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Some Legal Solutions for Contemporary Problems Concerning Groundwater and Aquifers

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I. THE SCOPE OF THE WORK

Groundwater relates to human demand upon it in several ways. Increasing human demand, relative to groundwater, makes

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these relationships far more significant today then ever in the recent past. Groundwater, like any mineral, supports the surface of the earth, so that its withdrawal and the failure to replace it can cause subsidence. Groundwater is important for drinking, agriculture, and industry; and if it is withdrawn without regard for its replenishment or if it is polluted in the ground, those dependant upon that diminished or damaged groundwater suffer. Groundwater's presence can hamper mining or construction projects, while dewatering these sites can harm both the resource and those who have been drawing on the groundwater. Finally, groundwater interfaces with surface water, so that bad things that happen are not likely to be confined to either ground or surface waters.

This paper deals with the way law and institutions need to deal with groundwater under contemporary conditions. The propositions of this paper concern the contemporary problems posed by human demand on groundwater and the legal and institutional processes that can be undertaken to deal with those problems. The problems are presented first and then the difficulties of solving them follow.

The problems of groundwater in this paper are described in terms that assert: (1) human demand upon groundwater should be carried on so that either aquifers can naturally recharge or else will be artificially recharged; (2) an integrated approach to all water—surface and groundwater—must be pursued on the part of law and institutions; (3) groundwater needs perhaps even greater protection from pollution than does surface water since groundwater purifies very slowly or not at all, even in the presence of great human effort to assist in its purification; (4) protection of groundwater from pollution is to be preferred, consequently, to any policy of allowing pollution and then cleaning it up; (5) the supply function of withdrawn groundwater must be considered in conjunction with groundwater's quality, its ability to sustain the surface, and its role in holding back or containing salt water intrusion; and (6) groundwater is not just a physical presence for engineers to withdraw or protect but a part of the economy, a support for society, and a renewing part of the world's ecology.

The attempted solutions to these problems are reviewed in this paper under assumptions that claim: (1) a purely physical engineering approach will not provide adequate protection to groundwater as a resource; (2) command regulations confined to such actions as limiting drilling, spacing wells, prohibiting water export from its region of origin, or rationing water in volume or use also will not provide adequate protection; (3) groundwater must be considered not only in physical terms but also in its economic and social roles, including the cost of extracting, protecting, abusing, exhausting, interdicting, or replacing groundwater on the one hand and the benefits or harms socially conferred by such actions on the other; (4) groundwater ought not to be considered as a free good, perhaps not even to the landowner under whose lands the groundwater lies; (5) groundwater use ought not to be subsidized so as to make it cheap to its users since this will skew the value the groundwater has to such users; (6) groundwater concerns the power of the sovereign and the moral attitude the sovereign takes toward both renewable and exhaustible resources; and (7) neither the sovereign nor society's power and moral attitude necessarily are better applied through command regulations designed to protect groundwater than they are through readjustments in property relationships concerning groundwater.

No industry is more involved than the mining industry with groundwater and the difficulties of sustaining groundwater's quality, quantity, movement, and general continued availability as a resource for human use. For the mineral industry (which includes the extraction of coal, oil and gas, ore, and aggregates), the presence of groundwater can be a nuisance to be removed, a resource to be used in mineral extraction, a substance to be protected from pollution by mineral extraction and the disposal of extraction wastes, and a necessity for the restoration of minerally exhausted sites. Continuously, the mineral industry is required by legislative mandate to behave in particular ways concerning groundwater and, as an industry, mining today cannot ignore the problems posed for it by groundwater nor the possibilities that there may be more economic and successful institutional ways to sustain the availability of groundwater than simple legal prohibitions.

This paper draws upon a wider range of experience than that of the mining industry, including agricultural irrigation, industrial cooling and dilution, residential, and other uses, as well as ways to rearrange property relationships among such users. But many of these ideas are applicable to the mining industry; and, in any event, knowledge of them offers potentially useful tools to the mining industry. For this reason, despite this paper's not being confined in its illustrations to the mineral industry, it still ought to offer useful experience and ideas to that industry too. These, at least, are its author's intentions.

II. GROUNDWATER'S CONNECTIONS

The focus on groundwater withdrawals prior to the 1970s was on protection of the aquifer from overpumping rather than protection of it from pollutant incursion (e.g., salt water) or protection of that surface land from subsidence. This has produced the view that:

> the most important operational aspects of modern water resources management [are] catchment, apportionment, and use of the resource . . . [A]ny legal approach to these aspects of management must be understood as a concept that deals with the form in which use will be permitted, the extent (in time, place, and quantity) and the actual practice of the user. This legal approach is a component of the wide concept of water management, the final objective of which is to ensure the most rational use of available water resources.[1]

In short, it is important to account for every drop pumped.

Groundwater has traditionally been exempted even from this much concern on the part of governmental regulators as long as the abstraction of water was used for domestic uses. This was so even when domestic use was extended by definition to include watering animals and providing for farm uses other than irrigation or the far broader purpose of municipal supply of drinking water.[2] But attending to the water pumped is by itself not

[1] Caponera, *Co-ordinator's Introductory Speech, Results of the IV World Congress of the Int'l Water Resources Assoc.* in 2 WATER FOR HUMAN CONSUMPTION, MAN AND HIS ENVIRONMENT, 67 (Maxwell ed. 1983) [hereinafter *Results*].

[2] Burchi, *Legislation on Domestic and Industrial Use of Water*, 1 WATER AND HUMAN CONSUMPTION, MAN AND HIS ENVIRONMENT 409 (Maxwell ed. 1982) [hereinafter *Legislation*]. Latin American law gives municipal drinking water for domestic use top priority. *Id.* at 411. Islamic law recognizes the Right of Thirst which permits persons to water their household and animals even at another's water supply. *Id.* at 411-12. The only limitation is "an obligation to refrain from wasting or misusing the resource," *Id.* at 415.

enough concern, though preferable to no governmental concern at all.

Since the 1970s, however, governments have enlarged the scope of their regulatory concern to include such matters as land subsidence and harm to the groundwater both within and without aquifers.[3] Even aquifers not being drawn upon by pumping have become subjects for governmental regulations.

> Now, with regulatory legislation passed in the 1970s, groundwater quality regulation is under consideration . . . for controlling pollution from sources such as land disposal of liquid, solid, and hazardous waste; septic systems and cesspools; saltwater intrusion from groundwater depletion; and activities such as oil production, irrigation, accidental spills, and mining. . . . [P]rograms include underground injection control, classification of groundwaters, landfill control, and well regulations . . . depend[ing] on the unique physical, economic, and political factors involved.[4]

Current interest in the United States at the state and federal governmental levels, in the protection of aquifer integrity from other uses and in the protection of land from subsidence by water withdrawn from aquifers, indicates a broadening of governmental responsibility in regulating groundwater. No longer is the concern merely with the rate of groundwater withdrawal or with aquifer exhaustion.

The relations of the aquifer to surface waters, to substances flowing into the aquifer, to aquifer function in holding back sea encroachment or holding up surface lands have been recognized as being as important as overpumping for use or overpumping for dewatering to permit other resource exploitation. Once that recognition occurred, legal regulation of some sort had to follow. In 1986, the United States Environmental Protection Agency's (USEPA) Office of Groundwater Protection required all USEPA program officers to incorporate as "internal office routine"

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[3] *Id.* at 411.

[4] N. GREGG, WATER RESOURCES PLANNING 281 (1985). (Iowa is proposing research to change modern agricultural practice in order to protect groundwater quality). *See* 2 AM. LAND RESOURCES BULL. (Sept.-Oct. 1987).

groundwater protection strategy into all their regulations, plans, and actions.[5]

A distinction needs to be maintained between groundwater generally and water confined in aquifers. Groundwater, of course, is a larger concept than the water confined in an aquifer. Water in transit to an aquifer or water saturated in near-surface clay layers are not aquifer water. Yet the pumping of this groundwater outside an aquifer occasionally can be as harmful as pumping that draws from within an aquifer and is adverse to its stabilization abilities.

Aquifer water withdrawals create separate problems. For example, pumping can reduce the artesian head of the water in the aquifer (the lifting power naturally present), creating the need for artificial pumping. The sediments within the aquifer can become impacted by pumping that interdicts natural recharge, so that the aquifer loses some or all of its rechargeability and ceases to be an aquifer. Water may still percolate through the soil. Once the porosity of the aquifer has been lost, however, no recharge will take place. Withdrawal of water faster than the recharge rate, accompanied by failure to inject replacement water, can also cause ground subsidence, either across a wide plain of land or by concentrated sink-holes.[6]

Land subsidence caused by the extraction of groundwater is similar to the subsidence caused by the withdrawal of gas and oil. Most aquifers have an adequate natural recharge rate, if pumping is related to this recharge rate. Unlike oil pools and gas domes, aquifers enjoy replenishment by natural means. Aquifers also can be artificially replenished with various kinds of waste water.[7] Through either recharge process, land subsidence from water withdrawal could be avoided.

Injection of water into strata emptied of oil and gas for storage would have a sustaining power that would prevent sub-

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[5] 5 HYDATA NO. 2, 2 (1986).

[6] J. POLAND, L. CARBOGNIN, & S. YAMAMOTO, *Economic and Social Impacts and Legal Considerations*, in GUIDEBOOK TO STUDIES OF LAND SUBSIDENCE DUE TO GROUND WATER WITHDRAWAL (Poland ed. 1984) (UNESCO Studies and Reports in Hydrology, no. 40, 119, 122) [hereinafter *Considerations*].

[7] J. POLAND, L. CARBOGNIN, & S. YAMAMOTO, *Review of Methods to Control or Arrest Subsidence*, in GUIDEBOOK TO STUDIES OF LAND SUBSIDENCE DUE TO GROUND WATER WITHDRAWAL 127 (Poland ed. 1984) [hereinafter *Subsidence*].

sidence once oil or gas had been withdrawn. The stored water, however, would risk pollution from unextracted hydrocarbon remnants and might be lost to further human uses.

Most people think that artificial recharge is easily accomplished. But they are wrong. An aquifer that either is not recharging fast enough both to maintain pumping levels and protect the aquifer's attributes, or an aquifer whose location lacks sufficient rainfall under contemporary weather conditions to supply the water from nature that is needed for recharge, will be corrected as quickly as believers in the easy fix would have us believe.

Many see artificial recharge as having only one major problem: aquifer contamination. That *is* a major danger.[8] But the operation of recharging an aquifer artificially, assuming potability of the water being used for recharge (or the isolation of the aquifer if contaminated water is being used or the already brackish condition of the aquifer if salt water is being injected), still poses its problems. This is true even if the repressuring of confined aquifers by artificial recharge is the only way to slow down or stop land subsidence or aquifer damage. Recharge water ought to be treated—which, in the present state of the art, cannot be done for water naturally recharging aquifers—in order to prevent aquifer clogging and contamination. Treatment of the recharge water, however, is only one among the several expensive steps that must be taken if an aquifer has to be artificially maintained.[9]

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[8] *See e.g.*, 9 INT'L ENV'T REP. 175, 245-46 (1986). For example, the French had refused, despite Dutch demands made persistently since 1946, to reduce the discharge of salt into the Rhine. A commitment by France was made in the 1976 Convention for the Protection of the Rhine to inject the salt as saline water into the ground. The salt is a by-product of the potash mines in Alsace and the Alsatians politically have prevented the injection program, though the French have promised a 1987 solution. *Id.* (Similar examples of popular resistance to ground injection programs for waste liquids could be replicated throughout the world. Nobody anywhere in the world loves a Love Canal.).

[9] *Subsidence*, *supra* note 7, at 128.

> [T]he injection of . . . [a] great quantity of water from diverse sources [can] create many problems [that must be] controlled by various chemical and physical treatments . . . [R]esults [of such experiments] were satisfactory when the water was clear; most of the problems of recharge through wells involved clogging of the well[s] and aquifer . . . [through] air entrainment, suspended particles in the recharge water, and micro-organisms . . .

If artificial recharge is to be undertaken, how is it to be done? If the aquifer is shallow and unconfined, near the surface and covered by a permeable layer, water can be spread on the land directly above the aquifer, and then allowed to percolate downward in a recharge much like nature's. There is a problem, however, if the confined aquifer is fairly deep, covered by relatively impermeable layers, recharged by percolation from a distant land surface on which rain fell, or has had its content provided in some previous geologic age without current prospect of natural recharge. For these kinds of aquifers, injection wells are necessary. The recharge water must be forced into the aquifer in order to repressurize it.[10]

Obviously, this latter practice demands energy, personnel, machinery, water accumulation and movement, and the money to provide each one of the necessities. Such an investment will always be postponed until no other choice is possible, even at the expense of relocating population from a region whose aquifers had been pumped dry and whose land had subsided. Money to the desperate would then seem of little value.

Fortunately, there is some good news about aquifer recharge—"conjunctive" storage and water harvesting. These techniques are among advantages to be gained from an integrated management of surface and groundwater. After all, surface and groundwater both are subparts of a single hydrologic cycle.[11]

> [W]ater-treatment cost and contemplated use of the recharged water are the principle factors involved in determining the economic feasibility of artificial recharge. *Id.*

[10] *See generally*, W. GORDON, A CITIZEN'S HANDBOOK ON GROUNDWATER PROTECTION, 10-11 (1984); M. JAFFE AND F. DI NOVO, LOCAL GROUNDWATER PROTECTION, 130-31 (1987).

[11] N. GREENWOOD & J. EDWARDS, HUMAN ENVIRONMENTS AND NATURAL SYSTEMS, 9-18 (2d ed. 1979). *See also*, K. KRAUSKOPF, THE THIRD PLANET: AN INVITATION TO GEOLOGY, 51-53, 62-67 (1974) (on the hydrologic cycle). Water harvesting has been defined as "runoff . . . produced from specially landscaped or prepared surfaces . . . or treated land surfaces . . . . [that] depends on size, slope, soil and material properties, and rainfall" that is then stored in reservoirs or by aquifer injection. Popkin, *Increasing Water Supply for Home Irrigation*, 3 PROCEEDINGS, WATER REUSE SYMPOSIUM, 2068 (March 25-30, 1979). Conjunctive storage means the reuse of wastewater, control of water seepage, evaporation control, vegetation management and protection from brackish water incursion, disposal and water conservation as part of a program to safely reuse water. Phillips, *The Direct Reuse of Reclaimed Wastewater: Pro, Cons, and Alternatives*, 60 J. AM. WATER WORKS ASSOC. 231 (1974).

Conjunctive water storage—or, for that matter, the total issue of water management regardless of source—requires the consideration of surface and groundwater impoundments together, with water being shifted from one to the other as wanted. Water harvesting from the surface of the ground minimizes evaporation. No programs of controlled ground water withdrawal, aquifer recharge, aquifer cleansing, the combatting of salt-water intrusion, and decisions about selective water for mining can be fully implemented without a joint consideration of both surface and groundwater.[12] At the very least, water is accounted for, is not economically wasted, is efficiently engineered, and is employed so as to minimize environmental harm.

Policy-makers for many years have urged such joint consideration. A 1976 declaration of the International Conference on Water Law and Administration speaks as well for this point of view as any other.

> [It] . . . urged governments to: integrate the management of groundwater with all other available water resources, including, for example, the employment, where practicable, of aquifers for the seasonal storage of surface waters, and the creation or improvement of groundwater recharge catchment areas to minimize losses of rainfall and to capture excess surface run-off.[13]

Putting aside the question of whether nature knows of any "excess," the prophetic words here are "when practicable." Practicability for conjunctive action has apparently turned out to be a scarce condition.

Yet the idea remains a sound one that should be vigorously pursued to implementation. Nature often supplies abundant rainfall when human enterprise does not need it. Such water should be stored and, in the past, has been stored in surface reservoirs. Surface reservoirs are subject to loss from evaporation and require much ground when most suitable sites already have been

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[12] GREGG, *supra* note 4, at 281.

[13] L. TECLAFF, *Declaration of February 14, 1976*, WATER LAW IN HISTORICAL PERSPECTIVE 220 (1985). In 1973 the United States National Water Commission also had "provided detailed recommendations on the integration of ground and surface water rights, the substitution of one source of supply for another, the establishment of public management agencies, and conjunctive management." *Id.* at 221.

taken for storage. Comparatively, therefore, the employment of empty or downdrawn aquifers for seasonal supply is an advantagement since water stored in them rather than in surface reservoirs will be protected from sedimentation, from erosion, from pollution, from surface run-off, and from acid rain. With ground storage, water is warehoused; aquifers receive protection; the surface land is given support against subsidence; and land use is not limited to holding water.[14]

Industry also has intermittent demands for water, especially water used in smelting, steam-powering, and other cooling processes. Once used, this water can be injected into an aquifer for later use, altering temperatures within the aquifer in terms of later industrial employments. Since aquifers do not have the duty of surface waters in maintaining aquatic biota, this alteration in temperatures is unlikely to impose any environmental hazard.[15]

Because aquifer recharge often has to originate on surfaces substantially distant from the aquifer, if natural recharge mechanisms are to be used in an artificial recharge process, careful thought must be given to the location of spreading zones.[16] These are the areas over which water is lagooned or injection wells are spaced in order to speed up or induce aquifer recharge. Substantial investments must be made for the erection of channels,

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[14] D. Agthe, *Potential Benefits and Costs of Inground Storage of Imported Water*, 22 WATER RESOURCES BULL. 129 (1986).

> Underground storage is frequently feasible because a . . . region has historically been overdrafting the [aquifer] that underlies it, leaving space in the aquifer for imported water to be stored. This storage space can occur at the consumption site or at an intermediate point between water supply and the market. *Id.*

[15] *Subsidence*, *supra* note 7, at 129 (citing practices in China where aquifers drawn down in the summer are injected with cooler water in the winter, causing less water to be used for cooling the following summer since the water redrawn from aquifer is colder). This study group points out, on the basis of extensive Japanese experience with reinjection of degassed water (i.e., water from which methane gas has been withdrawn for industrial fuel usage), back-washing at adequate intervals is necessary to continue long-term injection. *Id.* at 130 (more is involved technically than simply putting water into an emptied aquifer).

[16] G. Brighenti, *Water Resource Management in Areas Subject to Land Subsidence*, in WATER RESOURCES FOR RURAL AREAS AND THEIR COMMUNITIES, VTH WORLD CONGRESS OF THE INT'L WATER RESOURCES ASSOC., I 65, 71 (I. Kosinsky and de Somer, eds., 1985).

levees, and control structures for the water during the time required for it to percolate to the aquifer.[17] A permanent pooling of water on that ground surface would not be required. The surface, however, would be unusable for periods of time. This inability to use the surface in the spreading zones poses the greatest problem in situations where the recharged aquifer does not lie immediately below the pool from which it is recharged.[18] This separation would require the consent of the land owner of the spreading zone, a consent presumably purchased by the owner of the aquifer being recharged.

Where the surface is above the recharged aquifer and where the owner of the surface uses the water withdrawn from the aquifer for use on that surface, the combination of interests resolves potential legal conflicts. Where the location of the recharging pool has to be on a surface not above the aquifer and when the water redrawn from the aquifer would not be used on the surface where the recharge facilities are located, legal ingenuity would have to solve the problem. But, then, in the whole process of water harvesting, water transfer, conjunctive management of water regardless of source, legal ingenuity for common management is a necessity.[19]

As French water managers have determined,

> Cette relation implique necessairment une composante fonctionelle d'usage, ainsi que des liaisons 'metafonctionneles' des qu' intervient une multiplicite' des acteurs—c'est-à-dire la prise en compte d'interactions entre relations fonctionnelles propres à chacun de ceux ci dans le cadre d'un 'systeme regule'. . . . Si les relations de type amont-aval s'y prêtent en général assez

[17] Agthe, *supra* note 14, at 129-30. "[T]he high cost of acquisition of land rights in the spreading zone or rights to the aquifer [may be discouraging]. If the porous zones and the aquifer are subject to silting, this could also reduce the value of the groundwater project." *Id.* at 130.

[18] Brighenti, *supra* note 16, at 72.

> [I]nvestigation is concerned with identifying regional aquifers and evaluating their capabilities, recording all water takings and present consumption, establishing their estimated trend up to 2001, assessing the number of infrastructures currently in operation and planned as well as their potentialties, searching for new primary and secondary sources of supply and possibly finding new ways of reclaiming waste waters.

Id.

[19] V. Gleason, *Water Projects Go Underground*, 5 ECOLOGY L. Q. 625 (1976).

aisement, les relations d'identité peuvent être, beins moins évidents lorsque doivent etre considérées les interactions entre eau souterraines et superficielles, les effects du drainage, l'érosion diffuse ou les conséquences de l'imperméabilisation des sols résultant d'aménagements liés à une urbanisation.[20]

Consequently conjunctive storage, conjunctive use, and conjunctive management have become an increasingly unavoidable recourse, if demands for water are to be met with both engineering and economic efficiency. Land which is impermeable and upon which rainfall merely provides a source for flash floods illustrates the value of integrated water management.[21] In a basin whose surface flow and aquifer chargeability are understood as common elements within a single hydrogeographic region, flood waters can become a source of value rather than only a cause of damage,[22] because

[W]e have learned that ground water is usually hydrologically related to surface water, so that the traditional system of managing surface water and ground water separately fails to

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[20] Delavalle, Gendrin, Davigo, & Ollagnon, *La Gestion Patrimoniale des Eaux (The Patrimonial Management of Water)*, in WATER RESOURCES FOR RURAL AREAS AND THEIR COMMUNITIES, VTH WORLD CONGRESS OF THE INT'L WATER RESOURCES ASSOC. 241-43. Translated: This relation necessarily involves a practical component in use, as well as metafunctionalist ties as soon as a multiplicity of players intervene — meaning that the responsibility taken for the interactions between practical relations appropriate to each one of these in the framework of a frictionless system. . . . If the upstream-downstream type of relations yield easily enough, the identified relations can be much less obvious whenever one must consider the interactions between underground and surface waters, the effects of the drainage, the diffused erosion or the consequences of the impermeabilisation of the soils resulting from the land-parceling tied to urbanization. The authors continue, "Un 'systeme-eau' pourra donc, par la prise en compte de l'ensemble des relations d'identités réputées capables d'integrer les liaisons fonctionelles et métafonctionelles, constitutes le 'patrimoin commun' de l'ensemble des acteurs concernés." *Id.* at 242. (By taking responsibility for the entirety of the relations identified and with well-known capabilities, water systems will be able to integrate the functional and metafunctional ties, making up the common heritage of all the actors concerned.).

[21] R. Moses, *Maximizing Use of Surface and Underground Water Resources in Rural Areas — Legal Case Histories*, WATER RESOURCES FOR RURAL AREAS AND THEIR COMMUNITIES, VTH WORLD CONGRESS OF THE INT'L WATER RESOURCES ASSOC. I 1, 8-9 (The article is most concerned with what constitutes a "plan of augmentation" for expanding appropriative water rights.).

[22] E. Popolizio, *Criterios para el Analisis y Manejo de las Inundaciones en el Nordeste Argentino, (Criterion for the Analysis and Management of the Floods of Northwest Argentina)*, WATER RESOURCES FOR RURAL AREAS, I, 389, 394-97.

reflect the hydrologic reality: conjunctive management of underground and surface resources is required when the two connect up.[23]

"Connecting up," though, is more than just an actual or potential physical interchange with a hydrogeographic region. As the Argentine water engineer, Eliseo Popolizio, has noted, it also involves integrative planning for the rapidity of economic exchange within the region, the technology available, the human resources at hand, and the infrastructure required to realize all the potential for a "connecting up." Once humanity develops the potential aspects of surface and groundwater connections, it is not enough to note the existing physical interconnections. Political, social and economic "interconnections" are of equal importance to the physical ones.[24] The need for simultaneous use of all of them has been known since at least the late 1920s,[25] but the institutional accommodation has been lacking.

III. PROTECTING AND REHABILITATING GROUNDWATER AND AQUIFERS

The difficulty in protecting groundwater from contamination—whether from salt-water intrusion, hazardous wastes, infiltration from agricultural applications of fertilizers and biocides, or domestic sewage—proves the significance of interconnections. Pollution of groundwater did not come forward in the public consciousness until the mid-1970s, either in the United States or elsewhere in the world.[26] But when that consciousness emerged, at least a theoretical consensus was produced:

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[23] C. Wilkinson, *Western Water Law in Transition*, 56 U. COLO. L. REV. 317, 322 (1985) (citing Trelease, *Conjunctive Use of Groundwater and Surface Water*, 27B ROCKY MTN. MIN. L. INST. 1853 (1982)).

[24] Popolizio, *supra* note 22, at 397-401.

[25] S. Wiel, *Need of Unified Law for Surface and Underground Water*, 2 S. CAL. L. REV. 358, 359-63 (1929) (relying on the recommendations of geologists, economists, and water engineers). *But see* Wiel, *The Recent Attorneys' Conference on Water Legislation*, 2 CALIF. L. REV. 197, 201-03 (1929) (modesty of the proposal attorneys found acceptable).

[26] Wilkinson, *supra* note 23.

> Water quality management . . . is a complex discipline comprising elements of law, sciences, engineering, administration, economics, and finance.[27]

Since even in the United States many rural water utilities deliver untreated groundwater and since even treatment does not remove many of the contaminants coming into groundwater in these rural areas, prevention of groundwater and aquifer pollution is an important objective.[28] More and more jurisdictions in the world are following the ancient example of the Islamic *harim*, the protective zone for water-wells, by creating zones of capture and zones of protection that are usually the same, geographically. This is new legal action since neither Roman law nor the English common law made such provisions for protecting groundwater.

Certain activities within these wellhead zones are prohibited by new laws. Interdictions can even reach outside the zones, if water would flow from those prohibited activities into the protected zones.[29] These interdictions extend beyond a few strips of land beside canals and wells. Such narrow protection was all that was provided by the Islamic *harim* from its inception in the

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[27] E. Fano, M. Brewster & T. Thompson, *Water Quality Management in Developing Countries* (Pt. 2), in WATER RESOURCES FOR RURAL AREAS AND THEIR COMMUNITIES, VTH WORLD CONGRESS OF THE INT'L WATER RESOURCES ASSOC., II, 655, 657. This article stresses the need, therefore, for "qualified specialists with advanced training." *Id.* II, 657. *See* Sendlein, *Ground Water Regulatory Issues: Use of Technical Information and Geo-science Professions in Preparing for a Case*, in 12TH ANNUAL MINERAL LAW SEMINAR, MINERAL LAW CENTER, UNIVERSITY OF KENTUCKY, P-1, P-1-18 (Oct. 2-3, 1987).

[28] Gessaman, *Operational Performance of the FmHA Rural Water System Program*, WATER RESOURCES FOR RURAL AREAS AND THEIR COMMUNITIES, VTH WORLD CONGRESS OF THE INT'L WATER RESOURCES ASSOC. II, 671, 675. In Missouri, half the systems deliver untreated water from wells. In Iowa, North Dakota, South Dakota, and Nebraska, the groundwater supplied to customers by the systems was treated but was regarded as poor quality. These figures are descriptive as of the mid-1980s. *Id.*

[29] W. Loy, *Evolution Recente de la Legislation sur les Eaux Souterraines en Belgique*, in WATER RESOURCES FOR RURAL AREAS AND THEIR COMMUNITIES, VTH WORLD CONGRESS OF THE INT'L WATER RESOURCES ASSOC. II, 805, 806 (Recent Evolution of Legislation Concerning the Underground Waters in Belgium). A *decret* of 24 January 1984 reinforced those zones: "Ainsi l'eau sera mieux protégée contre les risques de pollution et les menaces d'épuissment et ce particulièrement pendant son séjour souterrain où elle est vulnérable de manière irréversible." *Id.* at II, 809. (Thus, the water will be better protected against the risks of pollution and the threats of exhaustion and particularly during its underground stay where it is vulnerable in an irreversible way.).

7th century A.D. until the breakdown of Islamic legal practices concerning this *harim* in the 19th century A.D.[30] Modern urban-industrial states, with their massive drafts of groundwater, discharges of wastes, and chemically dependent agricultural practices, need far larger protective zones. The protective zones for groundwater, indeed, may have to encompass subregions.

Public consciousness is focused mostly on pollution of aquifers that are sources for the public's drinking water. In the United States prior to 1974, federal legislative interest extended only to the bacterial contamination of water leading to human infection. Since that year, Congress has included a wide range of other sources of risk in drinking water to human health.[31]

As part of groundwater's protection, Congress instituted requirements for underground injection control and, later, extended its legislative mandates to groundwater contamination from landfills and surface impoundments.[32] Finally, Congress in 1986 adopted a statute extending further protection to underground public drinking water sources.[33] A reluctant President Reagan signed it, expressing regret that the major role assigned to the federal government was at the expense of state authority.[34]

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[30] TECLAFF, *supra* note 13, at 222-223.

[31] ENVIRONMENTAL PROTECTION: LAW AND POLICY 600, 600-03 (F. Anderson, D. Mandelker, D. Tarlock, eds., 1984).

[32] *See* Safe Drinking Water Act of 1974, [hereinafter Safe Water Act], 42 U.S.C. § 300(f), (j)-(q) (1982); Underground Injection Control Program [hereinafter UIC], 42 U.S.C. § 300(h) (1982). Some other statutes enacted later that are implicated in protection of drinking water sources, as well as potentially all aquifers from contamination, are the Resource Conservation and Recovery Act [hereinafter RCRA], 42 U.S.C. §§ 6901-6907, 6911-6916, 6921-6931, 6941-6949, 6951-6954, 6961-6964, 6971-6979, 6981-6986 (1982); the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 [hereinafter CERCLA] 42 U.S.C. §§ 9601-57 (1982); the Superfund Amendments and Reauthorization Act [hereinafter SARA], codified as amended at scattered sections of 10, 26, 19, 33 & 42 U.S.C. (which also added an independent statute); The Emergency Planning and Community Right-To-Know Act, [hereinafter Right to Know Act], 42 U.S.C. §§ 11001-11050 (1988 Pamphlet)).

[33] Safe Drinking Water Act Amendments of 1986, [hereinafter Amendments], 15 U.S.C. §§ 1261, 1261 note, 1263; 42 U.S.C. §§ 201 note, 300(f), 300(g-1) to 300(g-6), 300(g) notes, 300(h), 300(h-1), 300(h)2, 300(h)4 to 300(h)7, 300(i), 300(i)1, 300(j), 300(1), 300(j)1 note, 300(j)2 to 300(j)4, 300(j)7, 300(j)11, 6039(b), 6979(a), 6979(b) (1988).

[34] *See* 22 WEEKLY COMP. PRES. DOC. 831 (June 19, 1986); N.Y. Times, June 21, 1986, § I (Sunday) at 8, col. 2 (President Reagan's remarks). *See also*, K. Gray, *Drinking-Water Act Amendments Will Tap New Sources of Strength*, 8 NAT'L L. J. 51, 16-17 (Sept. 1, 1986).

Once the danger of drinking water contamination had manifested itself, no one in national politics wanted to appear indifferent to the risks.

Certainly conditions indicated both contaminated drinking water sources and a need for the wide scope of federal action in the United States. In the mid-1980s, out of 954 cities with populations exceeding 10,000 whose underground drinking water supplies were tested, 275 had been contaminated by water leaching from landfills and surface water impoundments.[35] Underground storage tanks, as well as these other sources, have caused major harm, much of it of a permanent and irreversible character, to groundwater that currently is—or can be anticipated to become—a source for public drinking water supplies.[36] Judy Campbell Byrd has said that aquifers are vulnerable to so many different kinds of pollution sources because,

> Land-use patterns tend to group more than one potential source of contamination together. For example, industrial parks are sometimes constructed on former municipal landfills and may

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[35] R. REPETTO, WORLD ENOUGH AND TIME: SUCCESSFUL STRATEGIES FOR RESOURCE MANAGEMENT, 13 (1986). The Ohio EPA environmental toxicologist, Gerald Poje, says that the discovery of additional contaminants in community water supplies "is directly related to the level of effort to test for pollutants." 15 THE HOTLINE (Ohio Environmental Council Newsletter), no. 9, 6 (1986). Current testing in such states as Ohio presently "is sporadic and highly localized at best." *Id.* Correction, once contamination has been discovered, includes removing the wells from service, air-stripping treatment systems, and isolating contamination sources. *Id.* The USEPA in Region V (Ohio, Indiana, Illinois, Wisconsin, and Michigan) has begun testing 15,000 community supply wells (of which one half had been tested by mid-1986) for VOC (volatile organic compounds) contamination. VOCs are used as degreasers, solvents and dry-cleaning fluids. Regulatory limits exist at the federal level so that many VOCs in allowable concentrations can be present in drinking water. *Id.* at 1. Conditions are far worse for public drinking water supplies in other countries. *See* Taplin & Meinking, *Health and Safety in the Field: Provision of Potable Water*, UNIV. OF MIAMI PUB. 901, 3 (1986) (even treated municipal supplies in the United States can be sources of water-borne disease). *See* Juranek, *Giardiasis: Transmission and Control*, 2 GENERAL ECOLOGY'S WATER RESEARCH UPDATE, No. 1, 4 (1986). Rarely, though, does this disease come from supplies drawn from underground, *Id.* at 3.

[36] S. Anthony, *Groundwater Pollution Control: A National Crime, A Regional Strategy*, 2 PACE ENVTL. L.REP. 215, 231-32 (1985). "Essentially, special and vulnerable groundwaters would receive a high level of protection, while groundwater that is not a potential source of drinking water or other beneficial use would not. Variances would be applied as necessary," *Id.* at 233 (discussing USEPA's National Groundwater Strategy).

> contain waste disposal sites and underground storage tanks, as well as likely spots for accidental leaks or spills.[37]

What seemed like a most practical ideal to a land-use planner becomes a serious threat to an aquifer, absent major efforts to prevent invasion of the aquifer by contaminants.

Natural conditions relative to groundwater present good news and bad news concerning aquifer protection. The soil layers through which water percolates in the process of reaching the aquifer have mechanisms that prevent or slow down the movement of potential contaminants from the ground surface or soil zone into the aquifer. The "mechanisms include chemical precipitation, chemical degradation, volatilization, biological degradation, biological uptake, and adsorportion."[38]

Once the contaminant succeeds in reaching the aquifer, the further good news is that there is very little dispersion. The contaminated water moves very slowly through the aquifer so that contamination is localized.[39] A well, therefore, could be drawing uncontaminated water from a portion of the aquifer only a few feet from where intensely contaminated water is located.[40] For these reasons, both surface conditions and parts of an aquifer can be very contaminated, with people still able to draw good water from the aquifer. That, then, is the good news.

What of the bad? The power of natural cleansing mechanisms in the soil can be overwhelmed by too much contamination.

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[37] J. BYRD, GROUNDWATER PROTECTION: EMERGING ISSUES AND POLICY CHALLENGES 7 (1985).

[38] GORDON, *supra* note 10, at 37-38.

> Many organic substances have extremely low solubility in water and readily settle out of solution or, "precipitate". . . . When substances transform from the solid phase or from the dissolved phase to the vapor phase, they diffuse in the atmosphere [which is volatilization]. . . . [S]ubstances . . . that are relatively soluble, nonvolatile, and refractory [not readily susceptible to biological degradation] . . . [are prevented] from readily migrating from the land surface into aquifer systems [by] adsorption. Minerals and amorphous (uncrystallized) inorganic and organic substances in the soil zone, and in deeper geological materials, all provide surface for adsorption of organic compounds.

Id. at 37-38.

[39] BYRD, *supra* note 37, at 2-3.

[40] Anthony, *supra* note 36, at 216-17.

Furthermore, not all soil overlays have these natural cleansing mechanisms, nor do all contaminants lend themselves to being volatilized, caught, degraded, or drawn up in biological activities. As for the contaminated aquifer itself, the slow movements of liquids within it make contamination "a semi-permanent condition once it has occurred."[41] Beyond the risk of permanent aquifer loss, localization makes the job of discovering areas of contamination within an aquifer extremely difficult.[42]

Three generalizations can be made about groundwater and contamination. First of all, the restorative cleansing of an aquifer is expensive. Second, restorations are "time consuming." "Because most problems have been recognized only after the pollutant has been moving and spreading for a number of years, the areal extent of pollution is ofter quite large [despite slow motion within the aquifer]. Consequently, it takes a long time to clean up these large problems."[43] And, third, the best efforts often fail. Even second and third clean-up attempts do not always produce a satisfactorily cleansed aquifer.[44]

Under these circumstances, and given the greater legal mandates to clean up contamination, decision makers are required to be conscientious about risk-assessment. Avoidance of a need to clean up has become important to them. Those who have to locate landfills, underground storage tanks and conduits, treatment lagoons, and other potential sources of contamination should know that they cannot make a mistake in location or operation without incurring serious liability. They need as much information as they can accumulate before a decision is made, or they risk causing profound environmental impacts, as well as being liable for heavy damages later. The problem for these

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[41] *Id.* at 217.

[42] *See generally* GORDON, *supra* note 10, at 3 (once contaminated, groundwater can remain so for thousands of years).

[43] L. CANTER & R. KNOX, GROUND WATER POLLUTION CONTROL 8 (1986) [hereinafter CANTER & KNOX].

[44] *Id.* "Because ground water cleanup activities are, in general, expensive, considerable interest exists in analyzing costs . . . [by way of] risk assessment, cost benefit analysis, cost-effectiveness analysis, decision-tree analysis, trade-off matrices, and sensitivity analysis for alternatives evaluation." *Id.* at 163.

decision makers, even when they try, lies in the paucity of pertinent information.[45]

In drafting the National Groundwater Protection Stategy, the USEPA "found that contamination was a wide-spread problem . . . that groundwater was vulnerable to contamination, hard to monitor, and difficult to clean up; and that groundwater was almost nonrenewable once it was contaminated."[46] The best course of action, therefore, is to prevent contamination of unpolluted aquifers or further intensification of pollution in aquifers already partially polluted, rather than allowing contamination and then cleaning it up. Maybe there is a "vast technical ability of this nation to solve its water problems . . . ."[47] But there are better ways to use that technology than creating polluted aquifers to be cleaned up.

Not that the cleaning of aquifers should not be undertaken. The efforts can be as simple as capping the aquifer with a layer of clay to block percolation of contaminants downward from the surface.[48] Or a barrier to the plume movement of pollution within the aquifer can be provided by an hydraulic wall. Drains would drop water from the surface, so that clean water, by flowing along the sides of the plume would seal off the pollution.[49] Perhaps the simplest recourse of all is the introduction of bacteria into an aquifer contaminated with elements capable

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[45] *Id.* at 159-60. "The main problem faced by all risk-assessment techniques is that a large portion of the needed information, such as risk pathways or acceptable concentrations, is unknown," *Id.* at 160. T. WATSON, R. HALL, J. DAVIDSON, & D. CASE, HAZARDOUS WASTES HANDBOOK 1-1 to 1-5 (4th ed., 1982) (makes this point emphatically).

[46] GREGG, *supra* note 4, at 297.

[47] Anthony, *supra* note 36, at 218.

[48] BYRD, *supra* note 37, at 3.

> More complex and expensive methods include trying to contain the contamination by building physical barriers, altering the groundwater flow, neutralizing the contaminants in the aquifer and/or pumping out, treating the water, then returning it to the aquifer. All are very limited in their effectiveness. . . . [A]ll are expensive. . . . All also require experienced, technically qualified people to tailor the clean-up technology to the needs of the particular site and to implement the clean-up plan.

Id. at 3-4. *See also*, R. KNOX, L. CANTER, D. KINCANNON, E. STOVER & C. WARD, AQUIFER RESTORATION: STATE OF THE ART (1986).

[49] GORDON, *supra* note 10 at 40. The dewatering of an aquifer can help cleanse it as well as pumping the water to the surface for aeration, though it is cheaper if the aquifer can be trenched so that water can simply flow out of it. *Id.* at 39.

of bacterial degradation. This method has perhaps less risk than the use of chemical additives for the reneutralization of contaminants introduced into the aquifer.[50]

Often one thinks of oxygen as a necessity for bacterial action. Oxygen is often present in aquifers in the dissolved form needed for bacterial action. But anaerobic conditions facilitate some bacteria and many compounds can be broken down better by such action.[51] In addition to oxygen, nutrients must be present for bacteria. The introduction of these necessary nutrients may lead to further contamination.

Microbial ecology for cleaning up aquifers, hazardous waste sites, mine drainage, and other contaminated waters is a recent research area, but "[m]icrobial metabolism is probably the most effective process in removing the compounds from the environment. . . ." under many difficult circumstances.[52] In addition to fecal matter which traditionally has been biodegraded by bacteria, heavy metals, phosphorus, and carbonaceous materials respond to biochemical oxygen demanding bacteria.[53]

A larger issue still under extensive scientific inquiry is the ability of bacteria to handle toxic organic chemicals. As of the late 1980s little is known concerning the degradation of trace organics in groundwater. In the United States, several projects

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[50] BYRD, *supra* note 37, at 3-4. The author's level of belief is low in the efficacy of *any* method: "For example, physical barriers deteriorate, flow alterations may be incomplete, and treatment neutralizes only specific contaminants." *Id.* at 4. Since genetic engineering is a likely prerequisite for microbial rehabilitation of contaminated aquifers, risks exist. *See* Pierce, *Development of Genetically Engineered Microorganisms to Degrade Hazardous Organic Compounds*, in HAZARDOUS WASTE MANAGEMENT FOR THE 1980'S, 431, 433-434 (Sweeney, Bhatt, Sykes, and Sprout, eds. (1982)).

[51] Anerobic action of this kind is similar, of course, to what occurs in the indigenous microbiota of the human alimentary system. This digestive process is as important to human existence as the biooxygen degradation in nature and the dissolved oxygen process fundamental to much aquatic life. *See* such basic works as C. KELSEY, THE PHYSICAL BASIS OF LIFE, 37-40 (2nd ed., 1928), J. BIRKELAND, MICROBIOLOGY AND MAN, 66-67 (2nd ed., 1949), R. DUBOS, MAN ADAPTING, 110-15 (1965).

[52] M. Lee, J. Thomas, & C. Ward, *Microbially Mediated Fate of Ground Water Contaminants from Abandoned Hazardous Waste Sites*, in WATER RESOURCES FOR RURAL AREAS AND THEIR COMMUNITIES, VTH WORLD CONGRESS OF THE INT'L WATER RESOURCES ASSOC., I, 113, 114 (1985). *See also*, *Id.* at 115.

[53] S. Hutchins & C. Ward, *Microbial Involvement in the Removal of Trace Organics During Rapid Infiltration Recharge of Ground Water*, in WATER RESOURCES FOR RURAL AREAS AND THEIR COMMUNITIES, VTH WORLD CONGRESS OF THE INT'L RESOURCES ASSOC. I, 123, 124 (1985).

have demonstrated that many trace organics in wastewater can be bacterially removed.[54]

Where aquifers are being recharged by rapid infiltration an optimistic conclusion can be reached. These methods are either a quick natural recharge or an artificial program which increases the water available for percolation without pretreatment. If the biologists working with bacteria in cleaning aquifers, or treating water on the surface before it can percolate or be injected into aquifers, are correct in their conclusions about the utility of the processes for all but a few "recalcitrant compounds," then the news is good.[55]

The best should not be the enemy of the good in pursuing biological or physicochemical means of cleaning up contaminated water. We will not turn waste into distilled water. But where public drinking water sources are concerned even one "recalcitrant" is too many. And the number of "recalcitrants" is likely to remain large in an urban-industrial economy which is dependent on chemical technology used in industrial, commercial, and agricultural operations.

Even if clean up techniques for aquifers were cheap, sure and speedy—which none is—the risks attaching to the existence of "recalcitrant compounds" (and to their as yet uninvented future companions) would require programs effectively protecting groundwater as well as such other sinks as lakes and oceans from contamination.[56] Only by keeping the contaminants out of groundwater can a reliable source of water for any human purpose be provided.

The protection of aquifers from contamination, therefore, has to be a land-based planning operation.[57] American federal

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[54] Pierce, *supra* note 50, at 435.

[55] Hutchins & Ward, *supra* note 53, at 124. "Groundwater has recently been recognized as a limited and vulnerable natural resource. . . . Yet most studies indicate that little attenuation of organic chemicals should occur in rapid infiltration systems." They found in 1985 that "there is virtually no information on long-term degradation of trace organics in ground water." *Id.*

[56] The ocean is the universal sink. It suffers in this capacity to a far greater extent, but in a manner similar to the absorptive capacities of lakes and aquifers. *See* THE 1985 CITIZEN'S GUIDE TO THE OCEAN 72 (1985). This book emphasizes the risks of industrial dumping of wastes at sea, which is a small problem compared to most other water pollution problems. *Id.* at 63, 67.

[57] Hutchins & Ward, *supra* note 53, at 124. "Land application is generally effective for the removal of many wastewater constitutents. . . ." *Id.*

law increasingly recognizes this fact. Sites exist in every state containing landfills and other surface sources of aquifer peril in the United States. For example, though sites can no longer be located in places dangerous to groundwater under current law, the state and federal governments still must deal with old sites that are existing, and persisting, dangers. Many of these are the sites that Superfund focuses upon for remedial correction.[58]

These troubled sites must have developed for them "remedial action master plant" (RAMP) that will "identify the type, scope, sequence, and schedule of remedial projects which may be appropriate in meeting an identified need . . . [and] [a]dditionally . . . lists the phases of a site contamination and liability audit."[59] Although immediate remedial actions are required by the RAMP, of greater significance is the RAMP's requirement of immediate action. Site-specific studies capable of developing better long—term solutions must be made. The RAMP drawing from these studies must contain analyses of alternative remedies to those selected; and all analyses must consider environmental impacts, costs, and risks of the procedures chosen by the RAMP, in order to prevent the cure from being worse than the initial disorder. After all, the purpose of RAMP is to develop the "optimal solution for meeting a given need."[60]

This RAMP action corrects not only past land use mistakes but also provides for aquifer decontaminations. What land actions might be taken that truly would *prevent* the reasonable chance of aquifer contamination? The answers are not easily determined in a technology that must produce, store, move, use and dispose of large volumes of substances whose penetration into any aquifer must cause damages ranging from serious to irreversible.[61] Maybe the answers on how to decontaminate are

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[58] CERCLA, 42 U.S.C. §§ 9601-57 (1982).

[59] CANTER & KNOX, *supra* note 43, at 160.

[60] *Id.* at 160. "Most of the work in developing structural approaches or protocols for addressing ground water pollution problems has been conducted in response to the Comprehensive Environmental Response, Compensation and Liability Act, P. L. 96-510 (known as CERCLA or 'superfund')." *Id.* at 159.

[61] The extent of risks at each of these stages is made clear by the excellent coverage in a two volume set of study materials: THE AMERICAN LAW INSTITUTE/AMERICAN BAR ASSOCIATION, IN CONJUNCTION WITH THE ENVIRONMENTAL LAW INSTITUTE, HAZARDOUS WASTES, SUPERFUND, AND TOXIC SUBSTANCES (1985).

more available than the answers on how not to contaminate an aquifer.

Four basic management strategy options are available for selection in any sort of national groundwater protection program. These options range from a goal that may be unrealistically high to the lowest goal of losing some aquifers in order to continue certain surface activities that the economy considers of more value than any potential future value in the lost aquifers. The options are:

> [1] Uniform management, which supplies the same protection mechanisms equally to all groundwater. [2] Aquifer classification, which groups groundwater into categories allowing protection to vary from class to class. [3] Contaminant classification, which groups types of contaminants and allows priorities to be set for protecting against contamination from specific substances. [4] Contamination source classification, which identifies specific sources of contamination and establishes methods and priorities for protection from them.[62]

The United States National Groundwater Protection Strategy rejected the first option on the basis that "the variation among groundwater formations, uses, and quality was so vastly different from place to place that it was impossible to construct and apply a national policy or uniform standards in all states."[63] Instead, the strategy

> identifies three classes of groundwater sources. Class I aquifers are irreplaceble drinking water sources. Class II aquifers are current and possible sources, but are replaceable. Class III sources are aquifers with undrinkable water. . . . [As a result,

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[62] BRYD, *supra* note 37, at 19. Byrd thinks that option 1 "may be an unrealistically high goal," *Id.* at 21. The second option, critics say, gives a license to pollute as long as the groundwater quality level is not exceeded. Option 3 "assumes some groundwater is not valuable. Potentially contaminating activities may be sited over aquifers of poor quality." *Id.* at 24.

[63] Anthony, *supra* note 36, 225-26. In an earlier USEPA draft this produced "the fear that EPA will use the 'lowest common denominator' of degradation of aquifers, and by doing so will intrude into state allocation laws, and be susceptible to politically expedient decisions." *Id.* at 222. (She sets out the history of the development of the strategy ultimately proposed on August 30, 1984, and seems to have reservations about USEPA's motives.).

> USEPA has established] a priority identification process for cleanup and location of hazardous and chemical waste disposal sites. Existing sites located over Class I aquifers would be given top priority in cleanup considerations. Potential sites located over Class I aquifers would not be eligible for new disposal or siting permits.[64]

Obviously these aquifer classifications and clean up priority schedules relate to the different options concerning the level at which the protection of groundwater is to be set. This can range from a very protective program to one not very protective at all. Of course, compared to the interest previously shown by law and institutions in groundwater quality protection, even the standards for the third category would be an improvement.

The national choices concerning groundwater quality in America are several. One option is to protect groundwater whatever its existing quality might be. This is one of the goals of the United States National Groundwater Protection Strategy. The second option is to pick a specific water quality level and then try to bring selected aquifers up to it, or to allow, conversely, a downward drift. And, thirdly, a survey of all aquifers could distinguish them "on the basis of their quality, use, vulnerability to contamination or other considerations, and then set levels of protection associated with each type of groundwater."[65] The United States has chosen to act by classifying aquifers supplying public drinking water as Class I. The goal selected will be a significant determinant in this adoption of a surface land management strategy designed to prevent groundwater contamination.

At about the time that the United States adopted its National Groundwater Protection Strategy, the Federal Republic of Germany developed a national program of zones for wellhead protection. This program interdicted or limited certain surface activities with the wellhead zones so as to prevent groundwater contamination. The West Germans, too, had three areal categories called "zones." The German plan focused much more on controlling surface activity and was far less concerned with

[64] 5 HYDATA, no. 2, 2 (1986).
[65] BYRD, *supra* note 37, at 18-19.

classifying aquifers than is the American. The zones function as follows:

> Zone 1—extends at least 10 meters from the well and excludes pedestrians, or vehicular traffic, agriculture, and application of chemicals, plus all activities banned in Zones II and III.
> Zone 2—excludes mining, blasting, cemeteries, oil storage, transport of radioactive substances and all activities not allowed in Zone III. The border of Zone III represents the distance that groundwater will travel in 50 days.
> Zone 3—ideally, would encompass the entire groundwater recharge area, but the true value of Zone III is to provide sufficient time for corrective action if contamination occurs. Banned activities include airports, feedlots and storage of potentially polluting substances.[66]

Given the broad nature of the prohibitions, however, it is evident that the German plans are not designed to protect all groundwater within the country, nor even all major aquifers. The primary purpose of the German plan, as is the case for the American, is to protect sources of public drinking water from contamination—or, speaking in realistic terms, from additional contamination. Neither country's plan is a total strategy for protecting all groundwater from all contamination, even if such a strategy were currently a technical and economic possibility.[67]

Evidently, these national programs of highly developed countries can never be cheap to implement. Traditionally people have not thought about groundwater contamination. They have believed throughout history (excluding, of course, the Islamic at-

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[66] 4 HYDATA, no. 4, 2 (1985). "To control individual misuse of household chemicals, the Germans also have installed signs at the zone boundaries reminding residents and those passing by that their drinking water supply lies beneath their feet." *Id.*

[67] BYRD, *supra* note 37, lists all of the efforts that would have to be put in place to accomplish (or even nearly accomplish) that goal: Waste reduction, recycling, and treatment, *Id.* at 27-28; effluent limitations and discharge permits, *Id.* at 29-30; design, operation and maintenance specifications, *Id.*, 30-31; best management practices to minimize risk of contamination from non-point sources, *Id.* at 31-32; controls on groundwater users to protect well locations, *Id.* at 32-33; land-use alternatives to prohibit activities in recharge areas, *Id.* at 33; technical assistance and training and public education, *Id.* at 34-36; incentive programs (tax advantages, loans and cost-sharing), subsidies, and other economic incentives (limiting crop insurance to farmers following certain directives, linking subsidies to such directives, etc.). *Id.* at 34.

titude) that groundwater was too plentiful or too replenishable to worry about either its contamination or its exhaustibility.[68] As Robert Repetto of the World Resources Institute has noted,

> Throughout most of the world, groundwater is treated as an open-access, common-property resource, the water belongs to whomever "captures" it by pumping it to the surface. Unfortunately, anybody can degrade its quality with impunity by contaminating it with effluents. Subsurface water is becoming one of the world's most valuable common-property resources, but the losses from improper management are enormous.[69]

The law and institutions become interested in groundwater only when facts indicate that drinking water sources might be lost, regional economies might be compelled to reduce regional gross product, aquifers might be mined to exhaustion just like oil or coal, and people might be forced into dramatic relocations.[70] It has turned out that there is more to groundwater than how much can be extracted from the well.

IV. RESTRICTING HUMAN IMPACT ON GROUNDWATER AND AQUIFERS

Even dedicated water engineers sometimes overemphasize the supply function of water withdrawn from the ground. They say,

> In formulation of ground water or ground water/surface-water management model, a suitable objective function is first defined. . . . For a ground-water aquifer, the objective function may be based on minimization of a total cost function . . . maximization of total pumpage . . . maximization of the sum of values of hydraulic head at specified points, minimization of the total water shortages . . . or on other objectives such

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[68] Wilkinson, *supra* note 23, at 322: "[W]e have become determined to abate water pollution, an issue given little or no attention in prior appropriation law." The same indifference substantially marked jurisdictions having the three Anglo-American rules of law for groundwater other than the appropriation doctrine.

[69] REPETTO, *supra* note 35, at 62.

[70] Wilkinson, *supra* note 23, at 327. He focuses on the present and potential problems of the Ogallala region in the United States, but his fears would fit other places, where the problems would have more deadly results.

> as the minimization of the sum of the squared differences between demanded and supplied pumpages.[71]

There is generally more to the use of groundwater these days than is contained within this management mode.

A UNESCO publication claims that other demands or potential responses must be included in any groundwater management plan.[72] Provision must be made for substitute water in the event of inadvertent over-pumpage. Plans for the conservation in the application and use of water must be prepared. The legal system must be provided a means of equitably apportioning overdrawn groundwater or its surface-water substitution. If recirculation and reuse of water is possible, plans must be in place to provide for them, or else plans must be in place for decreasing irrigation or reducing industrial production that has a heavy groundwater withdrawal component.

UNESCO insists that some provision must be made to change the "depth range of perforated intervals in well casing or screens to tap less compressible deposits,"[73] unless moving the wells in the field to tap "less compressible layers,"[74] has been included in the management plan from the beginning. At the same time, UNESCO's proposal indicates that these provisions do not exhaust environmental and socioeconomic concerns. Planning must be made for major groundwater withdrawals that might interrupt or interdict natural recharge and for withdrawals that are not accompanied with artificial recharge mechanisms.[75]

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[71] M. Heidari, *Optional Management of Large Aquifers for Irrigation Activity*, in WATER RESOURCES FOR RURAL AREAS AND THEIR COMMUNITIES, VTH WORLD CONGRESS OF THE INT'L WATER RESOURCES ASSOC. II, 1003, 1004 (1985). The "objective function," however, is qualified:

> Various physical, legal, and environmental constraints that must be satisfied are subsequently included in the formulation. . . . The constraints associated with these objective functions may include the maximum allowable drawdown and pumpage, and other quantifiable environmental, physical, and legal constraints.

Id. at 1004. (Still, these qualifications are scarcely uppermost in the planner's model.).

[72] GUIDEBOOK TO STUDIES OF LAND SUBSIDENCE, *supra* note 6.

[73] *Considerations*, *supra* note 6, at 127.

[74] *Id.*

[75] *Subsidence*, *supra* note 7, at 127. They are concerned with preventing land subsidence from groundwater withdrawal, but what they believe must be included in any groundwater management plan to prevent subsidence must also be included for other

Traditionally, those who use water and those who plan its use have been in conflict. This conflict occurs even when careful planning and legislation have been designed to phase in equitable solutions to water crises. The findings of Leslie Mack, an American water specialist, have been summarized as:

> [U]nderlin[ing] overuse of water; quality degradation, failure to utilize available water and to have laws and regulations compatible with natural laws; lack of authority to make decisions; and lack of desire of conflicting users to find solutions. As to prevention and resolution, she suggests *inter alia* providing state and local laws and regulations compatible with the natural occurrence and flow of water; organizing water districts with a manageable size; determining rules of use between users before conflicts arise, according to dynamic water regimes and not according to static permits; encouraging conservation and conjunctive use of surface and groundwater when possible; maintaining user participation in decision-making; and keeping administrative decisions on a local level when possible.[76]

In brief, all the *good* things are in this list that *good* people ought to want for both public and private *good*, whatever the cynical may believe. Nevertheless, here are at least some of the problems that must be addressed. These are also the goals that must be attained in managing both the use of groundwater and surface water which will serve for all but the simplest subsistence economies.

Whenever groundwater is dealt with on a regional basis, two worlds intermingle: the physicobiological (the renewable, stock, and living resources) and the socioeconomic (social and economic structures). Too often the latter has been thought to flourish at the expense of the former by transferring costs as if such externalities could be indefinitely passed away.

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reasons as well. Included, for example, are "conservation" proposals for changing "from ditch and furrow or to floor irrigation to overhead sprinkler irrigation or to drip irrigation" and "through change from crops requiring heavy [water] duty or demand to crop requiring less [water] duty, such as from cotton to orchards," *Id.* (One can imagine the political consequences of such proposals, even if only preproposed, much less if brought forward onces a crisis had appeared.).

[76] *Results*, *supra* note 1, at 67, 68-69. *See Legislation*, *supra* note 2, at 462-63 (abstract of the paper by Leslie Mack).

> [M]odern man justifies his continuous assaults on nature on the assumption of limitless environmental frontiers. This assault . . . translates itself into a continuous 'process of externality transfer', towards both environment and society, leading to a disregard of the community's rights, both public and private.[77]

But that cannot be all there is to reality. Regional socioeconomic systems that are dependent on groundwater, or its conjunctive use with surface water, are complexly hierarchical, with many interdependent elements.[78] They are not free of the physicobiological.

The users of the environment directly interact with the physicobiological in as exploitative a fashion as their technologies allow. These users, those who are the lowest in the region's socioeconomic hierarchy, tend to focus on highly local goals without regard for much coordination with others around them, or above them, in the hierarchy. National governments, at least in theory, have broader goals that cover the whole region, as do elements high in the economic hierarchy, for example, multinational corporations, whose levels of exploitation encourage them to be less parochial and, perhaps, more willing to internalize some costs in order to stretch out the possibilities of exploitation.[79]

Nowhere, however, are many altruists or selfless advocates of the physicobiological systems present. In a socioeconomic hierarchy with a comprehensive outlook, participants need not be altruists. Costs simply cannot continuously be passed on to the renewing environment. Constraints must be accepted on the

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[77] *Subsidence, supra* note 1, at 71-72 (summarizing Miguel Solanes, LAW, ENVIRONMENTAL EXTERNALITIES AND WATER, LEGISLATION). Solanes "defines the economic concept of 'externality' as those costs of productive activities which are not taken into account by policymakers and producers, who transfer their costs to other persons or society as a whole . . . ." *Id.* at 71. (A multiplicity of authors could be cited to this effect.).

[78] S. Orlovski & P. van Walsum, *Water Policies: Regions with Intense Agriculture*, WATER RESOURCES FOR RURAL AREAS AND THEIR COMMUNITIES, VTH WORLD CONGRESS OF THE INT'L WATER RESOURCES ASSOC., II, 1075, 1076 (1985).

[79] *Id.* "[I]n the majority of real systems these interactions lead to the deterioration of the environmental subsystem which is potentially dangerous for the existence of the whole socio-economic system in the long run. . . . No formal description can encompass [however] all the aspects of a real socio-economic subsystem." *Id.* at 1076-77.

use of both surface and groundwater. Otherwise, socioeconomic decision makers will continue to view these sources as amply able to meet the demands of even a pleonexic human system.[80]

In the case of the groundwater, the dawning of aquifer consciousness has been slow and comparatively recent. Maybe the contrary was true for the intelligent ideal of the Islamic *harim* protection of wells, but the idea found no imitators in Western legal systems until quite recently. Too often, the world's legal systems have been prepared to leave groundwater to a negative sum game.[81]

But since 1931 when New Mexico first successfully allowed an appropriative right in groundwater,[82] there has been an expansion of groundwater law at both the state and federal level in the United States. Elsewhere also in the world, legal-institutional changes have been instituted to protect, regulate, and otherwise act positively on behalf of groundwater. Groundwater's users and abusers have come under steadily increasing regulation.[83]

Where water is plentiful, an indifference to it is prevalent. Where water is scarce, a consciousness exists to get more of it, even when lip-service is being given at the same time to conservation. Neither situation engenders a caring attitude about water.

Too little thought, however, is given water of any sort, particularly in modern urban-industrial societies whose members exist in a seeming isolation from nature. If "their sense of living in a water shed is minimal,"[84] how much more minimal must be their knowledge of living in a region defined by an aquifer? Most Americans are only generally concerned about water pol-

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[80] E. ZIMMERMANN, WORLD RESOURCES AND INDUSTRIES 73 (rev. ed., 1951).

[81] REPETTO, *supra* note 35, at 9 ("The common-property status of many natural resources creates a destructive negative sum game.").

[82] Ch. 131, N.M.L. (1931), now N. M. STAT. ANN. § 72-12-1-10 (1978) (1987 Supp.).

[83] Wilkinson, *supra* note 23, at 317, 336. *See* Buresh, *State and Federal Land Use Regulation: An Application to Groundwater and Nonpoint Source Pollution Control*, 95 YALE L.J. 1433 (1985-86). A proposal has been made for a federal "groundwater residue guidance level" (GRGL) for pesticides in groundwater, Staff provided by MCKENNA, CONNER & CUNEO, PESTICIDE REGULATION HANDBOOK 10 (rev. ed. 1987).

[84] 42 POTOMAC BASIN REP. 5, 1, 2 (1986) (based on a survey taken by the Interstate Commission on the Potomac River Basin, Potomac State College, and Frostburg State College, with the assistance of the University of Maryland Survey Research Center).

lution, or water availability, or water use.[85] This is so even though water has "unique physical properites" and "plays a dynamic role in shaping the landscape and creating special habitats for all organisms."[86]

Only in recent years have urban dwellers acquired a vicarious consciousness of water problems that are distant in space and time.[87] Such changing public perceptions focus on fairly specific water issues. One might expect, therefore, legal actions to be fragmentary and not done as part of comprehensive water management.[88] Certainly, this has been the description of legal-institutional developments concerning the regulation of groundwater and the protection of aquifers.

Few lawyers have written as much on water as Dean T. Massey, whose work summarizes the piece-meal character of what American states have done in relation to groundwater regulation and aquifer protection.[89] Any jurisdiction's doctrine

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[85] "[T]here is a need for improving the public's general understanding of the watershed in which they live. . . ." *Id.* at 1.

[86] D. GATES, ENERGY AND ECOLOGY 13 (1985). *See id.* at 14-24 (for a comprehensive introduction to the "biogeochemical cycles," including the hydrological, carbon, nitrogen, sulfur, and phosphorus cycles).

[87] Shelley, Schoolmaster, and Roberts, *Voter Reactions to the 1976 Water Development and Quality Referenda in Texas*, 22 WATER RESOURCES BULLETIN, 485, 492 (1986), which analyzes the opposition in humid east Texas, the support in arid west Texas, especially the Ogallala region (which wanted more state funding for water development) and the support (which carried the election) in the urbanized areas of Dallas, Fort Worth, Austin and San Antonio, whose benefit would be "financial and aesthetic," *Id. But see id.* at 490, for a discussion of the immediate interest of San Antonio in the Edwards aquifer, which "has been subjected to intensive use and is highly susceptible to contamination." (citation omitted).

[88] As one example among many potential ones,

> Governments in the United States have responded to drought by crisis management rather than risk management. This approach has been grossly ineffective. . . . The development of a national drought plan is proposed. . . . [Does] the current approach, or policy, encourag[e] the adoption of appropriate and efficient management practices to ensure against abnormal risk[?] It would appear that it does not. In fact, current policy often discourages wise risk management decisions by producers. . . . [D]rought policy in the United States [has not been] equitable, consistent, and predictable . . . [and] assistance measures are often implemented in . . . an ineffective and untimely manner. . . .

Wilhite, *Drought Policy in the U. S. and Australia: A Comparative Analysis*, 22 WATER RESOURCES BULLETIN at 425, 436.

[89] *See infra* notes 91-100 and accompanying text.

for the ownership of groundwater while in place in an aquifer is indicative of what the state may do to those using or abusing the groundwater. States have been able to act legislatively and administratively concerning groundwater regardless of doctrine, even if a fragmentary character has been typical until recently.

Aquifer-consciousness is heightened by no particular judicial rule about groundwater. Aquifer-consciousness is also not intensified by predisposing legislative inclinations towards either command regulation or fixed property rights. Of course, a choice of rules that proves effective for protecting groundwater quantity and quality always produces another result. Aquifer-consciousnes both induces legislative actions and is intensified by successful legislative action. However, profound failure, too, can be the advocate for aquifer-consciousness.

The legal restrictions that have been imposed on groundwater over the years since 1931 have been mostly physical in nature. The rules often have been borrowed from what the law of oil and gas has provided for *in situ* conservation measures. This legal borrowing is not surprising because, both geologically and technically, a close relationship has existed from the mid-19th century between those drilling for and producing oil and gas for those drilling for and withdrawing water.[90]

Therefore, just as with oil and gas wells, one of the most common regulations in groundwater law has been well spacing. In the case of groundwater, the intention is to prevent unduly deepening and narrowing the cones of water withdrawal in aquifers, dropping water tables from over-pumping, and interfering among pumpers in their water withdrawals. These regulations establish a minimum distance between the location of wells. In addition, irrigation and industrial wells have been prohibited from locating within specified distances of public drinking water wells.[91]

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[90] S. TAIT, THE WILDCATTERS: AN INFORMAL HISTORY OF OIL-HUNTING IN AMERICA, 46-54 (1946) (In the early history of oil extraction in Pennsylvania and West Virginia, the salt-well drillers were the source of much technology for the burgeoning oil and gas industry and also the probable source of the new industry's now long-established indifference to brine pollution.).

[91] Massey & Sloggett, *Groundwater Management in Ogallala Aquifer for Irrigation*, in PROCEEDINGS OF THE SPECIALTY CONFERENCE, AM. SOCIETY OF CIVIL ENGINEERS 44, 48-49 (July 24-26, 1984) [hereinafter Massey & Sloggett].

The regulations on well spacing have been coupled with quantity restrictions on the amount of groundwater to be withdrawn from each well in order to maintain the productive resource of the aquifer as long as possible, particularly if the aquifer is being mined rather than exploited under conditions of recharge. Often regulation is done on a basin or sub-basin wide basis, rather than well by well, thus encouraging aquifer consciousness. The restrictions may be permanent. They also may be temporarily imposed while a hydrological survey of the aquifer is being conducted to determine the maximum withdrawal rate that can be maintained, consonant with some degree of recharge through natural forces.[92]

Since pumping from one well can lower the production of another well tapping the same aquifer, states seek to protect "a reasonable groundwater pumping level . . . either [in terms of] water level in the ground or pumping lift to the surface."[93] Of course, prohibitions against waste accompany all of this, requiring the capping of flowing wells and the operation of tailwater pits to collect runoff for recirculation or reinjection in the aquifer.[94] But, if prohibitions against waste were sufficient, the law would not have to address itself as to how "reasonable" groundwater pumping levels are to be maintained.

The state can simply set a limit on the quantity to be extracted, estimating that the aquifer can meet the restricted demand for each of the wells allowed. Or the state can mandate that, if technical improvements in a well whose withdrawal ability has declined will restore its previous pumpage capacity, then those technical improvements must be made before the state will intervene. Still other choices exist if the state demands "reasonable" actions in this task of water table maintenance.

All choices focus public attention on the existence and the need to protect and maintain aquifers from which withdrawals

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[92] *Id.* at 49-50. (Entitlement to water is often calculated in terms of acreage owned or leased overlying the aquifer. Some regulations maintain longevity of the aquifer being mined; rules about depletion are often adopted in relation to the aquifer's rate of replenishment.).

[93] Massey, *Economics of Groundwater-Pumping Level Statutes*, in PROCEEDINGS OF THE SPECIALITY CONFERENCE, AM. SOCIETY OF CIVIL ENGINEERS 1, 2 (1984).

[94] Massey & Sloggett, *supra* note 91, at 50.

of water are being made for surface use. The emphasis throughout each potential choice is on protecting the source of water for purposes of human surface use. Choices concerning groundwater generally have been made in an anthropocentric fashion.

Some choices for groundwater made by legal systems

> relate to a specific quantity of water and those rights allow for a reasonable lowering of the static water level at the . . . points of diversion. . . .an impairment means "unreasonable" lowering of the state water level when determining whether a proposed use impairs a use under an existing water right. . . . [choices also include] requiring that reasonable stable groundwater levels must be [administratively] determined and maintained, [or that the requirement] does not include maintaining historic levels, [or that it means] withdrawing groundwater beyond the capacity of the underground bed to yield such water within a reasonable or feasible pumping lift.[95]

Consequently, the most common feature of limitations based on water levels and water lift is a physical restraint, a physical maintenance, directly imposed by the law. In recent years, however, some economic criteria have begun to be taken into consideration but economic considerations by state regulators remain the exception.[96]

To enforce these physical limitations, states have created permit systems for wells, especially those to be newly drilled, in order to keep track of well location by registration and to reduce the rate of groundwater depletion. Exempting wells pumping less than 100,000 gallons per day is common, while even whole areas of some states are exempted on the basis of presenting no groundwater "crisis."[97] The regulations are designed to conserve water, of course; but they are also meant to keep down pumping costs for those exploiting the aquifer.[98]

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[95] Massey, *supra* note 93, at 4-5.

[96] *Id.* at 5-6. Some rules have the central state agency deny a permit if there would be an adverse economic effect on the area. Others administatively find pumping "unreasonable" if it is done with superior economic capability, "such as power generating companies or cities [that] impose costs beyond the economic reach of small prior appropriators." *Id.* at 6. Despite the title of his article, Massey's examples mostly concern physical limitations directly imposed on the groundwater resources in place, rather than economic considerations.

[97] Massey & Sloggett, *supra* note 91, at 48.

[98] Massey, *supra* note 93, at 2, 6.

Regulations often implement statutes which limit the use of groundwater to land where water use will assist in aquifer recharge. The legislative intent behind this "beneficial and economic use" is to keep water on the land of its pumped origination.[99] The purpose of these statutes is to regulate "evenhandedly," so that preferred rights, if any exist, are protected, or, if mutual access under a reasonable use doctrine is the requirement, the general availability of the resource is protected.[100]

The interesting common thread running through these illustrations of rules for protecting groundwater and water pumped from aquifers is the degree to which they focus on location: the well-field, the recharge area, the basin for surface water interchange, in short, the region-as-aquifer. No longer is the focus on some abstraction like "freely percolating water." The legal-institutional emphasis is increasingly on the aquifer, in a manner that can only raise public consciousness of the importance of aquifers.

First, the aquifers supplying public drinking water became the objects of attention. Then, the aquifers supplying water for any human purpose came into regulatory focus. Later still, the aquifers that might be of future use for some human purpose became natural resources requiring protection.

Perhaps, eventually, all aquifers and groundwater will receive the advantages of protective regimes. But, in the meantime, the public consciousness concerning aquifers steadily is being raised. The current plenitude of judicial decisions, statutes, administrative regulations, scholarly commentary, and popular writing on the subject begins to bring into political play that public aquifer-consciousness which has been so sadly lacking in the past.

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[99] Massey, *Interbasin Transfers of Water in Ogallala States*, in PROCEEDINGS OF THE SPECIALITY CONFERENCE, AM. SOCIETY OF CIVIL ENGINEERS, at 223-31 (July, 1985).

[100] Massey, *Great Lakes Water Diversion: Legal Issues*, in PROCEEDINGS OF SPECIALITY CONFERENCE, AM. SOCIETY OF CIVIL ENGINEERS, at 864, 870 (June 10-12, 1985). (While Massey concentrates on the appropriation jurisdictions, he is also concerned with jurisdictions that operate under the other three rules.). *See also* Massey, *Laws Affecting Inter-Basin Water Transfers in the United States*, PROCEEDINGS, IWRA [INTERNATIONAL WATER RESOURCES ASSOCIATION] SEMINAR ON INTER-BASIN WATER TRANSFER, at 15-19 (June 1986) (*See Id.* at Beijing: Chinese Hydraulic Engineering Society, 1986, 57-66 for a more comprehensive treatment.).

V. PROBLEMS IN PAYING FOR THE COSTS OF GROUNDWATER PROTECTION AND AQUIFER PROTECTION/REHABILITATION

Although legislative actions by American states concerning groundwater have economic components,[101] their major emphases still are upon the direct physical control over reaching the aquifer, pumping for the aquifer, protecting the aquifer, and recharging the aquifer. The concentration is on

> the development of new or alternate means of points of diversion, but a pooling of water resources, by water exchange projects, by providing substitute supplies of water, by the development of new sources of water . . . by the eradication of phreatophytes [economically useless plants consuming water] . . . [and by] the use of . . . water collected from land sources which have been impermeable, thereby increasing the runoff . . . .[102]

Many groundwater problems are unique to their physical and geological settings. Local soil conditions operate to facilitate, inhibit, or affect the quality of water percolating through these settings. Waters in aquifers produce more complex implications of a legal character than surface water because of these soil conditions.

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[101] In California, for example, a pump tax or replenishment assessment can be levied on all groundwater extracted. Basin equity assessments, in addition, can be imposed, increasing or decreasing the cost of groundwater. This regulates pumping patterns and influences the amount pumped. Joseph F. Poland attributes the success of California's program substantially to these assessment powers, Poland, Carbognin, Yamamoto and the Working Group. *See Considerations, supra* note 6, at 124. In Arizona, persons withdrawing groundwater within the AMA's first must pay an ultimate withdrawal fee of not over $5.00 per acre foot (in 1984 it was 50 cents per acre foot) to cover half the cost of administration, the cost of augmentation projects, and (in later years) the purchase for retirement of grandfathered rights. *See* Ferris, *Water Demand — Sharing a Limited Source*, 4 HYDATA, no. 5, 8 (1985). It is too early to tell if this charge will have the positive economic impact attributed to the California pumpage charges.

[102] Moses, *supra* note 21, at I, 1, 8-9. (Moses is speaking of a "new" source of supply to be obtained for an "overburdened system" without injury to any water user. Phreatophytes are plants drawing their water from the water table or soil layer just above it.).

Consequently, the emphasis upon the physical in the case of groundwater is understandable.[103] However understandable, the emphasis has over-stressed the physical. The neglect of what might be called the metaphysical aspect of groundwater has been the result. Human culture, not natural conditions, is where the stress should be placed in groundwater use.

Whenever the legal system has to consider elements in nature that have become resouces for human use, all the physico-chemico-geo-environmental and socioeconomic aspects always have had to be given positive consideration.[104] And the consideration of groundwater is no exception. Today, though, the decision-makers consciously have a larger series of options easily available to them.

Traditionally, landowners have thought that if a well were needed it could be created without asking anyone's permission. In their view, the cost of making the well, providing the pumpage mechanism, and paying for the operation of the pump were investment costs that prevented their actions from being subsidized water uses. But the groundwater itself was regarded by landowners with wells as a free good from nature. No cash payment, in their view, ever ought to be extracted from them by any government functionary or users' association.[105]

With such attitudes, a prevalent demand for groundwater could only be calculated in terms of present use, projected population, and economic growth. How much water people would want under these self-accelerating rules has to become the dominant—usually, the sole—consideration. The resource has not been regarded—indeed, under these conditions, scarcely could have been regarded—as being capable of having a price.[106]

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[103] GREGG, *supra* note 4, at 279-81. (The significance of the composition of the physical material upon which rainwater falls, over which it flows, and through which it percolates is well described in D. Firestone and F. Reed, ENVIRONMENTAL LAW FOR NON-LAWYERS, 91-93 (1983).).

[104] Orlovski & van Walsum, *supra* note 78, at II, 1076.

[105] REPETTO, *supra* note 35, at 62 and 85.

[106] Rogers, *Fresh Water*, in THE GLOBAL POSSIBLE: RESOURCES, DEVELOPMENT, AND THE NEW CENTURY, 225 (Repetto, ed. 1985).

> Demand . . . is a function of specific water uses and of users' characteristics. For a particular use in a particular climatic region, the demand for fresh water should be a function of both the user's income (or asset

The direct abstraction of water for use by the abstractor on his own property at the site of abstraction rarely results in a charge to the groundwater abstractor anywhere in the world today.[107] The imposition of such charges *may* be increasing. But, of far greater certainty, is the knowledge that even the metering of water thus abstracted has been rare.[108]

> [T]he right to abstract . . . underground waters which fall in the private domain of relevant landowners is inherent in the ownership of land lying above groundwater resources. . . . [S]uch rights can be exercised free from governmental interference, but subject to legal restrictions in the interest of . . . landholders sharing a common ground-water source.[109]

However, what about paying a charge for taking groundwater under these conditions? Such payments are not a common practice in the world. At least, *as yet*, payments by landowners for groundwater extracted from beneath their land remain uncommon.

True, "[i]t is practically universal practice that water supplied to the public for domestic and industrial use be paid for by the consumers."[110] But this is not true for much of the water provided rural to water users. If it is self-supplied as much of it is, charges rarely have been levied on the volume pumped.[111]

Where some governmental or quasi-governmental body is providing water for irrigation, institutional pressures have been such that the water traditionally has been provided to the irrigators at only a fraction of its distribution and development costs.[112] Even American rural water utilities, which are supposed

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> structure) and the price of water. Indeed, for all uses except domestic, the price should be the governing determinant of water use, other things being equal. Unfortunately, most studies of water use and demand either have not found statistically significant income and price effects or have not looked for such effects and have reported needs rather than demands.

Id. at 263.

[107] *Legislation*, *supra* note 2, at 415. (This is a worldwide survey as of 1985.).

[108] *Id.* at 422 (This is frequently true for water supplied to urban consumers.).

[109] *Id.* at 410 (He then discusses "noteworthy exceptions" to this rule for domestic (e.g., public water supply) and industrial abstractions.).

[110] *Id.* at 418.

[111] S. CIRIACY-WANTRUP, NATURAL RESOURCE ECONOMICS: SELECTED PAPERS 79 (Bishop and Anderson, eds. 1985).

[112] *Legislation*, *supra* note 2, at 418.

to be unsubsidized, self-supporting enterprises, still operate on the basis that water for rural users ought to be free or cheap.[113]

For American rural water utilities, subsidies have been almost as concealed as they have been for publicly supplied irrigation water in the United States. The economic health, however, of most rural water utilities is no model for irrigation districts or other entities providing water from either surface or groundwater sources.[114] This is illustrated by a glance at the tricks employed by rural water utilities to avoid paying for the costs of water supplied, despite the requirement that they show an ability to be self-financed.

Rural water users often have competing sources of supply that are free, which both compels low rates and provides an effective means of resisting rate increases.[115] The rural water utilities finesse this revenue shortfall in several ways. They choose not to build reserves (despite legal mandates that reserves be maintained), not to provide for annual depreciation expense, and not to have a sinking fund for any capital item's replacement. They anticipate that any future capital needs can be funded by borrowing and particularly anticipate that they can roll over the debt at low interest rates. Capital investments simply are consumed by them; and they merrily proceed by expecting—and getting—"penalty-free deferrals of debt service payments," by receiving loans at below market rates, and by enjoying considerable tax exemption.[116]

The result is a present happiness bought in anticipation of a long-run bailout at the expense of someone other than the cus-

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[113] Chicoine, Ramamurthy, & Grossman, *The Collective Provision of Potable Water to Rural Areas: Organization, Operating Cost and Demand Evidence from a Major U.S. Cornbelt State, U.S.A.*, in WATER RESOURCES FOR RURAL AREAS AND THEIR COMMUNITIES, VTH WORLD CONGRESS OF INT'L WATER RESOURCES ASSOC., II, 965, 967 (1985) [hereinafter Chicoine, Ramamurthy & Grossman]. Under the Reagan Administration after 1981, the amount of subsidized capital was reduced for such entities. *Id.* at 965.

> Because of the pricing policies followed by rural water districts . . . marginal price may not be exogenous in the long run. . . . [T]o individual customers in the short run, price will be exogenous. . . . During [this study], no rural water district altered its rates. Thus, for the purposes of demand estimation, the price of water can be assumed exogenous.

Id. at 971.

[114] Gessaman, *supra* note 28, at II, 679.

[115] *Id.* at II, 671, 674.

[116] *Id.* at II, 674-78.

tomers of rural water utilities, presumably the general federal taxpayer.

> [C]lear evidence [exists] that the customers of the rural water systems . . . are not paying the full economic cost of the water they receive. Even the most financially viable systems are . . . consuming their capital. Some systems that . . . have not been able to make their debt service payments have been collecting only a small proportion of the economic cost of the water they are delivering. In the short run, they can live on depreciation and deferred maintenance and defaulted debt service payments. In the long run, it will take substantial infusions of public funds to keep these systems operating.[117]

A program, therefore, that has enjoyed in one fashion or another a subsidy from the federal government alone of about thirty percent of the money needed to build and operate it, anticipated that in the future far greater expenditures will have to be spent on its behalf.[118] The idea that water is not free or cheap to the user dies a most reluctant death.

Insofar as the treatment of water as an economic good is concerned the case of irrigation water is far more extreme. The rural water utilities' operators seem frugal and foresighted by comparison. For irrigators, water is so cheap in the United States and most other countries that in many cases there are no social or economic inducements to conserve.[119]

Motives for conservation by irrigators, such as some kind of incentive to make possible the sale of conserved water, must be institutionally created. What happens to proposals for the expansion of seepage recovery systems, the improvement of on-

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[117] *Id.* at II, 679.

[118] *Id.* at II, 678. Interestingly enough, P. H. Gessaman concludes that these programs give "clear evidence that the fundamental purpose of the program . . . is being achieved at a reasonable [sic] level, though the cost of that achievement may not be reasonable [sic]." *Id.*

[119] R. Stavins & Z. Willey, *Trading Conservation Investments for Water*, in PROCEEDINGS OF A SYMPOSIUM, REGIONAL AND STATE WATER RESOURCES PLANNING AND MANAGEMENT, AMERICAN WATER RESOURCES ASSOCIATION 223 (Charbonneau & Popkin eds. 1983) (They are writing about the Imperial Irrigation District, which gets its water so cheaply that it has no economic incentive to conserve more than it did in the years 1973-83, and the Metropolitan Water District of Southern California, which is afraid its Colorado river supply will be drastically curtailed late in the 1980s.).

farm irrigation techniques which use less water application and more leach and tailwater, the lining of canals and laterals to prevent seepage loss, the installing of electronic monitoring controls to assure flexible deliveries so as to avoid spillage when the water is not needed? These proposals will never be undertaken in the absence of incentives.[120] People rarely behave in ways that are either altrustic or personally irrational.

There is no reason for the irrigator to assume a negotiation stance for subsequent sales of conserved water when water is sold initially so cheap. People must be made to realize that waste is *not ever* cheap, except in terms of political subsidies, and *particularly* water is not cheap when it is groundwater from some aquifer like the Ogallala whose costs are pushed upon future generations.[121] The continuation of such water policies is nonsensical from both an ecologic and an economic viewpoint. The metaphysical treatment of water—perhaps, especially groundwater—is just all wrong under the traditional free, or subsidized "cheap," goods view.

One might anticipate, this being so, that the rational efforts of contemporary critics would succeed. The presence of nonsense ought to be unbearable. But anticipations of this kind are doomed to initial failure. And the reasons are no less rational than the economic foundations upon which individual groundwater users make their decisions.

Irrigators, who self-supply themselves through wells tapping underground water strata, are regarded on almost a worldwide basis as obtaining "free" water.[122] Other irrigators, who receive their water through governmentally subsidized development and distribution systems, get it so "cheaply" that expenditures for water conservation of any kind are irrational on a personal basis, however wise they may be socially or ecologically.[123] This has

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[120] *Id.* at 225. The authors, one an economist for the Environmental Defense Fund, are trying to negotiate a sale of conserved water that is worth it to both sides. *Id.* at 230.

[121] E. Weiss, *In Fairness to Future Generations*, RESOURCES, no. 83, 4 (1986).

[122] TECLAFF, *supra* note 13, at 192.

[123] Lee, *Political Provision of Water: An Economic/Public Choice Perspective*, in SPECIAL WATER DISTRICTS: CHALLENGE FOR THE FUTURE 51 (Corbridge, ed. 1983).

been called "the success of failure."[124] "Perverse though it may be, the more socially desirable it is to discard a policy the more political support it is likely to receive. Political success is often explained by economic failure."[125]

In the case of subsidized irrigation water, the people who perceive themselves as benefited by the program are, of course, the farmers who receive the water. But beyond them are business interests who buy from, sell to, loan to, and collect from these farmers. And beyond these business interests are whole communities which have sprung up in what was arid space before the subsidized irrigation project appeared. Often, these communities would be ghost towns if the subsidies stopped, irrigation ceased, and the land reverted to its previous condition. The bureaucrats whose jobs depend upon how much service they supply and the politicians whose careers flourish because they preserve their constituents' subsidies are among the groups with a stake in this overall irrationality. Each one of these groups would suffer a private loss if either the government policy of subsidies or the legal structure providing for free self-supplied water were changed.[126]

Any attempt to turn the water system over to private, profit—motivated suppliers or to impose public charges commensurate with the true cost of the water supplied, inevitably will be met with vigorous resistance from all the beneficiaries of water subsidized so as to seem free or cheap. Resistance to any pricing equivalent to costs remain strong. Making "the desert bloom like the rose" carries a considerable self-righteousness that has proved politically useful.[127]

Truly, though, the farmers who get the break from all of this expenditure are the first ones who receive the subsidized irrigation water. The farmer, who self-supplies from the ground,

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[124] *Id.* at 61. "Indeed . . . the more inefficient the policy the more difficult it is politically to eliminate or modify it. . . . The more inefficent the government policy the more it will distort economic decisions away from those which would be made in the absence of the policy." *Id.*

[125] *Id.* at 62. *See* O. HERFINDAHL & A. KNEESE, QUALITY OF THE ENVIRONMENT: AN ECONOMIC APPROACH TO SOME PROBLEMS IN USING LAND, WATER AND AIR 86-90 (1965) (for a comparatively early study questioning traditional "pricing").

[126] Lee, *supra* note 123, at 61-62.

[127] *Id.* at 61.

has a continuing enjoyment of benefit from farm owner to farm owner. The sole exception occurs if the sale price of the farm declines to anticipation of aquifer exhaustion. But farm sales of land receiving subsidized irrigation water never seem to anticipate either a reduction of water or an increase in price to the level that supplying the water costs.

The value of the water subsidy gradually becomes capitalized into the price of the farm land receiving it. As a result, later owners receive only one benefit from the subsidy. And what is that sole benefit? This sole benefit is the avoidance by these later owners of a huge capital loss should the subsidy be discontinued. The situation is only somewhat less true for the non-farmers who have been enjoying the indirect benefits.[128] Gordon Tullock has called this "the transitional gains trap."[129] As a result, reform of any water subsidy program is made most difficult politically.

Consequently, while it now is common to say that, "water has become an economic good," and merely "a matter of economics and how much customers are willing to pay for water at their location,"[130] people see no reason to pay for what can be obtained freely, nor to pay very much for what can be secured at a nominal price. It has been said, "Americans once saw clean and inexpensive water as a kind of national entitlement; the resource, it seemed, was all but inexhaustible."[131] This kind of "entitlement" is by no means a matter of a long-past benefit for many massive water uses and their users.

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[128] *Id.* at 62.

> But the farmer who purchases his land after the subsidy is in force will pay for the value of the subsidy in the higher price he pays for his land. Because of this capitalization farmers will soon quite legitimately come to feel that they are entitled to the subsidy; after all they paid for it . . . [a]nd the larger and more distorting the subsidy the more farmers will lose from its termination and the more political resistance any termination will confront. *Id.*

[129] The gains are transitional because

> the gains will soon be competed away and the end results will be that no one is receiving a clear benefit. . . . But even without positive benefits from water subsidies, the losses that would be imposed if [water subsidies] were eliminated makes it very difficult politically to eradicate them.

Lee, *supra* note 123, at 63.

[130] Chicoine, Ramamurthy, & Grossman, *supra* note 113, at II, 969.

[131] Price, *A Water Crisis?*, RESOURCES, no. 83, 1 (1986).

> Any valuable good that is available at no or absurdly low cost will generate high, perhaps insatiable, demand, and that is the case with water. When the quantity demanded outstrips the quantity supplied, as is true nearly everywhere in the [American] West, consumers must be given a reason—an economic incentive—to curtail use. Put bluntly, most farmers, households, and industries will not conserve until prices force them to do so.[132]

Politically, it seems easier to follow the traditional views toward water. Under that limited view, projections from current levels of water use become "requirements that must be met, regardless of cost . . . [through] capital-intensive projects."[133] Suppose that the Ogallala aquifer has been mined, so that the High Plains seems to be running short of water. What then? Just plan for an interbasin transfer at federal taxpayer expense for the perfect solution.[134] The need that such "large-scale water diversions demonstrate[ ] [for] a long time period . . . for the necessary engineering, economic, financial, social and environmental planning and feasibility studies and to achieve the political consensus required to move such projects to fruition," becomes a part of the "required" cost structure mobilized to meet water "demand."[135]

Water resouces provide a general example of the refusal by decision makers to recognize scarcity value. This results in steadily increasing water "shortages" because failing to price water

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[132] Frederick, *The Legacy of Cheap Water*, RESOURCES no. 83, 3 (1986).

[133] *Id.* at 2.

[134] *Id.*

> In several areas of the West, renewable water supplies cannot keep pace with growing levels of consumption; even in the comparatively well-watered East, demand is bumping up against supply. . . . Under the combined pressure of growing demand, deteriorating quality, and higher values and therefore costs, the traditional, supply-oriented approach to water problems is foundering.

Id.

[135] GREGG, *supra* note 4, at 295. He proposes the possibility of interbasin transfers for replacing the mined Ogallala aquifer. He asks, "Is there a federal interest in making a participatory commitment now for that time frame in order to maintain the food and fiber production of the region?" He goes on to admit, "The gains resulting from any regional alternative approach . . . to the solution of water problems of the High Plains would not be distributed evenly among all those who might achieve some gain." *Id.* at 295-96.

in relation to its value produces excessive extraction and consumption.[136] Meeting costs comes to mean simply calculating price in relation to the money that must be spent in the extraction, treatment, and distribution of water, without regard to pricing the water in relation to its economic scarcity.[137] The focus is almost entirely upon physical problems—in the case of groundwater, on such problems as salt water intrusion, surface subsidence, and aquifer impaction.[138] All decision makers, who began by considering water as a resource to be freely accessed or who subsidized it so that water could be a cheap commodity, found themselves faced with strong political resistance to imposing a price or raising the previously underpriced sales figures.[139]

On the other hand, humanity's small experience shows that water use declines with a rise in price, even though water demand is, relative to other commodities, price inelastic. That is, a ten percent increase in price, while producing a drop in the demand for water, causes the demand to drop by only one and one-half percent to one and one-half percent to seven percent.[140] The reduction, however, is worth the effort of higher prices. Simply metering for water use, even when charges per unit are not cost equivalent, produces a permanent downward adjustment in water

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[136] Moncur & Pollock, *Scarcity Rents for Water: A Valuation and Pricing Model*, 64 LAND ECONOMICS 62 (1988).

[137] *Id.* Costs are not seen in relation to the scarcity value of water at all but only to use costs, while payment for water is often not even expressed in cash terms. *See Drinking-Water and Sanitation, 1981-1990: A Way to Health, A WHO Contribution to the International Drinking Water Supply and Sanitation Decade*, 1981, 14-15. The use of "unweighted unit-consumptive-use values" seems preferred, G. DAVIS, WATER AND ENERGY: DEMAND AND EFFECTS, 125 (1985) (prepared for the International Hydrological Programme by the United States National Committee on Scientific Hydrology) (UNESCO 1985). It seems enough that "rational water management . . . should be founded upon a thorough understanding of water availability and movement." *Id.* at V.

[138] Moncur & Pollock, *supra* note 136, at 71. This seems reinforced by the elaborate, nation-by-nation groundwater study done for the Commission of the European Communities. *See* J. FRIED, GROUNDWATER RESOURCES OF THE EUROPEAN COMMUNITY SYNTHETICAL REPORT (1982) (particularly the introduction by A. Andreopoulos).

[139] Rogers, *supra* note 106, at 297.

[140] "Price is expected to influence the demand for water negatively — that is, prices lead to lower consumption; in economic terms, this means that the price elasticity is negative. The studies of water demand mostly agree with the expectation of a negative price relationship with consumer demand." *Id.* at 264.

use.[141] Metering alone, therefore, would moderate water "demand" through upward price adjustments.

Imposing reasonably adequate prices covering the costs of providing water to preserve aquifers from destruction by pumping have the minimal advantage of moving public attention away from the fixed "need" for water—whether per acre, or per capita, or per industry. Once water is neither free nor nominally priced to its users, these previously privileged water users will choose to act in a more conserving mode. What was before not worth doing will become worthwhile. What before was a physical "need" for more and more water will become an economic and technical ability to lower water use.[142]

The small amount of existing experience shows that as the price of water increases, demand for water declines sharply. As yet, not enough is known about the level to which any ultimate "economic demand for water" could fall in what economists would regard as a rational system.[143] However, we should realize that there is no fixed physical "need" for water beyond the comparatively trifling requirements of the human body.

Nevertheless, despite pricing at cost as a way to achieve predicted water savings, this metaphysical method of managing water seems so much less "real" to water users and planners under the traditional systems. The physical presence of water engineering projects is what seems "for real" to most people. Water gushing from a tube in the ground or water being delivered to support directly some human use contribute to the belief that a physically fixed "need" for water exists. Most people remain reluctant to accept "need" as a metaphysical product of economics, social expectations, and legal-institutional systems. Gaining acceptance for this untraditional definition of "need" relative to water clearly will not be an easy task.

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141 *Id.* at 264.

142 *Id.* at 294-95.

143 "[R]ational water-pricing policies would have the largest potential impact of all government policies. Not only would rational policies lead to conserving water in current uses, they would also lead to reassessment of the wisdom of carrying out that particular activity at all." *Id.* at 267 and 296-97.

VI. SOVEREIGN FUNCTION AND MORAL CHOICE RELATIVE TO LEGISLATIVE ACTION FOR GROUNDWATER AND AQUIFERS

Since 1970, central state authorities have been increasing rural land use controls. At the same time, the role of the federal government has grown in rural land use control.[144] As one example, the United States Army Corps of Engineers has obtained jurisdiction over wetlands.[145] Perhaps, too, Congress finally has gotten serious over non-point source pollution.[146] Federal controls over land, streams, groundwater, and agricultural husbandry seem bound to increase greatly, with profound, hard-to-limit federal and state governmental interventions in agriculture, rural land ownership, and any private rights in groundwater.[147]

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[144] *See* LAND-USE CONTROLS: CASES AND MATERIALS, 963-88 (R. Ellickson & A. Tarlock eds. 1981); 2 ENVIRONMENTAL LAW: WATER POLLUTION AND HAZARDOUS WASTES, 213-15 (J. Battle ed. 1986).

[145] Myers, *Introduction: Agriculture and Property*, 34 KAN. L. REV. 411, 415-18 (1985-86). The Erodible Land and Wetland Conservation and Reserve Program Act has soil conservation provisions which have been seen as

> a symbolic turning point in farmland conservation at the federal level . . . orchestrated by a complex mix of urban, suburban, and rural interests as well as environmental groups that could signal the beginning of a new coalition for similar measures . . . a significant first step toward a program of effective federal involvement in soil conservation.

Id. at 418 (citing Malone, *A Historical Essay on the Conservation Provisions of the 1985 Farm Bill: Sodbusting, Swampbusting, and the Conservation Reserve*, 34 KAN. L. REV. 577). *See* Pub. L. No. 99-198, §§ 1201-1245, 99 Stat. 1354 (codified as amended at 16 U.S.C. §§ 3801-45 (Supp. 1988)). For the use of these conservation easements to relieve delinquent farm borrowers by exchanging a grant of easements for cancellation of debt, *see* 4 AGRICULTURE LAW UPDATE, no. 6, no. 42 (entire), 1 (1987).

[146] Water Quality Act of 1987, 33 U.S.C. § 1329 (1987). (This program for non-point source pollution existed previously under section 208 and section 205(j), a later addition, of the Clean Water Act, 33 U.S.C. § 1288 (1982)). (This 1987 legislation was passed over the veto of President Reagan.). R. Portney, *Environmental Legislation in the Ninety-ninth Congress*, RESOURCES, no. 86, 8 (1987). Portney finds the new bill "exhortation" and fears for its future implications:

> If such assistance blossoms into a subsidy program of the kind created to finance sewage treatment plants over the last fifteen years, it would be unfortunate . . . . [to have] [a]s a result . . . [similar] indeterminate effects on water quality in spite of the $30 billion or so that has been spent [on the sewage treatment plants of municipalities].

Id. at 9. Perhaps there were some objective, economic reasons for President Reagan's two vetoes of this act.

[147] Peskin, *Nonpoint Pollution and National Responsibility*, RESOURCES, no. 83, 10 (1986). Even state-wide efforts are shown by modeling to be insufficient. Federally

Some market proponents lament the employment of "traditional planning and land-use control tools" by either the state or federal governments that would "embark on a massive planning and farmland preservation strategy."[148] But even these critics are very doubtful whether they can prevent the broad implementation of centrally directed state controls on rural land.[149] If that should be true for rural land which until recently was regarded as substantially an unregulated real property interest, establishing fixed, enforceable, and transferable property interests in groundwater in its aquifer—as one example of a water right—may expect even more resistance.

Large numbers of people will probably continue to urge that the law does enough when it requires users of water to use water "reasonably." The discretion in courts and administrators, which is lamented by market proponents in their preference for independent fixed water rights, is preferred by others.[150] Under the reasonable use concept, administrators and courts have the discretion to decide reasonableness. They often exercise their dis-

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mandated interstate programs — in the absence of regional, river basin program — will be needed. *Id.* at 11. There are constitutional implications in comprehensive federal preemption of all water law. *See* Sporhase v. Nebraska, 458 U.S. 941 (1982), at 958-60.

[148] Delogu, *A Comprehensive State and Local Government Land Use Control Strategy to Preserve the Nation's Farmland is Unnecessary and Unwise*, 34 KAN. L. REV. 519, 533 (1985-86). An earlier well-known attack on centralized decision-making in land-use controls is Ellickson, *Ticket to Thermidor: A Commentary on the Proposed California Coastal Plan*, 49 S. CAL. L. REV. 715 (1975-76).

[149] Delogu, *supra* note 148, 537-38. The criticism has neither cut short the longevity of land-use controls nor affected the belief in their wisdom on behalf of their proponents. *See* Meyers, *supra* note 145, at 416.

[150] T. ANDERSON, WATER CRISIS: ENDING THE POLICY DROUGHT 90-91 (1983). Quoting Steven F. Williams: "At every stage of the (regulation) procedure, we see government agencies exercising enormous discretion . . . . This vast discretion has three dangerous facets: it is an occasion for influence-peddling, it breeds unfairness, and it erodes the rule of law." *Id. See also* Hirshleifer, *Forward*, in WATER RIGHTS: SCARCE RESOURCE ALLOCATION, BUREAUCRACY, AND THE ENVIRONMENT, (Anderson ed. (1983)):

> But in a populist era the idea of anyone having exclusive rights seems like an offense against the public. And in an activist age, the solution to be feared is subjecting all uses to the whim of a supervisory agency rather than to the even-handed enforcement of carefully defined property rights. When commissions or courts license . . . with tenure contingent upon . . . some ill-defined notion such as serving the public good, the result is a grossly inefficient allocation of water resources.

The lamentations might not be so strong if what they lamented were so firmly placed in groundwater tradition.

cretionary powers over a protracted period of time by either reversing or reinstating decisions that have reached a "reasonableness" conclusion in a particular situation. "Tenure can change at any time and owners can lose their apparent rights without any compensation."[151]

Compared to a system that determines property rights through the discretionary acts of judges and regulators, market advocates prefer independent fixed property rights. The defects in markets, including their failure, are trifling alongside a discretionary system. Market proponents abhor a dependency upon the meaning of "reasonableness," whereby its meaning is determined after a particular water situation has erupted into controversy.[152] The discretionary water regime, however, has its defenders. Market proponents are not the only contemporary advocates in the field of groundwater law.

The sovereign's role is, at the least, one of service for private property interests in groundwater. After all, the sovereign may be, in addition, a public trustee of groundwater. The sovereign, beyond this, may be the source of the delegation of the ability to own any property in land or any water source. This is certainly true under most current legal theories. Disagreement with this view exists among a minority, most of whom are natural law proponents. They argue that property "precedes" and is "higher" than any sovereign. Still, practically speaking today, the sovereign can take all property unto itself, even under the United States Constitution if due process is satisfied.[153]

But what if the sovereign has chosen to allow private property in a natural resource or to allow its own instrumentalities to identify such property as individual to them? In these cases, the sovereign likely would work best at resource specification, if the sovereign recognized the impact of market forces in property allocations. One need not advocate a pure market system in order to believe in the value of legal regimes accommodating markets.

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[151] ANDERSON, *supra* note 150, at 99 (groundwater has doubtful tenure rights).

[152] *Id.* at 34.

[153] St. Augustine may have been the first Christian theologian to assert this position, but he was followed by many more. *See* THE POLITICAL WRITINGS OF ST. AUGUSTINE 160-61, 229-31 (H. Paolucci ed. 1962). The American constitutional position is well summarized in Keystone Coal Assn. v. DeBenedictis, 480 U.S. 470 (1987).

Resources the sovereign puts into defining and enforcing property rights are public investments. They finance the turning of natural phenomena into natural resources and the carving of inchoate sovereignty into specific units of economic power.[154] If the costs are too high, the returns to the sovereign diminishing, and the private property interest subject to subsequent diminution, individuals will spurn such rights and the sovereign will have invested in their creation in vain. The individual would seek in lieu of so insecure an interest a return from some other source capable of financing at others' expense the financial advantage derivable from the conditioned property right.[155]

In air and water pollution matters, the definition and enforcement of private property rights have seemed too costly for most enforcers and investors alike. Private property rights have played a subordinate role to command regulation in dealing with air and water quality correction.[156] The sovereign seems to have kept too many natural resources in its inchoate self, subject only to sovereign discretionary command regulation.[157]

Yet when charge systems are put in place "at which the marginal cost of pollution is slightly greater than the marginal cost of pollution control," air and water quality enhancing measures should result from these cost-saving purposes. Money can be raised through these charges for the public treasury, either for the general fund or for correcting the damage from taxed activity. Under the theory of charges, the harm should be more rapidly reduced compared to the effectiveness of command regulations alone.[158]

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[154] CIRIACY-WANTRUP, *supra* note 111, at 221-22.

[155] ANDERSON, *supra* note 150, at 25. "[W]hen the probability of capturing benefits from a use is low, it is less likely that the owner will devote that resource to that use." *Id.* at 18. He continues: "What happens when private property rights do not exist? . . . The entrepreneur continually searches for opportunities to generate returns above opportunity costs or rents . . . . [T]he entrepreneur does not care whether he is creating a free lunch or dining at someone else's expense." *Id.* at 19.

[156] *Id.* at 85.

[157] CIRIACY-WANTRUP, *supra* note 111, at 67-71.

[158] Fano, Brewster, & Thompson, article in WATER RESOURCES FOR RURAL AREAS AND THEIR COMMUNITIES, VTH WORLD CONGRESS OF INT'L WATER RESOURCES ASSOC. II, 650 (1985). Though a charge scheme, it is shown to operate very much like a property system. *Id.* at II, 655-69.

An example of what happens, according to many economists, when the sovereign turns an aspect of its sovereignty into property, can be found in the institution of emission credits concerning air and water pollution. The sovereign can be indifferent to the quality of air and water or leave the quality to private nuisance or other actions. Conversely, the sovereign can set standards to be enforced by sovereign commands, with the aspect of air and water quality still within sovereignty's inchoate form.

More innovatively, the sovereign can turn the quality of air and water into property units to be commoditized, traded in the market, and treated like any other specific natural resource capable of individual ownership. By permitting the development of additional forms of property, what was once a natural phenomenon is turned into a natural resource.[159] In the case of air and water quality, however, the task is far more daunting than is the proposed commodization of groundwater while still confined in an aquifer.

The property rights in emission credits (which go a stage beyond the charge system as a property right) are said to lower compliance cost, quicken compliance, and permit movement to still better ambient conditions.[160] Once the property rights have been created in this regard and despite the history of the sovereign being unable to attract support for such property systems in the past, emission credits have worked positively in conserving the subject matter of the new property rights.[161] Better definitions have been sought by those who can derive a benefit from such property once its exclusivity, fixity, enforceability, and transferability have been created by the sovereign through the legal system.[162]

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[159] *See* ENVIRONMENTAL LAW 361-69 (Findley & Farber eds., 2d ed. 1985).

[160] T. TIETENBERG, EMISSIONS TRADING: AN EXERCISE IN REFORMING POLLUTION POLICY, 188-89, 200 (1985). It is too early to determine if such a program retards, or enhances, enforcement of the goals, though the chance of attaining them will prove to be enhanced. *Id.* at 189. The need to overlay the program upon a command-and-control structure had diminished the effectiveness of the property-rights approach, *Id.* at 214. *See also* R. LITOFF, REFORMING AIR POLLUTION REGULATION: THE TOIL AND TROUBLE OF EPA'S BUBBLE (1986).

[161] HAHN & HESTER, *The Market for Bads: EPA's Experience with Emissions Trading*, REGULATION NOS. 3/4, 48 (1987).

[162] ANDERSON, *supra* note 150, at 25.

At that point, the argument runs, people will be content with the individualized benefits of the property right. They no longer will have rational reasons for seeking further transfers from the general taxpayer or third parties or the environment as was the case when the values rested either in nature or in the sovereign.[163] Through commodization, a conservation effect will follow whether the commodity is a unit of air quality, aquifer water, or other formerly non-specific element. Thus, we are assured that the sovereign, if it wants environmental protection, has the choice of either command regulation or continuing the non-specificity of an unidentified aspect of a natural resource within an inchoate sovereignty.[164]

The hostility to an independent fixed property rights approach to natural phenomena is very strong. *Commoditicizing* these phenomena for market trading is abhorrent to many who prefer sovereign command regulation. In the case of pollution trading credits, Tom Tietenberg has said, "the notion that firms should have a property right in surplus emission reductions was not a part of the command-and-control system . . . . [C]onfiscation of created credits is a distinct possibility, destroying much of the incentive to create additional emission reductions."[165]

The same is true for property rights in groundwater or surface-water that rest upon "reasonableness" especially where the reassignment of priorities is required to achieve "fairness" or some other intervention is mandated in the "public interest." However credible the purpose of such interventions, they serve

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[163] *Id.* at 26-34.

[164] W. RAMSAY & C. ANDERSON, MANAGING THE ENVIRONMENT: AN ECONOMIC PRIMER, 253-81 (1972). The authors claim that this is a resource specifying and marginal-price approach particularly advantageous to both capital-market and socialist profit-motivated systems. *Id.* at 49-50. The West German environmental administrator, Eberhard Bohne, has studied closely the USEPA air emissions' reduction credits program. As a result, he has reached views different to a substantial degree from those of Tietenberg. *Supra* note 160. His views are set forth in a report to the Ministry of Environment, Nature Protection, and Reactor Security of the Federal Republic of Germany, early drafts of which he has been kind enough to allow his author to read. *See* E. Bohne, *Politics and Markets in Environmental Protection*, in REPORT TO THE GERMAN MARSHALL FUND OF THE UNITED STATES 137-39 (1987).

[165] TIETENBERG, *supra* note 160, at 215. (Some economists also have opposed "property rights in pollution."). L. HINES, ENVIRONMENTAL ISSUES: POPULATION, POLLUTION AND ECONOMICS, 246-48 (1973).

to prevent definition of value in the property right held and to prevent the efforts of the rights' holder to maximize profit. These intervening rules act through non-market controls in a no-longer-so-private right which has been converted into a public resource.[166]

Some critics, however, find that the property rights approach to subjects such as water is essentially amoral, akin to taking human life in order to neutrally, objectively, and amorally protect property rights.[167] These people continue to think that "if we're really going to move forward in our land ethic to become a community of humans in harmony with nature, we also must think very closely about our whole tradition of private property."[168] For many believers in an environmental ethic, fixed private property rights in renewable resources are not the help to humanity and nature that, say, the Austrian and Chicago Schools of economists assign them.

> Moral judgments are not exclusive to life-and-death situations. A less dramatic example would be an economic proposal for dealing with environmental pollution by implementing a system of licenses to pollute. Purchasing a license would create a personal property right to pollute. . . . Theoretically, various polluters could compete for licenses in an action, internalizing the cost of polluting and thereby creating incentives for industry to reduce pollution in the interest of increasing profits.[169]

At this point, the author simply sounds like other writers who would substitute the property rights system in resources in

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[166] Cuzan, *Appropriators versus Expropriators: The Political Economy of Water in the West*, WATER RIGHTS: SCARCE RESOURCE ALLOCATION, BUREAUCRACY AND THE ENVIRONMENT 13, 28-32 (Anderson ed. 1983).

[167] Malloy, *Equating Human Rights and Property Rights — The Need for Moral Judgment in an Economic Analysis of Law and Social Policy*, 47 OHIO ST. L.J. 163, 174 (1986). Malloy makes it clear that he rejects the Austrian and Chicago Schools, with their belief in the value of the free market in commoditizing this natural phenomenon. *Id.* at 163-64. He notes, however, that neither Milton Friedman of the Chicago School nor Friedrich Hayek of the Austrian School reject "the need to inject moral judgment and guidance into economic analysis." *Id.* at 174-75.

[168] Donald Worster, in *Ethics and the Land*, 6 AMERICAN LAND FORUM no. 3, 17, 27 (1986).

[169] Malloy, *supra* note 167, at 175. Malloy also discusses the administrative problems of implementing such a property scheme claiming that "[m]ost economists would probably admit to the difficulty of implementing this regulatory system."

place of the command regulation approach with the exception, perhaps, that the just quoted argument claims that increase of profits is the primary purpose of instituting a property system. However, an increase in profits, according to the standard proponents of independent property rights in pollution, is the least of the reasons for switching to such a system.[170]

But then the moral argument concerning renewable resources veers into another direction altogether. The moralist takes the position that licensing pollution is like licensing rape or mugging. "[T]he fact that polluters pay for the license does not obviate the danger to human life posed by pollution."[171]

In brief, many environmental moralists accuse those who propose charge systems, trading credits, or other independent fixed property rights that would commoditize resources such as the quality of air and water of being immoral and criminal. Implicitly, that allocation of water for human needs as a private property would fall under the same moral interdict. Under this interdict, the preference of those who would further commoditize and propertize nature would be required to undertake a subsequent reordering. Environmentalists who take this view assert that too many market and property proponents:

> reject the right of all people to enjoy life, liberty, and the pursuit of happiness. Furthermore, they . . . affront strongly held moral values and suggest policy directives so contrary to the normative values of the society that both the economic

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[170] TIETENBERG, *supra* note 160, at 188-202. Tietenberg considers profit only as a subordinate function of cost-effectiveness in attaining quicker, cheaper compliance. He points out that under the command regulation system, industry has "[t]he costs of compliance [that] include not only the control costs, but also the costs of seeking relaxed standards through lobbying and litigation . . . includ[ing] the resources committed to negotiation or legal defense as well as the payments required by any monetary sanctions imposed." *Id.* at 184. Such conflicts and motives do not disappear in a property rights system. The proponents of the French basin-wide charge system argue that a mediator should be maintained to sustain a "meneur de jeu," (leader of the game) primarily by carrying information among the participants so that they will know where the best interests lie for the property rights in dispute. Delavalle, Gendrin, Davigo, & Ollognon, *supra* note 20, at 243-44.

[171] Malloy, *supra* note 167, at 175. Economic analysis can be "a useful tool in evaluating law and social policy," but "some problems cannot be reduced to calculable form" and property rights and market trades must be overriden by "considerations of right, wrong, and the dignity of human life." *Id.* at 176.

> system and the legal system capable of reaching such conclusions are discredited.[172]

Environmental advocates abound who find this intolerable, even as a possibility.

On their own behalf, the economists who have been attacked do not deny the importance of choice, moral value, social preferences, or however such matters are denominated. Nor do they argue that such choices are non-economic decisions.[173] As they put it, "neither optimality nor efficiency is strictly a technical issue . . . at least for starting points, on moral judgments about who should have what rights. After that decision has been made, they depend on subjective evaluations of benefits and costs."[174]

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[172] *Id.* at 177. The view is not idiosyncratic. *See* T. O'RIORDAN, ENVIRONMENTALISM (2d ed. 1981) (summaries of views). Many environmentalists fear "the use of economic logic for environmental regulation." W. ROSENBAUM, ENVIRONMENTAL POLITICS AND POLICY 294 (1985). As Duncan Kennedy notes, these sorts of views may well be a part of movements that want to "blur the lines between . . . 'public' and 'private' enterprise. . . . ." Kennedy, *Toward a Critical Phenomenology of Judging*, 36 J. OF LEG. EDUC. 518, 520 (1986) "to chip away . . . at the owner's power," *Id.* at 525; that ask "whether there should be any private rights at all in mechanisms of interstate commerce," *Id.* at 534; that say, "In *Shelley v. Kramer* . . . the private sphere 'disappears,' since all private arrangements are dependent for their structure on enforcement of private law ground rules," *Id.* at 541; that claim "the notion of correctness, at least as we usually use the word in math or science or logic, just isn't applicable," *Id.* at 561; and that assert "professional knowledge of the nature of law . . . [is a claim] just made up out of whole cloth," *Id.* at 562. Private property, among these critics, simply is not the secure concept that a reader might find in the writings of proponents for the market, propertization, and commoditization.

[173] Anderson, *Introduction* to WHY DO WE STILL HAVE AN ECOLOGICAL CRISIS? 1, 1-3 (Armstrong ed. 1972).

[174] Anderson, *supra* note 150, at 87 n. 24. Terry Anderson seems sufficiently close to the views of Gordon Tullock, whom Malloy quotes as one of the proponents of the "amoral economist" that Anderson's views should not be regarded as untypical of Austrian or Chicago school economists on this point. Malloy, *supra* note 167, at 168. Alan Randall, an agricultural economist, believes that:

> Institutional economists . . . are more apt than those of the neoclassical tradition — most closely associated with cost-benefit analysis — to recognize the multiple objectives associated with environmental policy, including equity and distributional issues, and to examine the role of culture, laws, and the process of collective decision making in the formation of policy. [There is] the impossibility of reconciling the two perspectives . . . .

Environment: New Concerns in Farm Policy, RESOURCES no. 84, 17 (1986) (summarizing Randall's remarks at Conference on Agriculture and the Environment, April 21, 22, 1986). The Austrian and Chicago schools, as well as the Marshallians, probably are included among those in the "neoclassical tradition," who are accused by moralists and institutional economists alike of lacking sufficient values—or, maybe, just the "right" values.

The difference between the "moralist" and the "economist" lies in the location of the decision and the impact of the subsequent evaluations. Once a property right has been defined and the terms for enforcement and transferability are set forth in that initial definition, the economist claims that the right should be allowed to operate in the market only under predictable constraints previously laid down by the law to guide decisions by potential investors.[175] Subsequent unpredictable notions of "efficiency," "reasonableness," or "fairness" on the part of administrators and judges acting on the public behalf should not affect the tenure of the property.

Assuming that the property right in groundwater has been defined so as to compel its property holders to "face the full opportunity costs of their actions, [so that] they will take only those actions that produce positive net benefits for themselves and for society . . . ," many economists would then argue that the law has done enough.[176] Such a statement has all the morality of Aristotle's commercial or commutative justice. But then the theologians have always accused Aristotle himself of propounding a system that did not "allow for any real moral obligation."[177]

The choice of underlying values, therefore, cannot be avoided by an informed decision maker, moralist *or* economist. The choice of values is present even in incremental decisions. For example, choice of values inheres in the decision that must be made with regard to old rights in groundwater when new property rights in the water are set up. The decision has to be made whether or not to fold old rights into a new system, keep them in effect in grandfathered autonomy, or abolish them. The choice, whatever it may be, requires the wise decision maker to define these old rights. Only the lazy and feckless decision maker chooses some ambiguous allocation to some future time, in some future dispute, to make some future determination.[178]

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[175] Fractor, *Privatizing the Ground Water Resource: Individual Use and Alternative Specifications*, 24 WATER RESOURCES BULLETIN 405, 410 (1988).

[176] ANDERSON, *supra* note 150, at 17.

[177] *See generally* F. COPLESTON, A HISTORY OF PHILOSOPHY I, IV-V (1985). Aristotle, of course, has also been attacked by environmentalists for his mechanistic view of nature inherent in his first principle of logic. C. MERCHANT, THE DEATH OF NATURE: WOMEN, ECOLOGY, AND THE SCIENTIFIC REVOLUTION 229 (1980).

[178] TECLAFF, *supra* note 13, at 181. "Laws that assimilate pre-existing uses into the new system after a grace period represent the modern trend in water law." *Id.*

At the very beginning of any newly created rights, a decision should be made concerning the assimilation of old rights. In this way, they can become the equivalent of the new rights in the changed system. Some grace period for assimilation may be needed. The worst choice, though, is to try to leave old rights in place permanently unaffected by change, side by side with the new rights.[179]

The institution of an independent fixed property rights system in groundwater will require value decisions concerning old water rights. This will be the case especially if heavy investments in money, time, and labor have been made in rights under the previous system.[180] Certainly, if a jurisdiction moves from a reasonable use or absolute dominion rule to one that establishes independent property rights for groundwater in terms of surface land owned or water pumped, certain previous groundwater users will seek recognition for what they will insist are preexisting rights. Provision—as in Vernon Smith's and the New Mexicans' proposed schemes[181]—must be made for them.[182]

The initial reasons in the United States for the preservation of the values in old water rights would be constitutional. Yet in the United States there ultimately must be social, economic, and political reasons as well for preserving the old values. These reasons would be the same as in other countries, particularly, if a revolution were in progress concerning all property interests.

Decision makers may be making only incremental decisions when implementing the value choices between old and new prop-

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[179] *Id.* at 180. "Laws that leave pre-existing uses unaffected by a new regime may bring about a complicated and inefficient situation, in which different regimes apply to the same source of water." *Id.*

[180] *Id.* at 180.

> The quest for efficiency in utilization of scarce water resources may require that cancellation of many existing uses, in order, so far as is practicable, to begin anew with a system that more adequately protects the public interest. . . . [T]he sudden abolition of existing uses would cause economic hardship and uncertainty. The question then becomes: what new elements should be introduced and which old elements should be retained? *Id.*

[181] Smith, *Water Deeds: A Proposed Solution to the Water Valuation Problem*, 26 ARIZONA REVIEW, no. 1, 7 (1977); and New Mexico Water Resources Research Institute and the Univ. of New Mexico Law School, STATE APPROPRIATION OF UNAPPROPRIATED GROUNDWATER: STRATEGY FOR INSURING NEW MEXICO A WATER FUTURE 17 (1986).

[182] *See* TECLAFF, *supra* note 13, at 7.

erty rights. But they also may be doing far more. History reveals that in making choices like these whole political systems have found their justification for existence.[183]

The extent to which any old water interests are preserved, and the length of any grace period for converting them to a new right, depend upon the values the new system of property rights is to serve. Some economic losses for users under the old regime can be expected. After all, change would be unlikely if the old system had worked to general satisfaction.

Under the appropriation doctrine, for example, appropriators tend to claim a greater application of water for beneficial use than is really the case in order to protect the amount of water they do apply.[184] Thus under a new property system appropriators may get less water than before. They may have to take water of a different quality; they may have to change the nature of delivery; they may have to change uses; or they may lose control over the return flow.[185]

Only the greater specificity, enforceability, and transferability of any new property right in water for affected appropriators make deprivations by law of old legal rights economically as well as politically bearable. This superiority in the new property right is required if the change is to be constitutional under a government that can neither expropriate without compensation nor fail to offer constitutionally protected administrative procedures.[186]

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[183] This has been asserted about "hydraulic civilizations," at any rate. *See* K. WITTFOGEL, ORIENTAL DESPOTISM: A COMPARATIVE STUDY IN TOTAL POWER (1957).

[184] *See* TECLAFF, *supra* note 13, at 189-90.

[185] *See Id.* at 191; 187-88.

[186] ANDERSON, *supra* note 146, at 13. "The problem of third-party impairment due to alterations in return flows can all but be eliminated by defining water rights in terms of consumption rather than diversion [or pumping when reinjection is present]. . . . By reducing the consumptive use coefficient, the owner can free up water to be used elsewhere." *Id.* at 66-67. Constitutionally protected administrative procedure in the United States is sometimes called "the new property," C. Donahue Jr., *The Future of the Concept of Property Predicted From Its Past*, Pennock & Chapman 22 NOMOS 286 (eds. 1980). For constitutionally protected administrative procedures, denominated as "liberty interests," *see* Regents of the Univ. of Michigan v. Ewing, 474 U.S. 214, (1985). Statutorily created and protected administrative procedures also exist at the federal level. *See* School Board of Nassau County, Florida v. Airline, 480 U.S. 273, *reh'g denied*, 107 S. Ct. 1913 (1987).

VII. GUARANTEEING SUSTAINABILITY OF RENEWABLE AQUIFERS AND CONTINUING GROUNDWATER FUNCTIONS

A preliminary choice of values before any legal-institutional decision is taken is, therefore, unavoidable. The choice must be made deliberately and not left to decision by drift and apathy.[187] This is certainly true when some basic decision is made to conserve or enhance the condition of some resource such as groundwater quantity or quality. It is just as true when an instrumental choice is made to implement that improvement as for example by folding in old, existing, and uncertain, groundwater rights into any new system of independent fixed water rights.[188] The decision as to values is both basic and instrumental when the choice is whether to rely on command regulations or on a system of independent fixed property rights, or on a mix of both in groundwater law.

Those who would commoditize water in aquifers, even up to allowing injection rights of wastes into aquifers, seem to have just as much a grasp of natural values concerning groundwater as do those who would resist such action and who prefer the sovereign's command regulation. The ultimate value issue in any choice depends on what better serves the protection and preservation of groundwater. Will it be through property rights or the command regulation concept or a mix of them?

In the case of groundwater, aside from maintaining the sustainability of the aquifers, what other general choices based on value are there?[189] If legal systems merely opt out, all groundwater would be mined without replenishment. Nor, in all likelihood, would the tough choice of "water today, dearth tomorrow" ever be replaced with regimes of sustainability.

What is needed in the case of flow resources, such as groundwater, is a legal system—whether one of independent fixed property rights, command regulation, or both—that would let the resource be used within the limits of its sustainability relative to

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[187] *See* J. HURST, LAW AND SOCIAL PROCESS IN UNITED STATES HISTORY (1960). "[C]onscious direction and invention are bound to be marginal. This has various features, but they all favor drift over direction." *Id.* at 68.

[188] *See* TECLAFF, *supra* note 13, at 180.

[189] *See* S. BRUBAKER, IN COMMAND OF TOMORROW: RESOURCE AND ENVIRONMENTAL STATEGIES FOR AMERICANS 17 (1975).

human demand.[190] Robert Repetto compares this to John Locke's limitation upon property claims that would leave "as much and as good for others"[191] and with the accountant's theoretical concept of income, that is, "the greatest amount that can be consumed in the current period without reducing prospects for consumption in the future."[192]

This is also the goal of persons who would have flow resources administered directly from a moral basis.[193] Such state actions as Arizona's groundwater preservation strategy also have this as their goal. Arizona's strategy will use regulation and water replacement charges to achieve stability in groundwater by 2025.[194] The goal is also the same for those calling for a property system in water which would reach such a result by the owner's self-benefiting actions.[195]

There are also those who have no such goal. These "realists" take a different moral position from either the commoditizer of nature or those opposing commoditization. These "optimists" believe that nature can accommodate human demand without such elaborate precautions because the economy, society, and politics will always automatically adjust supply and demand so that sustainability is unlikely to be lost.[196]

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[190] REPETTO, *supra* note 35, at 16.

[191] *Id.* This passage doubtless refers to J. LOCKE, TWO TREATISES ON CIVIL GOVERNMENT Bk. II, § 31, 131 ("Nothing was made by God for man to spoil or destroy"), 33 (Repetto's identical quotation), and § 46 (1690).

[192] REPETTO, *supra* note 35, at 16.

[193] *See* Malloy, *supra* note 167, at 175. (Malloy might argue that some part of flow resources are beyond certain uses even if sustainability of the flow resource were possible). *See also* MERCHANT, *supra* note 177, at 236-52. Interestingly, the concept of a balanced maintenance has been applied even to wilderness areas in the United States. K. HAUGRUD AND THE STANFORD ENVIRONMENTAL LAW SOCIETY, WILDERNESS PRESERVATION: A GUIDE TO WILDERNESS SELECTION 64-78, 81-85 (1985).

[194] *See* FERRIS, *Water Demand - Sharing a Limited Resource*, 4 HYDATA no. 5, 6-9 (1980); FERRIS, *The Arizona Groundwater Code: A Model of Strength in Compromise* in WATER MANAGEMENT IN TRANSITION, A SPECIAL REPORT BY THE FRESHWATER FOUNDATION 39, 40, 44 (1985).

[195] *See* ANDERSON, *supra* note 150, at 25. "[P]eople will devote their efforts to defining and enforcing the rules as long as their perceived additional benefits from doing so exceed their perceived additional costs. In this sense, establishing and protecting property rights is productive activity toward which resources can and will be devoted."

[196] Beckerman, *The Myth of 'Finite' Resources*, BUSINESS AND SOCIETY REVIEW, no. 12; 21, 25 (1974-75). *See also* E. MURPHY, ENERGY AND ENVIRONMENTAL BALANCE 186-96 (1980) (discussing similar views).

And if sustainability should be lost? The economist Wilfred Beckerman answers the question for us.

> Furthermore, suppose that, as a result of using up all the world's resources, human life did come to an end. So what? What is so desirable about an indefinite continuation of the human species. . . . [T]o ensure that successive generations of people must indefinitely be brought into this world is not so obviously a big deal for anybody.[197]

Even the most inveterate developmental "optimists," however, reject such austere "realism" for the future. They opt mostly for sustainability either as an unavoidable natural replenishing or as a result of human technical fixes.[198] Sustainability seems what most legal and institutional proposals, whatever their theoretical origins, seek to attain.[199]

Command regulations certainly are intended to accomplish sustainability of flow resources. For too long groundwater has been treated as outside either regulation or, in much of the world, outside of a specific property rights system. A scarce resource which increasingly is losing even the vaguest appearance of something rightfully carrying a zero price has been priced as if it were a free good.[200]

Maybe those who see the market in groundwater as a potentially "positive-sum situation," where voluntary exchanges encourage the better use of resources, are correct.[201] The traditional methods of providing water through publicly financed projects that make the water available for a charge greatly below cost or by self-suppliers who pump from allegedly free aquifers are in trouble. Budgets for those projects have been cut. The demand stimulated in this fashion has led to increasingly unavailable water resources. Public opposition is increasing to a provision of "free" water that exploits the environmental or to a subsidized water that exploits the general taxpayer for an individual

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197 Beckerman, *supra* note 196, at 22.

198 G. O'NEILL, 2081: A Hopeful View of the Human Future 84-85, 238-39 (1981).

199 H. KAHN, W. BROWN, & L. MARTEL (with the Hudson Institute) THE NEXT 200 YEARS: A SCENARIO FOR AMERICA AND THE WORLD, 8, 26-27 (1976). *See also*, H. KAHN, THE COMING BOOM: ECONOMIC, POLITICAL AND SOCIAL (1982).

200 REPETTO, *supra* note 35, at 59.

201 *Id.* at 9.

water user's private advantage.[202] The reasons for public opposition range from the fiscal, to the environmental, to the aesthetic, and, "as a result, the marketing and transfer of water as a commodity is fast becoming the main source of water for growth."[203]

The role of government, if and when groundwater and other waters are commoditized, remains strong. That sovereign role includes providing information; educating the public; monitoring the groundwater resource; creating a legal and institutional framework for bulk sale of water and trading in aquifer access rights; and conducting research to improve engineering efficiency and the frugality of the agroindustrial use of groundwater. Other sovereign services must also be furnished that will be difficult or impossible to internalize into the market price for individual property rights in groundwater.[204]

The sovereign possibly will be required to do still more. Even a strong advocate of the market, Orlando Delogu, can claim that "[f]inally, [the] government at every level must continue to provide, or at least to assist in the provision of, the infrastructure needs, (i.e., roads, water projects, energy supplies), upon which the farm sector as well as other segments of the society depends."[205]

Therefore, it is most likely that neither a system of command regulations issued by the sovereign nor a system of fixed units

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[202] An excellent discussion about water in terms of market failures, the cost of government interventions, and general dissatisfaction with the current operations of American water use is in NATURAL RESOURCES LAW: CASES AND MATERIALS 42-78 (J. Laitos ed. 1985).

[203] Brochure, UNIVERSITY OF DENVER COLLEGE OF LAW'S NATURAL RESOURCES PROGRAM AND WATERSHED WEST, WATER MARKETING: OPPORTUNITIES AND CHALLENGES OF A NEW ERA, (Brochure dated Sept. 24-26, 1986) (The periodical, *Water Market Update*, dealing with sales of water rights in appropriation jurisdictions, began publication in January, 1987.).

[204] REPETTO, *supra* note 35, at 9-10. Repetto is pleased that Exclusive Economic Zones have brought forty percent of the ocean within their jurisdiction by national proclamations and the Law of the Sea Convention; but he laments that inadequate governmental resources in capital, personnel, and administrative capacity will prevent a private property system from operating efficiently within these zones. *Id.* at 116. (This underscores the importance of government in any private property regime over flow resources.).

[205] Delogu, *supra* note 148, at 536 (Footnote omitted). Water projects often meet the required cost-benefit ratio by the sale of hydropower.

of independent private property, acting alone, can sustain a resource such as groundwater. Even under a private property system of the most intensely individual kind, the sovereign has non-delegable duties to perform.[206] Otherwise the individual property units will lose their value because they will have lost their security. Even a sovereign rejecting private property, given the sophisticated demands of urban-technology in both developed and developing countries, cannot leave renewable phenomena today in nature as an amorphous part of the sovereign's inchoate self.

Rather, the sovereign must specify economically-significant natural phenomena as natural resources to be administered for human use. The sovereign must act in this specific way if its command regulations are to operate effectively. Beyond this specification, the sovereign needs identifiable units of property, just as the holders of those units need sovereign activity, if renewable resources such as groundwater are to continue their renewability.

The holders of those units of property may be individual human beings, corporations controlling private capital, or instrumentalities of the sovereign. This specification is an effective means of locating a natural phenomenon as a human resource, identifying a property right in the resource, and commoditizing that property right in the market. As a result, the sustainability of the renewable resource will be supported by advantaging whomever may be the holder of this unit of property.[207]

Sustainability of groundwater of potable quality or, at least, of quality no worse than nature provided, should be the purpose of every contemporary legal system. In this regard, the water

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[206] In English legal history from the sixteenth to the nineteenth centuries, this is what is meant by the statement that "property was always discussed in the political context of authority and liberty." J. POCOCK, VIRTUE, COMMERCE, AND HISTORY: ESSAYS ON POLITICAL THOUGHT AND HISTORY CHIEFLY IN THE EIGHTEENTH CENTURY 70-71 (1985) (footnote omitted).

[207] These ideas concerning the importance of resource specificity follow CIRIACY-WANTRUP, *supra* note 107, at 216-21, as well as CIRIACY-WANTRUP, RESOURCE CONSERVATION: ECONOMICS AND POLICIES (3rd ed. 1968). The ideas concerning the function of property are indebted to Jacob H. Beuscher. *See* F. Thomas, *Law in Action: Legal Frontiers for Natural Resources Planning: The Work of Professor Jacob H. Beuscher*, LAND ECONOMICS MONOGRAPH no. 4, 26-30 (1972).

confined in replenishing aquifers simply is paradigmatic of all renewable resources. Aquifers, too, now require human assistance to sustain their renewability as a result of human demand upon their powers of self-sustenance. If some kind of human help is not forthcoming, aquifers are at risk to irreversible pollution or exhaustion. The danger is similar to the risks of any renewable resource impacted by the massive demands of the human economy and technology.

VIII. SOME DECISIONS ABOUT WHAT TO DO

The groundwater resource is adversely affected today both as to its quantity and quality. Quantity problems are not universal to all regions; but since the mid-1940s well construction and extraction have increased and produced overdrafts—and actual mining—of groundwater in many areas of the United States. The aim of wise persons pumping groundwater should be sustained yield from aquifers in order to avoid the difficulities that overpumping can cause and the possible disaster of aquifer destruction. In order to do so, conjunctive water planning[208] that would treat surface and groundwater as two interrelated resources should be inaugurated. Once such a conjunction has been established, surface water that would have been lost to high evapotranspiration or flooding could be used to augment groundwater stocks.[209]

Where groundwater quality currently is concerned, there is a perception of severe risks threatening the resource. In an

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[208] *See* Carpenter, *Conjunctive Use in the Sevier River System*, 113 J. OF IRRIGATION AND DRAINAGE ENGINEERING, (1987).

[209] HIGH PLAINS ASSOCIATES: CAMP DRESSER & MCKEE, INC., BLACK & VEATCH, ARTHUR D. LITTLE, INC., SIX-STATE HIGH PLAINS-OGALLALA AQUIFER REGIONAL RESOURCES STUDY — FINAL REPORT, REGIONAL STUDY ELEMENT B-5, LOCAL WATER SUPPLY AUGMENTATION ASSESSMENT (July 1982). The study considers "weather modification; snow pack management; water harvesting and catchment areas; noncultivated area treatments, such as pitting, chiseling, water spreading, diversions, and vegetative management to increase infiltration and reduce runoff; cultivated area treatments, such as deep plowing, clay pan control, terracing, benching, leveling, basin tillage, runoff recovery, and soil conditioning; management and control of noxious, deep rooted wood perennials, and phreatophytes; reestablishment of native grasslands; direct use of brackish or saline waters; blending with [non-saline groundwater]; desalination; . . . secondary recovery of capillary/molecular waters; transfer of groundwater use rights; and evapotranspiration management and reduction" (report summary). *Id.*

industrial state like Ohio, 20,000 leaks from underground storage tanks were occurring in the summer of 1988 and, while 100,000 tanks in the state were under regulation, thousands of other tanks were unregulated, many of them known to only a very few people.[210] Government has not been indifferent to this or other kinds of pollution sources threatening the groundwater resource. Out of the fifty states, District of Columbia, and six territories, forty-six have implemented programs to control discharges of groundwater.[211] Unfortunately, current studies show little coordination of the relationship between groundwater quality protection programs and groundwater diversion programs, while the quality protection programs themselves have been called "highly variable."[212] Even as the risks have become more evident, actions have not uniformly dealt with them, as is made clear when one state in 1988 has as few as fourteen potential contaminants listed while another has as many as 190.[213]

What more then ought to be done, in addition to the conjunctive planning called for above, and what likely will be done in order to protect groundwater quality and to encourage the maintenance of sustainable yields?

(1) The prevention of pollution of groundwater from underground storage tanks, injection wells, and mineral extraction industries such as oil and gas, aggregates, and coal is needed. These may pose no greater risks than landfills, industrial surface waste storage, or the transit of hazardous materials; but they often represent a more continuous operation, may be harder simply to close down or order into a temporary cessation of activities, and may have greater economic impact in their function.[214]

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[210] OHIO ENVIRONMENTAL COUNCIL 20,000 LEAKS UNDER OHIO: ENVIRONMENTAL AND HEALTH THREATS FROM LEAKING UNDERGROUND STORAGE TANKS IN OHIO (August 1988).

[211] Goldfarb, *State Groundwater Quality Protection Activities*, 24 WATER RESOURCES BULL. 697 (1988) (discussing UNITED STATES GENERAL ACCOUNTING OFFICE, GROUNDWATER QUALITY: STATE ACTIVITIES TO GUARD AGAINST CONTAMINANTS (GAO/PEMD-88-5)).

[212] *Id.* at 698.

[213] *Id.* at 697.

[214] The Ohio Water Protection Implementation Matrix, Part III, Ohio Ground Water Protection and Management Strategy (July 5, 1988 update) sets forth the different approaches that the state will take concerning these different activities. This is an example of what one industrial state plans to do.

(2) The protection of groundwater is essential from the incursion of dispersed surface chemicals such as fertilizers, pesticides, plant growth inhibitors, and other applications particularly associated with agriculture. Iowa, for example, has undertaken a study to set standards for "synthetic organic compounds" used in agriculture,[215] while Nebraska has provided steps to prevent nitrogen infiltration into groundwater in quantities dangerous to the human food chain.[216] Legislative actions of this kind can be expected to increase since farmers can scarcely claim to be unaware of the risks to groundwater posed by their modern agricultural operations.

(3) Critical groundwater areas must be identified where extraction stresses an aquifer or some pollution source is threatening to damage groundwater.[217] Unfortunately, although two-thirds of the states in 1988 had implemented aquifer mapping programs, "only 12 possessed effective sole-source aquifer programs under the Safe Drinking Water Act."[218] And one must bear in mind that implementing a program is not the equivalent of providing adequate protection to an aquifer.

(4) More information about all groundwater, not merely what is contained in a threatened aquifer, needs to be gathered. With over fifty percent of the population of the United States getting its drinking water from groundwater, that fact is reason

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[215] Killorn, *Iowa's 1987 Groundwater Protection Act*, in PROCEEDINGS OF THE 17TH N. CENTRAL EXTENSION-INDUSTRY SOIL FERTILITY WORKSHOP 84 (St. Louis, Mo., October 28-29, 1987) (Potash and Phosphate Institute 1987) (these standards are to be in place by 1989).

[216] Hergert, *Water Quality Issues in Nebraska*, in PROCEEDING OF THE 17TH N. CENTRAL EXTENSION-INDUSTRY SOIL FERTILITY WORKSHOP 88, 91 (1987). These phases are to be applied in previously determined Special Groundwater Protection Areas. Under the Nebraska Program's Phase 1, Nebraska will ban fall and winter application of commercial nitrogen fertilizer on sandy soils if the nitrogen/nitrate concentration in groundwater ranges from zero to 12.5 ppm; in Phase 2, the farmer must attend nitrogen management seminars, analyze the water, apply nitrogen on fine textured soils only after November 1 or when soil temperature is 50 degrees F. or cooler if the groundwater analyzes between 12.6 and 20 ppm of nitrate; and in Phase 3, when nitrate levels have exceeded 20.1 ppm, *all* application of nitrogen fertilizers is banned on *all* soils.

[217] Noonan, Rosenberg, & Wood, *Constraints to Managing an Interstate Aquifer*, 110 JOURNAL OF WATER RESOURCES PLANNING AND MANAGEMENT 191 (1984).

[218] Goldfarb, *supra* note 211, at 697.

enough alone to learn about groundwater's location, movement, replenishment, quality, volume, and other properties.[219]

(5) The physical removal of groundwater, like the physical removal of stream water, needs to be done with consideration of how consumptive the use will be and how much of the water extracted eventually will find its way back into *some* aquifer, even if not the aquifer of the extracted water's origin.[220] This would require a regulatory scheme, perhaps under the public trust doctrine or perhaps simply under the traditional police power, that would require variations in the rate of allowed pumping, in the maintenance of prescribed water tables, in the retention of a minimum content, and in the return or substituted flow of at least a portion of what has been extracted.[221]

(6) Efforts should be made to specify the groundwater resources's particular use, whether it be as recipient of injected liquids, as the object of dewatering in some mining operation, as a source of water for irrigation, industrial cooling, or drinking water, or in relation to some other human purpose. Having done this, efforts should be made to identify the particular beneficiaries of these usages and the degree to which they depend upon some aspect of groundwater for their benefits. The traditional failure to establish these specifications and identifications has led to the wastage and abuse of groundwater and other resources that seemingly are there for some "free" taking.[222]

(7) The decision should be reached about continuing with a method base entirely upon command regulation which is intended to allocate, augment, or protect the groundwater resource or of going to a system having individual property rights for groundwater while it is in the aquifer. Perhaps the Nobel Laureate in Economics, James Buchanan, is right. He wants to

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[219] For one example of a popular brochure on these needs, *see* OHIO EPA, GROUNDWATER 1 (987) (the dependence of Americans for drinking water on groundwater). For Ohio's groundwater strategy, *see Id.* at 15-16.

[220] Ausness, *Water Rights, the Public Trust Doctrine, and the Protection of Instream Uses*, 1986 U. ILL. L. REV. 407 (1987).

[221] *Id.*, at 431-33, 435-37. Professor Ausness makes it clear at the beginning of his article that measures employable for protecting surface streams can also be employed for the protection of aquifers.

[222] Nelson, *Private Rights to Government Actions: How Modern Property Rights Evolve*, 1986 U. ILL. L. REV. 361, 377 (1987).

eliminate the traditional regulatory approach, which he calls "social engineering," so that a system of endowments, claims, rights, or characteristics in individuals can be established over what otherwise would be natural elements simply regulated by government.[223] In this way, what he calls "the spontaneous order of the market" would arise and control for sustained yield the exploitation of such resources.[224] Maybe this proposal for innovation is mistaken and we ought to opt for a stringent system of standards vigorously enforced.[225] Perhaps environmentally sensitive life styles can and should be coerced[226] or maybe, as James Buchanan urges, every element of the pain/pleasure calculus ought to be dumped from public regulation of the economy.[227] The point is that the time is ripe for trying out the privatization of groundwater in the aquifer in order to learn how many good results—if any—will be produced.

This paper has been an effort to briefly survey both the current problems of the groundwater resource and some proposals for providing sustainable yield, protecting quality, preventing surface subsidence, and even interdicting pumping from some groundwater sources. This author thinks subsidization of groundwater usage at free or cheap prices should stop and believes that it is politically possible to at least curtail such subsidization. After all, in the United States between 1980 and 1985, water usage declined ten percent as water went up in price, as pumping costs rose, and as aquifers were drawn down—and this does not take into consideration the decline in water usage

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[223] J. BUCHANAN, LIBERTY, MARKET AND STATE: POLITICAL ECONOMY IN THE 1980S 264-66, 268-69 (1986).

[224] *Id.* at 88. Buchanan is not an anarchist nor one who believes markets can operate at a sophisticated level without government. Laws and institutions are essential. *Id.* at 269.

[225] Latin, *Ideal Versus Real Regulatory Efficiency: Implementation of Uniform Standards and 'Fine-tuning' Regulatory Reforms*, 37 STAN. L. REV. 1267, at 1301-04 (1985).

[226] Brooks, *Coercion to Environmental Virtue: Can and Should Law Mandate Environmentally Sensitive Life Styles?*, 31 AM. J. JURIS. 21, 61 (1986).

[227] BUCHANAN, *supra* note 223, 262-64. He argues that it is not simply impossible to compare different individual's concepts of utility but that it is impossible to define even one individual's concept of utility.

caused by the drought of 1988.[228] This author does not believe, however, that charges to be paid for groundwater by landowners withdrawing it from under their own soil are politically likely, regardless of the sort of fund into which the money would be paid. What this paper has sought to do above all, however, is to push decisionmakers in the direction of further action about groundwater protection than current events seem likely to produce soon. If many people keep an attitude of indifference toward the groundwater resource or follow only traditional institutional methods relative to the groundwater resource, then groundwater will continue to be misused, wasted, and occasionally irretrievably destroyed as a renewable resource, with consequent regional declines in food production, a slowing of general economic growth, disappointments in aspiration for rising living standards, and local political instability.[229]

This sounds dramatic. But so pervasive is the relationship of groundwater to present and potential human demands upon it, that such a statment is not dramatic at all—only realistic. If this paper has succeeded in conveying the perceptions of danger and of likely success in avoiding such danger, then the paper has succeeded.

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[228] U.S. Geological Survey, *Eighth Analysis, Nat'l Water Supply*, N.Y. TIMES, Aug. 31, 1988, at 12, col. 3. Between 1950 and 1980, however, water use had doubled, with harmful consequences to the levels of water tables, groundwater quality, and aquifer replenishment. *Id.* at col. 4.

[229] Ensminger, *Agriculture, Food, and Employment*, 38 KIDMA, THE ISRAEL JOURNAL OF DEVELOPMENT 2, 19, 23 (1988).