S7-110 Rotyped copies

Calif 245

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

INTERREGIONAL MANAGEMENT OF GROUND AND SURFACE WATER 1/

by H. E. Thomas 2/

For several years I have had a slight aversion to the term "management" without knowing exactly why, unless it's because, in the minds of its proponents, "management" is increasingly becoming an end in itself, rather than a means to an end. Inasmuch as "management" is the dominant word in the title of the paper assigned to me, I have consulted a dictionary--Webster's New World College Edition--to learn what the younger generation is being taught about management. Here it is:

> manage (from L. manus, hand) 1. originally to train a horse in his paces; hence 2. to handle or wield a weapon or instrument, or control or guide a vehicle, boat, etc. [This definition refers to manual dexterity.] 3. to have charge of, direct, conduct, administer--as, she manages the household. [This definition could lead us into the Battle of the Sexes, which is outside the scope of this conference.] 4. to handle or use money, supplies, etc. carefully. [This definition would seem to be applicable to water supplies, but the dictionary marks the use as Rare.] 5. to get a person to do what one wishes, especially by skill, tact, flattery, etc.; make docile or submissive, to control. 6. to bring about by contriving; contrive; succeed in accomplishing: often used ironically. [These definitions suggest a trend in management toward control of people rather than of inanimate objects; I feel that my qualms about and subconscious aversion to the term are quite justifiable.

I would not inflict upon you my personal feelings toward managment in general if it were not for my conviction that the management of water supplies will depend chiefly upon our effectiveness in managing people--by contriving, skill, tact, flattery, etc., as Mr. Webster says. To develop this idea I should like to touch very lightly on some of the limiting factors in water-resource management.

1/ Approved by the Director, U. S. Geological Survey for presentation at the conference on the Economics of California's Water Development, Lake Arrowhead, California, August 12-13, 1957.
2/ Pacific Area Chief, Ground Water Branch, Water Resources Division, U. S. Geological Survey, Menlo Park, California.

Physical Limitations

Physical limitations are presumably of basic importance in water management because they define the realm of possibility, and thus indicate what <u>can</u> be done. A year ago I might have said that an understanding of these physical limitations was of greatest importance, because the specialists in other fields would be handicapped so long as definitive answers were not available. But my morale has been subdued ever since I attended a symposium sponsored by the Conservation Foundation last September, which was attended also by Dr. Wantrup, but dominated by specialists in law. Their attitude was that the physical data pertain to simple molecules which respond consistently and therefore predictably to natural laws, so that definitive physical data <u>can</u> be obtained, and that, even with tremendous effort expended on people and their complex brain cells, our best legal and sociological talent would come up with less definitive answers than those already available concerning physical conditions.

For my part, I still would not belittle the importance of understanding the physical limitations, or the size and complexity of the task. California has long since taken the lead in development of a State water plan, which was approved in the rough by the State Legislature in 1931. Now we have a far more comprehensive summary of the concept, but Harvey Banks still has a tremendous task ahead in obtaining the additional detailed data necessary to consummate the plan.

On the principle that water management would require storage and distribution facilities capable of furnishing water as needed, even though the supply is replenished at rates that may vary within wide limits, the physical limitations for any service area might be in the storage facilities or in the rates at which water could be put into or taken from those reservoirs. If water is stored on the surface, these limitations might be set by the availability and size of reservoir sites, or the rate and volume of inflow, either natural or imported. For underground storage the limitations may be in the dimensions and permeability of the aquifer, or in the rate of natural replenishment, or in the potentialities for artificial recharge.

Economic Limitations

I prefer to pass rather quickly over the subject of economic limitations also, on the ground that my qualifications entitle me to the role of student rather than professor in this conference. I presume that the economic factors should be controlling as to what <u>will</u> be done, and thus form a bridge between what can be done (the physical factor) and what is desirable for the greatest good (the social factor). My principal association with economic factors has been in reading the results of analyses of costs and benefits for specific projects.

Social Limitations

Every society is guided by certain rules of conduct, some of which are coded into laws, others expressed in the unwritten or common law, still others formulated in the literature or conversations of members of the society. What we call "progress" results in some changes in these rules with time, but generally with considerable lag, so that one could find many instances of adaptation of our inherited social customs or attitudes to present conditions. There are also numerous areas of conflict.

In the field of water resources, various limitations on effective management are likely to be imposed by the prevalent attitudes of the people toward their environment in general, toward water resources in particular, and toward the proponents of management and the scientific data that support their position.

Attitude Toward Environment

In his studies of "Our World from the Air: Conflict and Adaptation" Gutkind (1956, p. 1-41) contrasts the intimate and direct "I-Thou" relationship between man and nature in primitive villages today, and in most of the world in former times, with the abstract and impersonal "I-It" relationship in modern civilization. He then describes more specifically several stages in the changing attitude of man to his environment--first, one of fear and longing for security, when man feels himself a part of nature, but solves his practical problems empirically; second, one of growing self-confidence and increasing observation leading to a more rational adaptation of the environment to differentiated needs, although the intimate "I-Thou" relationship persists; third, one of aggressiveness and conquest, in which he remakes his environment with expansive ruthlessness, and may neglect or exploit the natural resources, with which he has an abstract (I-It) relationship. Gutkind can see also a fourth stage, just barely taking shape, involving responsibility and unification, with careful adjustment to environmental conditions and new possibilities. From Gutkind's discussions and photographs it appears that the "I-It" disregard for environment is most apparent in areas of concentrated population and machine power, and the "I-Thou" relation holds where man and his works are still puny in comparison with the natural environment.

Water as an essential part of the environment was a basic factor in the settlement of the arid regions of the West. The Spanish communities in California, the Mormon communities in Utah, the early cattle ranches and homesteads all were located where springs or perennial streams were available for water supply, for it was universally recognized that to exist on the land one must have water supplemental to the sparse rainfall. The attitude that water "belongs" in the environment in which it is found has doubtless been a factor in the Nebraska legislation and State Supreme Court decision that restrict the use of water to lands within the watershed; the superiority of rights of owners of land overlying a ground-water basin as against exporters from the basin in California; the recent controversy over the Echo Park dam site on the Green River in Utah; the almost forgotten controversy over exportation of water from Owens Valley even after Los Angeles had purchased the land and water rights; the Counties-of-Origin statute in California; and the general restriction, in States adhering to the riparian doctrine, that riparian use must be within the watershed.

If we all conformed to the "I-Thou" relationship by adjusting to the natural environment, most of us in the West would be goatherding and sheepherding mountaineers, as in Switzerland, because the highlands are the chief areas of water surplus in this arid region. Instead, a larger and larger proportion of the population is living in areas of water deficiency, but transporting its water hundreds of miles from these surplus areas--the "I-It" relationship that bends nature to man's desires. If these people do not have to go to an oil town for gasoline for the car, or to the diamond mines of South Africa to become engaged, or to Hawaii to enjoy pineapple and grass skirts, they see no reason why water should not be delivered to them where they want it. The question Should the Water go to the People, or Should the People go to the Water? was prominent in the last session of the California legislature, and the clash in attitudes may well continue for some time.

Attitude Toward Ownership of Resources

We are accustomed to a dual system in our use of the world's goods. Some things--our homes, our cars--we have exclusively, for use or nonuse according to our whim, and we may invite others to share them, or exclude them from the privilege. Many other items--a picnic bench in a recreational area, a spot in a fishing stream, a car-length on the highway--belong to us no more than to anyone else, but also no less than to anyone else; these are public property, and we may appropriate them, in accordance with regulations set forth, for our use only so long as we need them.

Most of the natural resources--including accumulations of gravel, sand, limestone, ore deposits, solid fuels, etc., as well as the soils with their forest or grass or other vegetative cover--are subject to exclusive ownership by individuals, and the boundaries of the private property are readily determined by surveying techniques. Some complications have developed in the case of petroleum, because of its ability to migrate across property boundaries as it is extracted, but individual property rights can be preserved by unitization of the reservoir within which the resource is confined. By contrast with the solid resources, the atmosphere has always been recognized as common property, in which we all have rights, wherever we may be.

Water lends itself to analogies both with the static solid resources and with the mobile and fluid atmospheric resource, and thus society has come to regard it as private property under certain conditions, and as common property under other conditions, or perhaps under the same conditions but in a different place. After falling as rain or snow upon private property, water may remain there until it returns to the atmosphere, or it may move slowly from the property as ground water, or move rapidly as surface runoff. Our concepts concerning water rights are not altogether consistent, as shown by statutes and court decisions pertaining to water in various phases of the hydrologic cycle. Presumably water in the atmosphere would be regarded as common property, but prior to artificial rainmaking the question rarely came up. In Texas, rainwater falling on one's property belongs to the owner to do with as he pleases, so long as it remains there, and this might well be the attitude in most States, although some Western States have declared "all" water to be public property and subject to appropriation on the basis of priority of use. The public attitude would doubtless be very generally that the landowner owns all the water in his soil, and in most States he also owns the ground water underneath. However, in some Western States the landowner owns only that part of the ground water that lawyers call "percolating" water, and not that which they say is in a "definite underground stream." In several Western States all ground water is public property, but in others only the surface water and "underground streams" are public waters subject to appropriation, and the rest is owned by the landowner. And in still other States only the surface water above a specified "minimum" or "average" flow is public water, and all the rest is in private ownership. If there is any general trend for the Nation, it appears to be that where water is in least supply and greatest demand it is most likely to be dedicated to the public, subject to appropriation; where the demand is little and the supply great, we still have the inherited attitudes of private ownership. In the States that try to retain both concepts, the static or slowest moving water is commonly left in private ownership; the water moving more rapidly and therefore more obviously crossing property boundaries is taken in public ownership.

Attitude Toward Difficulties

In any society it may be expected that the great majority are not specialists in any aspect of water, and will therefore choose to minimize their personal attention to it so that they can spend more time and effort on their other interests. Several props can help in this endeavor. The general public can delegate their responsibilities to specialists who choose to make a career of water. They can let things ride until a crisis develops, and then devote considerable attention to the subject for a brief time. And in order to keep up with the Joneses in matters of public interest, they can familiarize themselves with various facts and figures, which usually turn out to be averages and broad generalizations.

A common response to a crisis is containment and isolation, to prevent a general conflagration or disruption of our economy. This has obvious advantages in fires and riots, and we have used the technique also in domestic controversies and international "incidents." Containment and isolation seem also to have been the general rule in difficulties or controversies over water. The tendency to consider each trouble separately and independently is evident in the numerous governmental units set up to overcome them; irrigation districts, drainage districts, levee districts, flood-control districts, etc. Controversies, too, seem simpler if they can be localized and restricted to specific issues. The limitations of State boundaries and of court jurisdictions, and the multiplicity of hydrologic units varying one from another, tend to hold problems down to small size, and there are also the common handicaps of inadequate data, and the rules of evidence that prevent introduction of "irrelevant" material. Finally, in many controversies a major point at issue is the legal classification of the water, even where this legal classification is scientifically unsound and misleading. The result has been that our body of water law includes a great mass of analysis of specific problems, but a dearth of synthesis of major aspects of the water resources and their development and use.

By delegating to specialists the responsibility for studying all aspects of the water resources, the general public obtains large volumes of another form of analysis of specific problems. These do not necessarily increase the public understanding of the situation, however. The specialist's technique may be to learn more and more about less and less, and there is an increasing tendency for specialists in each field to talk and write only to others within that field, using a specialist language, so that to an outsider one awesome product of science is a modern Tower of Bable. Analysis of specific problems, rather than synthesis, has been the chief product of the specialist approach.

A surfeit of involved legal patois on the one hand, and of scientific jargon on the other, is doubtless sufficient to confuse and frustrate many of the people living in areas where water supply is a critical problem. Those who nevertheless try to educate themselves in matters of water resources are likely to obtain generalizations based on averages. Here mathematicians should take a hand in educating the public as to the meaning of averages, whether they pertain to rainfall, runoff, ground-water recharge or discharge, or water levels in wells. These averages indicate central tendencies, but alone they are not definitive of the water resources, because the dispersion from the average also is a major factor. Average figures have been handicaps to the extent that they have led to the common concept that the "average" condition--whether flow in a stream, water level in a well, or volume in a reservoir--is something that should be maintained at all costs. As long as precipitation deviates from the average, other elements in the water-resource picture also must vary.

A major reason for our dependence upon reservoirs--surface or underground--is the great deviations in water supply, especially precipitation and runoff, from the long-term average. The reservoirs, by providing space for storage of the widely varying quantities of natural inflow, should permit us to withdraw water in accordance with our needs, subject to the limitation that, if the reservoir is to serve our purposes perennially, the average withdrawal cannot be greater than the average inflow. Here it may be necessary for the realists to combat an attitude that is common among baseball fans, football alumni, and parents: "We have had several years above average; let's keep it that way."

Conjunctive Use of Surface and Subsurface Reservoirs

After this rather long prologue concerning the various limitations to water-resource management in general, I am ready for the topic I have been asked to discuss. Since my specialty is in physical data, I should consider the conjunctive use of ground and surface reservoirs from the standpoint of what can be done. Although examples can be cited of such conjunctive operation, it is by no means a common practice, and there is still doubt in many minds as to the possibilities.

Surface and ground-water reservoirs serve the same broad purpose of holding back the water provided by precipitation at highly varying rates, and releasing it more in accordance with human needs. Certainly in many places, and probably as a general rule, this broad purpose could be better achieved by conjunctive operation of the two types of reservoirs than by their separate and independent operation. In fact, such conjunctive operation can overcome some of the difficulties encountered in operation of multipurpose surface reservoirs, and also in pumping so heavily from subsurface reservoirs that reserves are seriously depleted.

In surface reservoirs constructed for flood control, the prime requisite is space to hold the flood runoff of heavy storms, and that space must be emptied as soon as one flood is past to be ready for the next flood. Wherever this water can be used for artificial recharge of a ground-water reservoir, the water is conserved and can be made available for future requirements.

Surface reservoir sites are a limited resource. On some streams they are so limited that only a part of the average annual runoff can be stored. Wherever ground-water reservoirs are available to accept some of this runoff, they serve an important purpose in conservation. The surface reservoir, by receiving water at highly variable rates and releasing it at rates more suitable for recharge, is an essential part of the conjunctive operation. Conjunctive operations may also reduce some of the conflicts of interests of various types of water users--those who want water released during the growing season for irrigation, or throughout the year for municipal or industrial use, or at varying rates in accordance with hydroelectric power demand, or maintained at certain levels in lakes for recreation. Wherever water released for various purposes can be stored in ground-water reservoirs, it may be made available to other users when they need it, which may be months or years after the time of release from a surface reservoir.

Wherever the annual evaporation greatly exceeds precipitation--that is, in any arid region--there is a net water loss from surface reservoirs by evaporation. Thus, even with a maximum of surface-storage facilities, we cannot save and use all the water that flows into surface reservoirs, and this is characteristic of the places where water is most in demand and most valuable. Here the conjunctive use of ground-water reservoirs, if available, promotes water conservation, for the water stored underground is largely, or even entirely, beyond the reach of evapotranspirative processes. Ground-water reservoirs constitute the only means of conserving a major portion of runoff in desert regions for future use, because about half that runoff is likely to be lost from surface reservoirs, either by overflow of small ones or by evaporation from those large enough to capture the water from maximum floods.

It may be concluded, therefore, that conjunctive operation of surface and subsurface reservoirs could enhance our control and use of water, wherever physical conditions are suitable for such operation. Obviously, then, we need more physical data in order to be assured of the possibilities within each region as well as the possibilities of attaining better balance among regions. And, just as obviously, we need the economic data that will enable us to weigh the advantages and disadvantages of each modification.

There remain for consideration the limitations imposed by the traditions, mores, and beliefs of society. If these are such as to hamper unduly the management of water resources in the best public interest, the specialists concerned with watr have failed in at least one respect: that is, in informing the public. Sometimes it appears that they fail even in education of each other, for the engineer, the economist, the lawyer, the geologist, the chemist, the soil scientist each may work in ignorance of what the others are doing.

To the proverbial plaint of the specialist that there is not enough information for a complete answer to his specific questions, the layman might well answer that there are too many data for a straight answer to his general questions. The layman can be expected to have a special interest in water only as it affects his welfare, and in the great mass of legal and scientific literature already available he can find support for any contention he might care to make in furtherance of his own special interest.

I feel that there is not a large gap between what we have and what we need for "management" of the people who must give their assent to any program for management of water resources. We need a "generalist" approach in addition to our specialist approach, to achieve a synthesis of the results of the specialist's analysis of specific problems. And as a means of developing these generalists, closer coordination or perhaps "combined operations" of groups of specialists in diverse fields might provide the comprehensive and overall understanding which we need, and which is needed by the general public.

Reference cited

Gutkind, E. A., 1956, Our world from the air: Conflict and adaptation, p. 1-41 in Thomas, W. L. (ed), Man's role in changing the face of the earth; Chicago, Univ. of Chicago Press, 1152 p.