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HYDROLOGY AND WATER LAW: WHAT IS THEIR FUTURE COMMON GROUND?

By

Arthur M. Piper and Harold E. Thomas

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Perspective

We live in an age of social and economic evolution—evolution so deep reaching and rapid it constitutes a revolution in numerous fields of human concern. Long-standing concepts of what is appropriate and orderly face drastic modification if they are to survive. To this situation the principles of applied hydrology and the tenets of water law are no exceptions. Their common ground, incomplete in the past, becomes tenuous when projected into the future.

To hydrologists it is common knowledge that the Nation has some trouble spots in water supply, occasioned by burgeoning population, by standards of living that seem luxurious to other peoples if not to us, and by a tremendously dynamic industry whose voracious thirst for water seems insatiable. Seldom is the "trouble" a mere lack of water in a quantity sufficient to serve all real needs; rather, water usually is available only part of the time, at greater-than-customary cost, or under competition among several potential uses. We can expect only that such spots will increase in number and in geographic reach.

1/ Approved by the Director, U. S. Geological Survey, as a contribution to a Conference on Water Resources and the Law, University of Michigan, Ann Arbor, September 4-6, 1957.

2/ Respectively Division Hydrologist, Water Resources Division and Pacific Area Chief, Ground Water Branch, U. S. Geological Survey, Menlo Park, California.

Applied hydrology must accept two guides for the future:

The 1- or 2- cent ton of water—to be used once, polluted in some degree, and then dumped on neighbors downstream—has become a thing of the past. Water-supply facilities will become progressively more costly and more complex; concomitantly, those who develop the facilities will want assurance that their investments can be recovered within the life of the developments.

More and more, the rational solution for water-supply stringencies will require concerted action by fairly large groups of water users who must make mutual concessions to the common advantage. As the stringencies become more numerous and of greater geographic reach, the interests to be compromised will become more diverse, and the nature of the desirable compromise may change substantially from one time to another or from one place to another. In such circumstances, a body of water law would be a severe handicap if it were rigid.

In essence, the common water law expresses basic equities between users or potential users of water, as conceived in preponderant public opinion. That opinion springs from cumulative experience with a particular hydrologic environment, so that conflicting tenets in the common law arise from experience with different environments. Statutory water law takes a further step in that it seeks to project those equities to suit future conditions and all hydrologic environments in the area covered by each statute.

Water law, whether common or statutory, seeks to define in absolute terms the extent to which an individual may enjoy a right to water or the use of water. Under the principle of legal precedent, such definition is generally inflexible and timeless. The more complex the hydrologic environment, the more circumscribed the right that can be stated in absolute terms. Herein lies a prospective dilemma—the realities of applied hydrology probably will tend toward compromise among individual interests in water or in use of water, over wider and wider areas, but the evolution of water law seems more likely to restrict than to widen the scope within which compromise will be possible.

The hydrologic cycle and water law

Man depends upon a multitude of "sources"—streams, reservoirs, lakes, wells, springs, infiltration galleries, cisterns, the soil—for the fresh water that he needs for his personal use, for his industries, and for the plants and animals that furnish his food, shelter, and clothing. The ultimate source of practically all this water is precipitation, and the "sources" mentioned will yield a perennial supply only if they are replenished by precipitation seasonally, annually, or at longer intervals.

The term "hydrologic cycle" is applied to the march of events marking the progress of a particle of water from the atmosphere through various environments upon or under the earth's surface and back to the atmosphere again. The continuity of the cycle is a basic hydrologic principle; because of that continuity, the distinctions between water in the several phases of the hydrologic cycle (precipitation, soil water, ground water, surface water) are only transient at many places and times.

Evidences of diverse action and reaction between the various phases of the hydrologic cycle are numerous and widely distributed: storage and diversion of surface water may cause waterlogging of land at some places, but may reduce the ground-water supply at other places; pumping from wells may reduce the flood discharge of streams at some places but stop the flow of springs and reduce the base flow of streams at other places or times; soil-conservation measures may reduce the net supplies of ground water or of surface water in some areas but increase them in others; projects intended to drain surplus surface water may also deplete the ground-water supplies.

Unfortunately, not all such interplay and interrelation within the hydrologic cycle has been generally and clearly recognized in statutes or in court decisions pertaining to water. At least in part this may reflect the human tendency to isolate and contain our problems, and scale them down to small size. The isolation of water problems has been facilitated, of course, by the fact that disputes and problems in colonial days and in the first century of the Nation's history were few and far between. Experts at law have contributed to isolationism by setting up distinct "classes" of water which have no sound scientific basis, and by formulating unlike rules and hypotheses for each class. This classification commonly includes:

1. Surface water in watercourses—rivers, creeks, and natural streams in general.

2. Ground water in "defined underground streams"—limited to the most obvious occurrences because the burden of proof is usually placed on the person claiming existence of this class of water. Examples are the water in caverns or in tongues of gravel and sand that underlie stream channels but in turn are underlain and bordered by impermeable rock.

3. "Percolating" water—that is, all other ground water.

4. "Diffused surface water"—that is, water on the land surface but not in watercourses or lakes.

5. Springs—natural discharge points for ground water, and therefore derived from class 2 or class 3.

In defense of this legal system of classification, inherited by us from past generations, it may be argued that the quality and usefulness of water do not depend on the name by which it is called; also, that the legal classes summarized above are not much more artificial than the hydrologist's distinction between surface water and ground water: a now-you-see-it now-you-don't distinction that can refer to the same water molecule at different times and places. A classification commonly is made to suit man's convenience. He is likely to become confounded, however, if he assumes a separation that does not exist in nature, or vice versa, and legislates or renders judgments on the basis of that false assumption.

As one example of hydrologic fallacy in the legal classes of water, consider "diffused" surface water—that is, water on the land surface but not in a defined watercourse. In the humid East, diffused surface water as a class commonly is associated with flood conditions and the "common enemy" doctrine may prevail: each property owner may exclude the invader from his land by whatever means he sees fit and under some circumstances may damage adjoining property without liability.3/

3/ Callahan, C. C., 1957, Principles of water rights law in Ohio: Ohio Dept. Natural Resources, Div. of Water, p. 16.

Other States invoke the "civil law" doctrine or the doctrine of reasonable use of land, respectively. The civil-law doctrine holds that the natural flow of diffused surface water from high land to low cannot be obstructed by the owner of the lower land. The third doctrine, however, would permit such obstruction if necessary in order that a "reasonable use" of the lower land might be sustained. In these instances the hydrologic situation is relatively simple although the legal status seems confused.

In the semiarid West, however, "diffused" surface water may assume a very different aspect. For example, in Texas it is considered to be a part of the land on which it occurs and the property of the landowner. A certain code of regulations would permit a landowner to intercept and use up to a specified maximum quantity of diffused surface water. If all owners exercised this right they might, in certain subbasins, intercept all the diffused water and the flow in stream courses would be reduced to the base flow. In the semiarid environment, such water commonly does not pose a flood threat and exists only ephemerally. Most of it would soon reach a surface stream ("watercourse") or would infiltrate the land and become soil moisture and ground water. Having reached one of these destinations, it would acquire a different legal status. Under these circumstances a landowner may legally confiscate, while it is transiently diffused, water to which he would have no legal claim once it reached one of its natural destinations. In this case, the law submerges hydrologic differences in a single, inflexibly defined water class.

An opposite fallacy is involved in the treatment of water in "watercourses" and that in "defined underground streams." To these two classes the same legal rules are applied commonly. The popular concept of an "underground stream," or an "underground lake," or any other body of water in very large open spaces underground probably is derived from knowledge of mines and caverns and possibly from Dante's "Inferno." Open spaces so large are, however, relatively rare in nature. Practically all underground water moves through small pore spaces, rather than in channels comparable in size or nature to those of surface streams. Such movement is percolation in the non-legal sense presented by dictionary and encyclopedia. Such movement probably prevails in a majority of instances that have been classified legally as "defined underground streams." In other words, as a general rule no scientific distinction can be made between the water legally classified as "percolating" and that in a "defined underground stream." For either, a competent hydrologist could define the boundaries ("bed and banks") of the aquifer ("stream"), and could trace the lines of flow with an accuracy that would be limited only by the data available. In summary, legal precedent applies unlike rules and nomenclature to situations that commonly are identical hydrologically.

The legal tenet that ground water is "percolating" water unless proved otherwise stems from court decisions made when principles of ground-water behavior were all but unknown. It is in conflict with the principle of continuity in the hydrologic cycle and the demonstrated interrelationships between the several phases of that cycle. For conformity with hydrologic reality, the legal tenets ascribed to flow in "defined underground streams" should be applied to the great majority of ground-water occurrences. As has been shown, this would reverse legal precedent.

Our common failure to recognize and heed natural hydrologic areas as the basis for development and regulation of water has brought us into conflict with the principle of continuity in the hydrologic cycle. The boundaries between Nations and States have created problems in water allocation; many of these have been resolved by treaties and compacts, amicably but not always effectively. In some States, counties have been specified as the units for water administration, and these are likely to create similar problems. Although such political boundaries may be far less than ideal for purposes of water regulation, we realize that they were not established primarily for that purpose, and we endeavor to reach a reasonable solution within the limits prescribed for the problem. But many districts formed primarily for water development or control—including irrigation districts, drainage districts, reclamation projects, ground-water districts—have areal boundaries unrelated to hydrologic reality. Many instances could be cited where the regulation of water has been ineffective because part of the water was beyond the jurisdiction of the responsible agency.

The "hydrologic equation" and water law

The "hydrologic equation," an expression of the law of conservation of mass, states simply that for any specified area and interval of time, the total inflow of water must equal the total outflow, with proper correction for changes of storage within the area. For most natural hydrologic units, precipitation is the dominant source of "inflow," and climatic fluctuations are such as to assure fluctuations of that inflow with time, and consequent fluctuations of the outflow or of the volume in storage, or both. All of us have seen enough of water to take these fluctuations for granted and to recognize the cause-and-effect relationships between storms and floods, droughts and water shortages.

A corollary of the hydrologic equation is that any water withdrawn for use must result in a corresponding reduction either in outflow or in the volume of stored water. In other words, if use is permitted a reduction in outflow or in storage must be accepted. This precept has not been accepted in all water law.

In surface reservoirs it is standard practice to store water when there is a surplus in the stream, and to draw upon the reservoir storage when the natural inflow is insufficent to satisfy the established uses. Ground water occurs in natural reservoirs, to which the same principles apply just as logically. If these natural reservoirs are to be regulated as are surface reservoirs, they should store water—and water levels should rise—during the principal recharge season of each year; also, the general trend of water levels and storage should be upward during a series of wet years. Conversely, water levels should drop and storage should diminish during the season of greatest withdrawal each year, and the trend should be downward during a series of dry years.

The hydrologic concept of ground-water reservoirs is that nature maintains an essential balance between recharge and discharge; as the rate of recharge rises or falls, the storage in the reservoir increases or decreases until the natural discharge (by springs, evapotranspiration, seepage to streams, and perhaps flow to other aquifers) again balances the recharge. Every modification by man to develop and use water necessarily induces changes toward a new equilibrium on the part of nature. The water produced by wells is not "new" water, but merely water that has been diverted from its natural course. If a well had not taken the water, it would have been discharged naturally into a stream or a spring, or dissipated by evaporation from areas of high water table or by transpiration of native vegetation. The taking of ground water through wells is comparable to the diversion of surface water from streams, except that it is easier to trace the course the stream water would have followed if it had not been diverted. It is a necessary corollary that every well must be expected to modify the natural movement of ground water—it may reduce the quantity of water available to salt grass, or greasewood, or willow, or to a shallow-water area subject to evaporation; it may reduce the flow of a spring, or the discharge of a stream fed in part by ground water; it may also diminish the yield of other wells in the vicinity by lowering the ground-water level.

In areas where ground-water development is intensive, a common objective of applied hydrology and water management is to achieve a balance between the long-term outflow (including the withdrawals for use) and long-term average inflow. In some areas an approximate balance has been achieved. Such a balance can be upset, however, if water rights are defined on the basis of the original or maximum withdrawal from each well, rather than on the basis of the withdrawal at a time when inflow and outflow are in essential balance. Subsequent to the initial period of maximum withdrawal, the storage in a natural reservoir and the outflow therefrom may change substantially, in response both to climatic fluctuations and to human activities. The resultant equilibrium thus might be far different from that in the initial period.

On the other hand, many water users believe that ground-water law should involve a guarantee of pressure in flowing wells and of a certain water level in pumped wells. In other words, the manner of diversion should be a basic part of a water right; this sentiment is supported by court decisions in some States. Such a guarantee, however, may nullify the value of a ground-water reservoir for storing water, just as a guaranteed constant level in a surface reservoir would make that reservoir no more effective than a wide place in an unregulated stream. As already pointed out, effective reservoir operation for storage, for ground water as well as for surface water, requires that the reservoir be filled in times of surplus, and then drawn down to meet water needs in times when the inflow is at a minimum. An administrator could maintain constant water levels in wells only by restricting the withdrawals from the reservoir during periods when the need for water is greatest.

With respect to a surface reservoir, water rights generally apply only to a specific quantity or rate of flow of water, there being no requirement as to the part of the reservoir where such water must be stored. If ground-water rights were comparable, they would apply only to a specified amount of water, leaving to the holder of the right the responsibility for diverting that water from the reservoir by the most practical means—springs, base flow, flowing wells, shallow pumped wells, deep wells, or subirrigation of crops—but with no guarantee that any particular method of diversion could be used forever. Even though a ground-water right is solely to a specified amount of water from an underground reservoir, the State nevertheless might reasonably require each person to develop his supplies with the least possible adverse effect upon previously developed supplies. Some wells today interfere unnecessarily with prior developments—an interference that could have been avoided or greatly reduced if the well owner had had expert advice as to the location and depth to drill his well.

Maintenance of a constant volume in storage—with the corollary that the outflow (including withdrawals for use) must fluctuate with the varying inflow—does not in general meet our requirements for a stable maximum supply, but many instances can be cited where it would be desirable for society. Constant levels in lakes or channels are desirable for recreational areas, power, and navigation in many localities. Similarly for ground water, the public might best be served by maintaining conditions conducive to spring discharge, subirrigation, or flowing of artesian wells, particularly if the alternative is a different use of the same water with no more beneficial use of the total resource. Here the misuse of general hydrologic principles would be in applying statutes or "leading decisions" indiscriminately throughout a State without regard to the special hydrologic conditions and objectives in each area of water use.

Hydrologic environments and the basic doctrines of water law

In simplest terms, doubtless oversimplified, the United States spans two unlike hydrologic environments in which unlike basic doctrines of water law have evolved. These are the humid East with its common-law or riparian doctrine, and the arid and semiarid West in which the doctrine of prior appropriation has developed, either exclusively or in conjunction with the riparian doctrine.

The two environments adjoin one another approximately along the 97th meridian. To the east lie the 31 States of the humid and subhumid East. There, as pointed out by Thornthwaite,[4] precipitation

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[4] Thornthwaite, C. W., 1948, An approach toward a rational classification of climate: Geog. Review, v. 38, pp. 55-94.

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as a rule is greater than the potential evapotranspiration—that is, greater than the potential rate at which the sun can pull water into the atmosphere from free water surfaces and through the leaves of vegetation. There, in general, precipitation is more than that necessary to sustain agriculture, and ordinarily the water surplus would more than suffice for the consumptive needs of man and animals in a simple agricultural economy.

To the west lie the 17 States of the arid and semiarid West. There, as a rule, average precipitation is less than potential evapotranspiration. There, accordingly, the overall water supply is perennially insufficient for growing crops on all the land otherwise arable. Within these 17 Western States, however, there are scattered areas of perennial water surplus—chiefly along the north Pacific coast and high in the mountain ranges. These areas of surplus dominate the water-supply situation because commonly they are tapped to alleviate water deficiencies in the arid lowlands.

Riparian doctrine

The United States has been peopled largely by migrants from humid regions, chiefly in Europe. These people, accustomed in their homelands to a relatively simple economy based on a relative abundance of water, found a familiar environment in the eastern half of the United States: precipitation during the growing season ordinarily sufficient for crops, and a closely woven network of perennial streams carrying surplus water across the land to the ocean. To this familiar hydrologic environment, and to the simple agriculture that prevailed in the era of colonization, the common water law of the homeland was applicable directly.

In essence this common law—the riparian doctrine—postulates that the right to use water is a property attached to and inherent in the land, with exclusive ownership of that right resting in the landowner. In the original sense of the doctrine, an owner of land that spans or is contiguous to a "watercourse" is entitled to have the stream flow through or by his land, essentially undiminished in quantity and unimpaired in quality; he may make whatever "natural" use of the water he desires, and he does not forfeit those rights by failure to use them. The so-called natural uses are those necessary to life on the riparian land: to meet domestic and culinary requirements and to water domestic animals. If such uses were sufficiently large, a riparian owner could legally intercept the total flow of a stream, and another riparian owner downstream would have no clear basis for redress.

In respect to ground water, a landowner has "riparian" title to any that underlies his land. In the original sense of the riparian doctrine, he can withdraw whatever quantity of that water he wishes, for any purpose, without regard to possible effects on a neighbor.

There is an obvious hydrologic fallacy in the riparian doctrine. Specifically, exclusive and unlimited right to use water, attached to specific parcels of land, can be real only if the water does not move laterally. In streams the water moves obviously—from the jurisdiction of one riparian owner to that of another. Beneath the land surface, most ground water moves just as definitely, though slowly. The fallacy is not of serious consequence in the environment from which the riparian doctrine sprang—a humid climate coupled with a simple agricultural economy. Under those conditions the overall surplus in precipitation ordinarily assures that the limited water-supply requirements are met in full.

The theoretical right of unlimited water use under the riparian doctrine becomes a figment in urban or metropolitan areas; under intensive agricultural development through irrigation (which is expanding steadily even in the humid East); or under an industrial economy. Even under a humid environment, large demands for water at the places of concentrated use may become mutually exclusive or may drastically curtail the supply available to riparian users downstream. Accordingly, in the evolution of the common water law certain variants of the riparian doctrine have become established to various degrees in certain of the States. The principal variants are outlined beyond.

Principle of reasonable use.- Numerous court decisions have established the principle that "unnatural" uses of water under a riparian right must be reasonable in amount and in kind. This so-called American doctrine, or doctrine of reasonable use, places a transient restriction on the earliest riparian owners who might initiate a large use for a purpose other than natural—that is, for a use beyond sustaining life on the riparian lands. However, because "reasonable" becomes in time more or less synonomous with "ordinary," the mild restraint inherent in this doctrine fails as soon as a substantial number of riparian owners begin using water for a common unnatural use. In the end, the doctrine may accelerate rather than prevent competitive use under which the total water supply might in effect be confiscated by a few large riparian owners.

Mild as it is, the restraint of the reasonable-use doctrine has not been applied in all the States. For example, in a recent Wisconsin case (Town of Empire vs. City of Fond du Lac, 1956) the appellant points out that the decision of 1903 by the Supreme Court of Wisconsin, in Huber vs. Merkel,[5/] has stood for 53 years. That decision concluded that:

5/ Huber vs. Merkel, 1903, 117 Wis. 355, 94 N.W. 354.

> "The owner of land had, at common law, a right to sink wells thereon and use the water from them supplied by percolation, in any way he chose, or allow it to flow away, even though he thereby diminished the water in his neighbors' wells, and even though in so doing he was actuated by malicious motives."

Principle of correlative rights.- A further stage in evolution of the riparian doctrine holds, in essence, that all the riparian owners in a given basin enjoy the total water supply of that basin in common and, in a time of water shortage, should share proportionately in that total supply. This principle has been applied primarily to ground waters. It faces up to the reality that water supplies are finite in volume. Apportionment of a total supply is reasonably straightforward if all the riparian owners use water in the same way, as for irrigation. Complexities arise wherever unlike uses are involved.

Principle of prescriptive rights.- The principle of prescriptive rights is little more than an acknowledgment that conflict of interests in water can become so involved as to preclude a straightforward solution under the riparian doctrine. It is not based on any hydrologic principle and works to intensify competition in the development of water. Under the principle, an "adverse" use of water that is maintained "openly and notoriously" for a sufficient term of years acquires a legal status equal to that of other uses in the same basin. Thus, a riparian right that is not used can be lost to, or impaired by an adverse use upstream. The term of adverse use required to establish a prescriptive right is determined by an applicable statute of limitations; the term varies greatly from one State to another.

Administrative control of waters under the riparian doctrine.- As the riparian doctrine is based on property rights in use of water, the States in which that doctrine prevails can exercise administrative control of waters only under their police powers to preserve the "public welfare, safety, and health." The extent of such control varies widely among the States. Some, but not all of the controls are based on or seek to apply hydrologic principles. New Jersey probably has gone farthest in its effort to limit ground-water withdrawals to perennial yield, as in the vicinity of Atlantic City. In that State, control is exercised through a system of term licenses that are issued to users and that have many of the effects of the appropriation doctrine (which will be outlined). Licenses are renewable if the Division of Water Policy and Supply determines the total water supply to remain adequate. However, because the licenses do not run indefinitely, at least one manufacturer declined to locate a new plant in the State.

The riparian doctrine in summary.- Among the 31 States that constitute the humid eastern half of the United States, the riparian doctrine prevails in all except Minnesota and Mississippi. As of July 1, 1937, Minnesota abrogated the riparian doctrine and adopted the doctrine of appropriation for both surface waters and ground waters, excepting domestic uses serving less than 26 persons, uses for purposes originating within the geographic boundaries of municipalities, or prior beneficial uses. In 1956 Mississippi similarly adopted the doctrine of appropriation, but in respect to surface waters only.

In recent years, several other Eastern States have examined their water policies and water laws rather critically, to appraise their adequacy and hydrologic reality in respect to ever mounting demands for water. These include Delaware, Georgia, Iowa, Kentucky, Maryland, Michigan, Ohio, South Carolina, and Tennessee. Among these examinations, that by the Water Policy Committee of South Carolina succinctly expresses a common appraisal in these words:[6/]

6/ South Carolina Water Policy Committee, 1954, A new water policy for South Carolina: Report to General Assembly, p. 30.

"It is only with the overdevelopment of a stream or other water supply or its curtailment by drought that we realize how outmoded and inequitable our water law has become. It is outmoded in that it recognizes only 'domestic uses' of 150 years ago. It is inequitable both to riparian owners and to the people of South Carolina as a whole. As each riparian owner who in the past may not have used his water takes even his small share, he reduces the amount for all riparian owners in common. Thus, a riparian owner who early has invested in equipment to use water sees his investment reduced in value as his equipment operates at less and less of its capacity. As an owner in common he has a valuable right; as an individual owner he has a right that decreases in value as it is used in common.

"The State as a whole also loses. Under present laws there is little that can be done to prevent a needless amount of our water wealth flowing unused into the ocean. Under modern conditions the riparian doctrine imposes a second injustice on the peoples of South Carolina. Under strict interpretation the riparian doctrine gives use of water only to those owning land bordering the watercourse. Others in the State can use the water only by grant of the riparian owner, by legislative grant or by prescription—adverse use for the time required by law to convert the use into a right. The people of South Carolina as a whole are restricted in their enjoyment of an important resource even though the State holds final title to it."

Doctrine of prior appropriation

In the semiarid to arid climate that prevails over the 17 Western States, the riparian doctrine would be unreal. Some parts of these States receive enough precipitation to grow grasses and grains; these areas have developed in dry farming, especially of wheat. Over the West as a whole, however, arable lands receive entirely too little precipitation for crops; commonly they are remote from sources of irrigation water, and are more extensive than could be served by the total water supply. Thus, agriculture is successful only where, and to the extent that, water is available for irrigation. This general deficiency of water is aggravated by the water demands of expanding urban areas and industry.

The doctrine of prior appropriation evolved under and conforms to the realities of this climatic environment. In brief the doctrine holds that title to all water rests in the State or the "public," that individuals can appropriate water for beneficial use, that as between appropriators "the first in time is the first in right," that the right of water use is forfeited after a statutory period of nonuse, but that the right is neither contingent on nor proportional to landownership. Appropriations are recorded under a system of applications and permits under State or county agencies.

The appropriative doctrine is absolute in respect to surface waters in seven of the Western States—Idaho, Montana, Wyoming, Nevada, Utah, Colorado, and New Mexico. These form a continuous belt spanning both flanks of the Continental Divide from the Canadian boundary to the Mexican. By implication the doctrine is also absolute in respect to the ground waters of those States, although specific legislation to that effect has not been enacted in all.

Three of the Western States—Arizona, Kansas, and Oregon—have adopted the appropriative doctrine as their primary water law but, in so doing, have recognized "vested" riparian rights to the extent of prior beneficial use of water under those rights. Also, these "vested" rights were made subject to forfeiture after a statutory period of nonuse. In 1955, Oregon adopted a comprehensive Statewide ground-water code which is based on, but embodies a highly significant departure from, the appropriative doctrine. Arizona lacks a comprehensive ground-water code.

In the remaining Western States—Washington and California along the Pacific Coast and North Dakota, South Dakota, Nebraska, Oklahoma, and Texas to the east of the Continental Divide—both the riparian and the appropriative doctrines are in effect currently. Space in this paper does not suffice to review the many ramifications in application of two doctrines to regulating water development and use. In some respects Texas is in the most complex situation, in that it follows three uncoordinated doctrines for three "classes" of water, as follows:1/ Surface waters, or those in "watercourses,"

1/ Irrigation Engineering and Maintenance, August 1956, Survey of water rights by States: vol. 6, p. 50.

are regulated by both the riparian and appropriative doctrines, concurrently. "Diffused" surface water, or that not in a recognized watercourse, belongs to the person on whose land it exists. Ground water, where regulated at all, is regulated by conservancy districts under the riparian doctrine, with some concessions to the principles of reasonable use and of correlative rights.

Limitations of the appropriative doctrine.- When it applies exclusively, the appropriative doctrine affords an obvious and practicable mechanism for curtailing the use of water from streams or lakes whenever such development overtakes total supply. Adequate records of the valid appropriations and of streamflow are required, of course, but usually these records are available or can be developed without undue delay for an adjudication.

In the area of the appropriative doctrine, water legislation has grown and developed throughout the history of utilization of the water resources. Rather generally, the waters first used for irrigation were from streams, and surface-water disputes were already raging when ground-water development was still practically nonexistent. Surface-water legislation resulted from obvious and immediate needs, and generally many years elapsed before statutes pertaining to ground water were enacted. As a result, surface- and ground-water rights are commonly recorded and administered separately, although in many States under the supervision of the same official—commonly the State Engineer. These conditions create some problems in regard to rights in interconnected supplies of surface and ground water. States that have adopted a single doctrine of water rights can resolve such problems fairly readily.

The difficulties are increased markedly if, within a single State, the appropriative and riparian doctrines apply concurrently. In some States, for example, surface water is considered as a public supply subject to appropriation, whereas ground water is recognized as appurtenant to the land and therefore privately owned. As pointed out by Hutchins:[8/]

8/ Hutchins, W. A., 1956, Legal aspects of ground-water problems: Pacific Southwest Inter-agency Committee, minutes of 56-1 meeting, Attachment B, 9 p.

> "Correlation of rights is not feasible in a State which, for example, recognizes exclusive appropriation rights in surface streams, and rights of absolute ownership of percolating waters. Even if such percolating waters are conclusively proved to be physically tributary to a surface stream, the stream appropriator obviously can have no legal claim on them if they are held to be the absolute property of the overlying owner."

In respect to ground water, exclusive application of the appropriative doctrine would seem to offer the same mechanism for scaling use to supply; in actuality, however, the mechanism is far from effective. Reasons include the following:

1. When the natural regimen of a ground-water body is changed by withdrawal or other act of man, commonly the effects are obscure and develop over a long interval.

2. Extensive hydrologic records and investigations are prerequisite to monitoring the behavior of a ground-water body under use. For few areas and for no State as a whole are such records and results of investigation available. Consequently, overdraft commonly escapes recognition while it is small.

3. Under most existing ground-water codes, incipient or actual overdraft would invoke the declaration of a "restricted-use" or "critical" area and the prohibition or restriction of additional wells or increased withdrawals. Such prohibition or restriction may be futile; development would be checked, but not necessarily its adverse effects.

4. The causes and effects of ground-water overdraft are not reversible immediately or fully. Consequently, cutting off withdrawals in the reverse order of their priorities of appropriation does not assure that the effects of development will be retraced. Under these circumstances, here stated all too briefly, responsible officials very commonly are reluctant to invoke statutory provisions, under the appropriative doctrine, for reducing use of ground water. They may have either of two reasonable doubts: that the available facts would suffice to sustain the administrator in any appeal from his order for reduction, or that the statutory procedure would in fact recapture the status of the earlier appropriators.

New Mexico has had the longest experience under statutes applying the appropriative doctrine to both surface water and ground water. Four cases from that experience are enlightening, as follows:[2/]

2/ Bliss, J. H., Administration of the ground-water law of New Mexico: Am. Water Works Association Jour., vol. 43, pp. 435-440, 1951.

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1. Under native conditions, certain large springs in the northern part of the Roswell Basin acted as natural relief valves t the artesian basin. The water from these springs was quickly appropriated by early settlers. Owing to subsequent intensive development of the ground-water supply by wells, the artesian head has so decreased that the flow from individual spring orifices either has ceased or has diminished greatly. Thus, certain holders of the earliest surface-water rights in the basin have abandoned their developments.

The artesian basin having been developed excessively, it has been closed to further appropriation by the State Engineer. Under this action, however, holders of the depreciated surface-water rights are precluded from obtaining relief by tapping the ground-water body that sustained those rights under natural conditions. In this instance, applicable law treats surface water and ground water as though they afforded distinct and separable sources of supply. Actually, as has been suggested, the separation is fanciful.

2. The Pecos River Compact, which governs the allocation of stream waters between New Mexico and Texas, provides that: "New Mexico shall not deplete by man's activities the flow of the Pecos River at the New Mexico-Texas state line below an amount which will give to Texas the quantity of water equivalent to that available to Texas under the 1947 condition.* * * In maintaining the flows at the New Mexico-Texas state line required by this compact, New Mexico shall in all instances apply the principle of prior appropriation within New Mexico." These terms pose a prospective dilemma as developed in the following paragraph.

A considerable part of the base flow in the Pecos River was derived, under native conditions, from the artesian and unconfined ground-water bodies of the Roswell Basin. The ground-water developments that have been cited, however, have greatly diminished this base flow and their ultimate effect on the flow of the river will not be evident for many years to come. The ultimate effect may be so great that the flow at the State line is diminished, "by man's activities," to less than that of 1947. In this situation, suspending the junior surface-water appropriations probably would be ineffective because in large part they do not involve base flow. Suspending the true junior rights, those in ground-water sources, would in theory affect the river flow and ultimately might satisfy the terms of the compact. However, this remedy would take effect over a long term and would not offer an immediate solution.

3. In an irrigated area, ground-water development tends to concentrate around the most productive wells and the most productive lands. Consequently, some parts of a particular ground-water source may become overappropriated while other parts, with less desirable lands or smaller yields of water, are virtually untouched. In the northern part of the Mimbres Valley, for example, the ground-water supply has been fully appropriated in the vicinity of Deming. In the southern part of that basin, however, considerable additional draft might be dispersed over an extensive area with little detriment to prior appropriators to the north. At one time the State Engineer permitted no further appropriations in certain areas of the basin, the boundaries of those areas having been fixed somewhat arbitrarily, of necessity. This approach proved unsatisfactory, especially near the boundaries of the designated areas. In consequence, the entire basin has been closed to further development. As of 1951, the State Engineer had not developed an acceptable formula under which continued appropriations might be permitted in areas of light development even while they were denied in adjacent areas of optimum development.

4. One section of the New Mexico statute provides that the State Engineer shall determine where public waters are available for appropriation. It was under this section that authority had been assumed for closing a basin either in part or in whole. However, a basic question has been raised: does the State Engineer have authority to make such determinations for whole basins or parts of basins, or must each application for a new appropriation be assessed on the merit of its individual situation?

Trends in water management

Ideally, water law would define the rights and obligations of individuals in respect to use of water, provide for necessary regulation by States or other appropriate jurisdictions, and yet allow reasonable flexibility whereunder the Nation as a whole might effectively manage its water destiny. As was pointed out or implied in preceding pages, current water law embodies some fallacies and numerous inconsistencies from one State to another. To hydrologists the current law seems a confused and confounding basis on which to attempt resolving water problems of the future.

To the Nation's tremendously dynamic industry, not even the humid East can offer, into the indefinite future, an overall surplus in water supplies. In the arid and semiarid West the prospective imbalance between water supply and water demand is greater. As a whole the Nation must use its water supplies more and more effectively as time goes on—providing artificial storage to smooth out nature's fluctuating supply; reclaiming waters polluted by domestic or industrial wastes and those naturally of inferior quality; and allocating available supplies to the greatest overall advantage. The total water supply—on the land surface in streams and lakes, in the aerated zone of soil water, and in the saturated zone of ground water—must be managed collectively as a single resource serving a single aggregate need.

In the introduction to this paper it was stated that the rational solution for foreseeable water-supply stringencies will lie in concerted action by fairly large groups of water users, making mutual concessions to the common advantage; also that the nature of the desirable compromise may change substantially from one time to another or from one place to another. The writers believe that the following concepts are emerging in the areas of greatest pressure on water supplies:

1. An individual's claim to exclusive jurisdiction over any particular amount of water, to be used as he sees fit and then discarded, will come to be viewed as a caprice of history. The riparian doctrine, with its concept of absolute property rights in water, will become obsolete.

2. One principle of the appropriative doctrine—that ownership of all water supplies rests in the "public," collectively—will become widely accepted. Other principles of the doctrine will be modified in general opinion—appropriations of water will become contingent on a use which returns the greatest potential advantage to the "public" at that particular time and place; and the dogma of "the first in time is the first in right" will be softened to something less than an absolute priority without regard to the manner of water use. In other words, the appropriative doctrine will become coupled to the police power of the State, to the end of optimum advantage to the general public welfare. A first step in this direction has been taken in the ground-water code adopted in 1955 by Oregon.

3. Water sources and reservoir sites on the land surface and water sources and natural reservoirs beneath the land surface will come to be managed as a single supply, for allocation among all needs. In this situation, only an agency of the utility type, either an arm of government or functioning under governmental license, would appear to have the necessary broad competence.

Following are the challenges posed by foreseeable trends in the water-supply field: To the hydrologist, that he acquire and adequately interpret the large body of water facts required by the Nation for prudent and effective management of its water destiny. To the specialist in law, that he shape a body of water law fostering and permitting such management, under adequate and appropriate checks and balances. Only by meeting these challenges in substantial measure will hydrology and water law find a wide common ground in the future.