaluation of basic underground water source protection legislation); technical assistance; plan review and approval; permit approval; training; enforcement; data management (for input into the centralized EPA system to maintain essential records); surveillance and investigation (to detect, investigate and report suspected contamination cases); and public participation and information distribution (including provision for consultation with the public and a new system for handling complaints).[123] Here, again, there are areas of resemblance to the EEC's directives, particularly in the requirement of inventories, permit approval, data management, and monitoring. The element of public participation, however, is absent from the EEC guidelines and has been left rather to the OECD in its recommendations to develop provisions for information of the public, though only to the as yet quite limited extent that domestic law permits in most European countries.[124] Section II.2 of the OECD guidelines on cooperation in frontier regions urges that:

> In accordance with the principle of equal right of access . . . Countries should in particular take care to see that persons exposed to a significant risk of transfrontier pollution are informed through channels selected by the Countries themselves and enabled to the same extent as persons in the Country of origin to take part under similar conditions in administrative and judicial hearings and proceedings.[125]

The EPA's proposed hazardous waste guidelines and regulations of December 18, 1978,[136] form an ambitious program to manage and control hazardous waste from the point of generation to the point of final disposal. To this end they resemble the EEC guidelines on disposal of toxic and dangerous waste, but they go much further in establishing procedures specifically for protection of ground waters. Note, however, that they are not aimed at protecting ground water alone, but also surface water, air, and soil.

The proposed regulations, like several of the EEC directives, establish a "black" list, but any waste would be considered hazardous if found to be toxic, chemically reactive, ignitable or corrosive.[127]

123. 43 Fed. Reg. 47133 (1978).

124. *See* Teclaff, *Harmonizing Water Resources Development and Use with Environmental Protection in Municipal and International Law,* 16 NAT. RES. J. 807, 830-34 (1976).

125. *Supra* note 118, at 1531.

126. 43 Fed. Reg. 58946 *et seq.* (1978).

127. *Id.* at 58954-58967.

Producers of more than 100 kilograms a month of hazardous wastes would be required to keep records of their quantity, constituents and disposition, and to use a manifest system to assure that wastes are delivered to an authorized disposal, treatment or storage facility.[128] Hazardous waste landfills would have to be lined with impermeable materials to prevent leaching through the soil and into water sources.[129] Constant monitoring of sites would be required, and closed sites would have to be monitored and maintained for twenty years to prevent leakage.[130]

Included in the proposed EPA regulations is an innovative procedure designed to measure or "model" improper management of waste by simulating the leaching action of rain and ground water in the acidic environment of landfills or open dumps. This has been termed the Extraction Procedure (EP).[131] The extract resulting from the EP is available for whatever toxicity test is specified in the regulations. Among other advantages, this procedure ensures coverage of wastes which might not appear to be hazardous under direct testing, but whose hazardous constituents can be released by poor management. Waste which has the potential to cause significant human health and environmental damage if not managed properly (i.e., if not delivered to a Subtitle C facility) is considered hazardous.[132]

To analyze a waste for chronic toxicity to humans, levels of contaminants in the EP extract are related to potential environmental concentrations and to levels believed hazardous to humans. This assumes disposal of the waste in a "nonsecure" landfill or dump—one in which there is nothing to prevent subsurface movement of leachate—located directly over a usable aquifer that is a source of drinking water. After the EP has been applied to the waste, a dilution factor is applied in an attempt to duplicate actual human exposure and reasonably indicate risk from the ground water route. In order to protect human health, the maximum allowable contaminant concentration permissible in the EP extract would be ten times the level that would be acceptable in drinking water.[133] Waste with an EP extract more than ten times the levels of contaminants allowed by the EPA National Interim Primary Drinking Water Standards[134] would be considered hazardous. The three elements, therefore: the

128. *Id.* at 58969-58979.
129. *Id.* at 59010-59011.
130. *Id.* at 59005, 59011.
131. *Id.* at 58952.
132. *Id.*
133. *Id.* at 58953.
134. 40 C.F.R. §141. These standards are being revised.

Extraction Procedure; the assumption of mismanagement of a dump site; and the linkage to the drinking water standards, provide a screening mechanism to show which wastes require special management. The process of monitoring and evaluation is designed to close loopholes as much as possible. For example, producers who claim that they do not generate hazardous wastes and have not requested a determination that the waste is improperly listed will be checked out by EPA. They are to be treated as violators, guilty of improper management, if it is discovered that they *are* in fact generating a hazardous waste.[135] In other words, the onus is on the producer to confirm that his waste is not hazardous by regularly checking it against the hazardous waste characteristics and the "black" list.

Concerning site selection of storage facilities, the proposed regulations tie in with the Safe Drinking Water Act and its "sole source" designations. All facilities are to be located, designed, constructed and operated so as to prevent endangerment of an underground drinking water source beyond the facility property boundary, or of an aquifer designated as a sole or principal source aquifer according to Sec. 1424(e) of the Safe Drinking Water Act of 1974.[136] More specifically, a facility must not be located in the recharge zone of a sole-source aquifer unless it can be demonstrated, at the time when a permit is issued, that the facility is designed, constructed, maintained and monitored to prevent the aquifer's endangerment.[137] The owner or operator of a landfill or surface impoundment facility would be required to install and operate both ground water and leachate monitoring systems, to maintain records of monitoring activities, and to locate the landfill so the bottom of its linear system or natural in-place soil barrier is at least 1.5 meters above the historical high water table.[138]

CONCLUSIONS

By comparison of the current state of international conventional law, the measures already in force or proposed in domestic legislation, and guidelines of international organizations for the harmonization of national laws, it is clear that existing treaties and institutions established under them are far from adequate to cope with the increasingly serious problems posed by ground water pollution—past, present, and future. There are a large number of older frontier waters

135. 43 Fed. Reg. 58946, 58954.
136. 42 U.S.C. §300f, 300h-3 (e) (1976).
137. 43 Fed. Reg. 58946, 59000.
138. *Id.* at 59005 and 59009.

treaties which afford an indirect and limited protection to ground waters through restrictions on surface water utilization. There are a few—very few—treaties which give their implementing entities authority to consider ground waters within the scope of their responsibilities for data-gathering, information exchange, and proposing programs to the contracting parties on pollution abatement and control. But even the most progressive do not contain adequate provision for standard setting. This shortcoming applies also to model conventions, such as the Helsinki Rules and the proposals of the Asian-African Consultative Committee (1973), which not only do not contain provision for standards, but at best are limited to ground waters which form part of an international drainge basin defined by the surface watershed.[139] The commissions established by these treaties, apart from being dedicated in the main to the resolution of surface water problems, suffer not only from the inherent weakness of such bodies but also from a lack of guidelines for dealing with the more specific aspects of ground water pollution, such as the effects of land use which is not related to and often at a considerable distance from an aquifer. Furthermore, since these treaties and model conventions are geared primarily to surface waters they usually are based on principles which do not fit the circumstances of aquifer contamination.

How, then, should the international control of ground water pollution proceed? Far too little is known yet about the location of ground water and ground water recharge areas, the interrelationships between ground and surface waters, the pathways of ground water pollution, the cumulative and synergistic effects of pollutants, especially toxic and other hazardous wastes, and even about the location of such obvious potential sources of pollution as landfills and dump sites. Here and there we find an appropriately humble acknowledgement of the current state of ignorance and of the truly awesome problems facing the drafters of national and international measures to contend with ground water contamination. In its proposed hazardous waste guidelines and regulations, for example, the EPA rather plaintively protests that:

139. Helsinki Rules on the Uses of the Waters of International Rivers, International Law Association, Report of the 52nd Conference held at Helsinki, Aug. 17-20, 1966, 477-533 (1967); Art. II defines an international drainage basin as determined by "the watershed limits of the system of waters, including surface and underground waters, flowing into a common terminus." Identical wording is contained in Asian-African Legal Consultative Committee, The Law of International Rivers, U.N. Doc. A/CN.4/274 (1973), p. 226, text in D. A. Caponera, comp., The Law of International Water Resources 45 (1978) (F.A.O. Background Paper No. 1/Rev. 1, Legislation Branch).

> We do not underestimate the complexity and difficulty of our proposed regulations . . .
>
> . . .
>
> Our proposal is the result of two years of analysis and consultation. . . . [O]ur objective has been to create a program based on as much substantive data and analysis as possible, but even where we have limited data the statute requires that we establish standards and controls.[140]

This statement reveals the twin horns of the dilemma: if treaties, transnational guidelines, or domestic legislation do not mandate the timely establishment of standards and controls, untold damage may be done before enough substantive information is gathered to form a sufficient basis for detailed regulation. Conversely, if standards and controls are established on the basis of insufficient information, current and future users of ground water may be vulnerable to hazardous contamination.

Whatever form the international regulation of ground water pollution takes, whether by treaty or by harmonization of domestic laws, it should be couched in terms sufficiently flexible to permit the administering entity or entities the widest possible leeway for keeping abreast of technical and scientific developments. There must be data gathering on a continuous basis and of a more detailed kind. The EPA proposed regulations noted above, for example, point out:

> EPA considers leachate monitoring extremely important because it can provide an early warning that ground water contamination may occur. This early warning is crucial because once ground water contamination has occurred, it is extremely difficult or impossible to remedy, particularly where an aquifer is located far beneath a facility. Ground water monitoring alone does not sufficiently protect the environment because the leak must move through and cause extensive contamination of the zone of aeration before it reaches and contaminates the ground water.[141]

To date, no treaty or other instrument of transnational effect requires anything other than ground water monitoring, and very few contain more than a general reference to research.

There is no longer any question that modern treaty practice incorporates the duty to exchange information and to notify other states of plans, projects and activities that may affect them adversely.[142] This duty of exchange and notification is readily per-

140. 43 Fed. Reg. 58946-58947 (1978).
141. *Id.* at 58986.
142. *See* Teclaff, *supra* note 124, at 846-50.

ceived in the case of floods or other natural disasters and of large-scale waterworks, diversions, or irrigation projects whose effects are widespread, but the scope and extent of the duty are by no means so obvious in the case of polluting installations and activities, especially where ground water is concerned. A state's official ignorance may be considerable if its hydrogeological service is understaffed or only recently come into being. The gathering of adequate ground water data, more than any other water-related activity, requires the fullest possible cooperation from individual users and from individual polluters, present and potential.[143] There is justifiable doubt as to whether a state is obliged to pinpoint the location of every municipal landfill, follow the routes of underground water movement in every abandoned mine working, and trace the migration of petroleum from every gas station within so many miles of the border, and report on all these. Nevertheless, the international regulation of pollution appears to be progressing toward the concept that states sharing a resource are obligated to provide the fullest information possible and to bring their information gathering methods to a comparable degree of technical expertise. The draft EEC directive of 1978 on protection of ground water against pollution is quite specific on the matter. Article 10 of the guideline requires:

> 1. For the purposes of this Directive, the Member States shall supply the Commission, at its request, to be made separately for each case, with all the necessary information, and in particular:
>   a) the hydrogeological conditions referred to in Article 5;
>   b) details of the authorizations granted;
>   c) results of the monitoring and inspection operations carried out;
>   d) results of the inventory (of authorizations granted in respect of "black listed" discharges), provided for in Article 9.[144]

But the information is to be used only for the purpose for which it was requested, the Commission and all other officials are not to disclose information "of a kind covered by the obligation of professional secrecy," and data relating to particular undertakings or associations of undertakings are protected from publication.[145]

If they have the capability of acquiring and mandating the transmission of sufficient data, entities responsible for the protection of

143. *See, e.g.*, the Susquehanna River Basin Commission's regulations, 43 Fed. Reg. 34127 (1978), requiring developers of ground water to meter withdrawals, monitor water table levels, and report regularly on at least two score parameters of water quality.

144. Draft EEC Council of Ministers Directive to the Member States on Protection of Groundwater Against Pollution, *supra* note 93.

145. *Id.*, art. 10 (2, 3 and 4).

transboundary ground waters are in a position to promulgate standards and regulations. These standards should identify toxic and hazardous pollutants, require a continuing record of such substances from origin to disposal, establish criteria for the safe storage of wastes, and provide for the inventorying of dump sites, abandoned as well as active, that are liable to cause transboundary pollution. Other measures which should form part of an agreement can be divided into those pertaining to water utilization and those pertaining to land use and activities, but in either case different regulations may be required according to the purpose to which ground water is put. Protection of a resource used for drinking water supply would have to be especially stringent; something like the "sole source" designation provided for in the federal Safe Drinking Water Act[146] could be employed to advantage. Such protection zones should include, if possible, the entire area of an aquifer shared by two or more states, or at least that part of it in which activity in one state might cause pollution in another state or states.[147] (It may be impractical to include the entire aquifer, since some water-bearing formations extend for hundreds of miles.)

Measures relevant to the control of water utilization to preserve ground water quality include: well spacing; regulation of pumping rate; isolation and sealing off of contaminated wells; monitoring and regulation of irrigation practices; establishment of minimum flows in surface streams interconnected with transboundary aquifers and control of surface diversions; establishment of salt water barriers in coastal areas where sea water intrusion is a problem; and artificial recharge of aquifers with water of a specified standard of purity. Measures for the abatement and control of ground water pollution from land use activities should comprise the regulation of pest control practices and fertilizer use in agriculture and forestry (including inventories of products used); of feedlot operation and other polluting practices in animal husbandry; of mining and oil or gas drilling, including disposal of mine wastes; and of all types of storage sites capable of causing aquifer contamination through improper location, design and management. Ultimately, such measures should also include control of individual septic tanks; vacation-cottage and tourist development; industrial zoning and the regulation of urban growth and suburban sprawl.

146. 42 U.S.C.A. §300h-3(e) (1976).

147. The concept of a "designated international groundwater area" as a basis for apportionment of ground water to prevent excessive depletion of the resource has already been developed by A. E. Utton in *International Groundwater Management: The Case of the U.S.-Mexican Frontier*, 57 NEBR. L. REV. 633, at 652-54 (1978).

Provisions such as these go far toward "moving the city" in order to preserve the well and some may appear altogether utopian, an intolerable encroachment upon national sovereignty, the purlieus of local government, and private property. Nevertheless, concepts of land use regulation already are finding their way into international and interprovincial agreements on protection of water resources. Zoning is one of these concepts. The idea of limited use zones assigned to specific activities and specific means of waste disposal so as to contain the most polluting activities within the smallest possible compass and to isolate them from areas of natural resources value, has taken hold at least in surface water management. The 1978 Great Lakes Water Quality Agreement, Article IV (1)(f) and Annex 2[148] of Article IV (1)(f) provides:

> Limited use zones in the vicinity of present and future municipal, industrial and tributary point source discharges shall be designated by the responsible regulatory agencies within which some of the Specific Objectives may not apply. Establishment of these zones shall not be considered a substitute for adequate treatment or control of discharges at their source. The size shall be minimized to the greatest possible degree, being no larger than that attainable by all reasonable and practicable effluent treatment measures. The boundary of a limited use zone shall not transect the International Boundary.[149]

There is no reason why such a concept could not be employed to advantage in transboundary ground water management to concentrate waste disposal and waste discharges away from possible contact with aquifers. The counterpart of the limited use zone, the "sole source" designation to exclude polluting activities from the vicinity of a source of potable water, is already extant in domestic legislation to protect ground water (the U.S. Safe Drinking Water Act) and, as noted above,[150] has been employed in an interstate context.

A further measure toward the harmonization of land use regulation on both sides of a frontier and the resolution of transboundary ground water contamination problems, which are apt to be highly localized, is suggested by the recent OECD Guidelines for Strengthening International Co-Operation on Environmental Protection in Frontier Regions.[151] Part III of the Guidelines makes several recom-

148. 1978 Agreement Between the United States and Canada on Great Lakes Water Quality, entered into force Nov. 22, 1978, text in BNA IEF 31:0691, at 31:0602 and 31:0608.

149. *Id.* at 31:0602.

150. *See supra* note 115.

151. *See supra* note 118.

mendations. First, that countries encourage their regional and local entities to cooperate with their counterparts across the frontier in resolving specific environmental problems; second, that they devise where necessary whatever bilateral or multilateral frameworks may be needed for carrying out joint action; and finally that they ensure that such transfrontier cooperation work as effectively as cooperation between provinces of the same country. It also recommends that countries expressly empower officials in regional or local administration to establish all necessary contacts with their counterparts on the other side of the frontier. If such cooperation across frontiers had been common practice, some of the problems of ground water contamination that now plague the U.S.-Mexico border—in particular, the El Paso-Juarez situation[152]—might not have arisen or at least might have been ameliorated.[153] It is probable also that where a continuing process of consultation, coordination, data gathering and exchange, and joint preparation of plans and projects is carried on between regional and local entities of neighboring countries, the element of public participation and public information so essential where there is risk of ground water pollution will be greatly strengthened.

Given the known (and unknown) interconnections of surface and ground water, the increasing withdrawals of ground water, the growing toxicity of industrial wastes and the problems associated with their disposal above and below ground, the long history of industrialization in such politically fragmented regions as western Europe, plus the fact that so many frontiers intersect areas of dense population, mining activity, heavy industry, and intensive agriculture, it is inconceivable that ground water pollution will not become a major international issue in the future. Even the most remote frontier zones in the most underdeveloped countries may not be spared because their very remoteness, if combined with what appear to be suitable geological characteristics, may make them attractive as waste disposal sites. We already have one example of the export of waste from one country to another for disposal in an area close to an international boundary.[154] A heavy responsibility lies on all countries to preserve

152. *See* Day, *Urban water management of an international river: the case of El Paso-Juarez*, 15 NAT. RES. J. 454 (1975). But the situation has improved recently, according to Day, *International Aquifer Management: The Hueco. Bolson on the Rio Grande River*, 18 NAT. RES. J. 163, 176 (1978).

153. See the discussion and examples of involvement of political subdivisions of states in the treaty-making process in Alheritiere, *International Cooperation and Inland Waters: The Influence of Federalism*, in WATER IN A DEVELOPING WORLD 166, 168-75 (1978).

154. *See supra* note 25.

the quality of underground waters and to prevent harm to human health and the environment that could be more horrendous than any surface water contamination yet known. Ground water, because of the nature of its occurrence and its association with that sovereignty which has always attached to land in international law, may be the very last element of the environment to be considered a "commons." Yet perhaps the concept of international trust[155] should be applied to it in view of the irreversible damage that may be done, lest we

> ". . . pursue,
> Like rats that ravin down their proper bane,
> A thirsty evil, and when we drink we die."[156]

155. On the concept of international trust, *see* Teclaff, *The Impact of Environmental Concern on the Development of International Law,* 13 NAT. RES. J. 357, 385 (1973).

156. SHAKESPEARE, MEASURE FOR MEASURE, Act I, sc. 2, 1 n. 132.