Ground Water in California

economic and social causes and effects of overdraft on state's water resources subjects of current studies

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About 30% of the irrigated lands of California receive their entire water supply from ground water and about three quarters of the cities, towns, water, and sewage districts in the state draw all or part of their requirements from the same source.

Ground water is an important resource which—in many parts of the state—is fast being depleted.

The ground water reserves from which the state draws today are in large measure a stock or fund which has been built up gradually through past periods of time. The present rate of use in parts of the San Joaquin Valley, the Los Angeles area, Santa Clara County, the Salinas Valley, and elsewhere in the state exceeds the average replenishment, and a state of overdraft exists.

Increasing Depths to Water

The occurrence of overdraft is accompanied by a decline in water pressures and an increase in the depths from which it is necessary to pump. Probably the greatest fall in the water level in any one part of the state during the past quarter of a century has occurred in the Delano-Earlimart-Richgrove section of the southern San Joaquin Valley. Here the water level has dropped a maximum of about 200 feet since the early 1920's, and is now as much as 350 feet below the ground surface.

Water levels in the Lindsay area have fallen up to 100 feet since 1921 and at least one well in the Raymond Basin near Los Angeles recorded a drop of 81 feet between 1924 and 1937.

Other things being equal, an increase in the depth to water results in an increase in pumping costs. This increase occurs not merely because more power is consumed in pumping from the greater depth. It is usually more important that the fall in the water level may necessitate great capital expenditures for deepening the well and changing the kind and size of the pumping plant.

The decline in the water level may have other effects. In areas near salt water, a recession of the ground water plane below salt-water level creates a danger of salt-water infiltration. This has already occurred in parts of the Sacramento-San Joaquin Delta, the Santa Clara and Salinas valleys, and in the Long Beach area.

The need to go deeper for water may bring a deterioration in quality even in areas which are not near salt water. For example, in the west side of the San Joaquin Valley some of the wells tap strata below 1,500 feet. The water in these beds has a high chloride—saline—content and can only be used when diluted with better quality water from higher levels.

Another undesirable effect caused by a decrease in water levels and water pressures is subsidence of the ground surface.

In the southern San Joaquin Valley, the ground surface has subsided over an area of about 300 square miles, the maximum fall being approximately seven feet. A similar phenomenon has been observed in part of the Santa Clara Valley. Here the center of subsidence is the city of San Jose, where between 1912 and 1936 the ground surface dropped five and a half feet.

Analysis of Overdraft

A decline in the water level is highly complex with respect to its causes, effects and remedies. In analyzing overdraft, it is necessary to differentiate between cyclical and long-run causes of a fall in water levels. This type of analysis presents problems for the social scientists as well as for workers in the physical sciences.

For example, the amount of draft varies from year to year. If a comparison of draft with replenishment is to be made for the purpose of determining whether overdraft exists, a figure which is truly representative must be derived from the varying annual figures for actual draft.

Fluctuations in draft are produced in part by such cyclical factors as variations in rainfall, but they may also be caused by changes in market conditions. Changes in crop prices react upon draft through changes in the total acreage irrigated, in the types of crops grown, and in the financial ability of the farmer to deepen his wells.

There are problems associated with overdraft which fall principally within the realm of socioeconomic analysis.

One series of such problems relates to the economic and social consequence of overdraft; the price our economy is paying for the need to follow retreating water levels resulting from overdraft; the proportion of the increase in costs due to increased expenditures for power necessitated by greater lifts, and how much is due to capital expenditures for deepening wells and changing the type and size of the pumping plant; the effect of the increasingly large investment in wells and pumping equipment on the size of farms; whether the high fixed costs resulting from heavy expenditures for wells and plant react adversely on ground water conservation; the extent decreases in power rates, improvements in pumping technology and high prices for agricultural products offset the increase in pumping costs due to receding water levels; the forms of adjustment which may be expected if prices decline.

The immediate economic and social problems inherent in the occurrence of overdraft are of very great importance, but even greater problems arise if ways and means by which overdraft itself may be checked, are considered.

In some countries, like Mexico, and some states, such as Nevada and Utah, laws have been enacted which make the right to pump ground water subject to state approval and control. In California, attempts to curb overdraft have taken other forms—there are no laws allocating rights to pump waters percolating in an underground basin.

Additional Water Supplies

In some instances, conservation of waters wasting from adjoining watersheds has offered a possible solution. The realization of this solution involves problems of social organization. Because a suitable organization may not be found readily or agreed upon, conservation may be delayed some time after the need for checking overdraft is first recognized.

Where the additional water supplies are to be imported from outside areas—as from Hoover Dam to Los Angeles—the problems of social organization may be even more complex. These problems require quite as much consideration as the engineering plans.

In the controversy over the 160-acre limit, there is an example of the difficulties which arise if the problems of ground

Continued on page 14

WATER

Continued from page 9

water are not carefully examined when additional supplies are secured.

Ground Water and the Courts

Until recently the sole limitations imposed by the courts upon rights to pump were that the water should be put to a reasonable beneficial use, and that, in the event of a shortage, water could not be exported from a ground water basin. Even this latter rule was modified by the provision that if a party other than an owner of lands overlying the ground water basin obtained water for a period of five years without being served with an injunction, his right was secure. Neither of these rules provides an effective control over competitive pumping and overdraft.

This year the California Supreme Court has attempted a more satisfactory solution. In an important decision—the so-called Raymond Basin Reference Case—it was ruled that mutually prescriptive rights had been established as between landowners and others pumping from an overdrawn basin, and draft was limited to *safe yield* by a proportionate reduction of pumping by all users.

Important Problems Remain

The court has power to allocate rights only in cases brought before it. Should the entire burden of apportioning pumping rights be left to costly litigation? Should legislation provide administrative control over overdraft? If so, what form should such legislation take? Is an all-round reduction of pumping rights the most desirable basis economically and socially for preventing overdraft? Is a period of five years appropriate for establishing whether pumping by outside users is causing overdraft?

There is an elaborate system of statutory and administrative controls upon the use of surface waters. Social institutions governing the use of ground water are at once less diverse and less adequate.

Further Studies Needed

Most of the research relating to ground water problems in California has been concerned with the physical aspects of overdraft. While it is necessary to continue such studies, the most urgent need is an understanding of the economic and social causes and effects of overdraft in their regional setting and historical development. With such an understanding, the various attempts which have been made to deal with the problem of overdraft, and the reasons for their success or failure can be investigated. Possible improvement of the social institutions under which ground water is used in California might then be explored. The Giannini Foundation is undertaking a series of ground water studies with this end in view.

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The first of the Giannini Foundation Ground Water Studies, "Ground Water in California—the Present State of Our Knowledge," may be obtained without cost by addressing the Agricultural Information Office, 22 Giannini Hall, University of California, Berkeley 4, California.

MECHANIZATION

Continued from page 10

Farm tractors have also received considerable attention in recent years. Much interest has developed in new small general purpose tractors. The latest has a rear-mounted engine which gives the operator full vision of the attached equipment. These small units have a full complement of attached tools and are adapted to the 40- and 50-acre farm.

Hydraulic controls for both mounted and trailed machines give the operator complete finger-tip control of his implements. The shifting of a simple control raises or lowers a plow or angles a disk harrow through a properly placed hydraulic cylinder.

While many of California's field crops are lending themselves to mechanization, the fruit and vegetable industry still has a long way to go. Many operations connected with the fruit industry can never be mechanized because human judgment is necessary in such operations as pruning, thinning, and harvesting.

A successful onion harvester has been developed recently and a group of flower bulb growers in San Diego County plan to try it hoping to solve some of their harvest problems with it.

An electronic grader and color sorter is under development. The machine, while originally designed to separate lemons into six sizes and five color grades, may have other applications.

The sorting of adobe lumps out of beans is no problem with a new machine that uses the difference in skin friction between the two for effecting a separation.

These are some of the many significant changes in the farm equipment field as well as in the agricultural practices in California during the past 20 years.

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PIPE

Continued from page 8

them, but this has not yet been verified. It may be desirable to avoid the condition where the pipe is alternately wet and dry. On slopes, this can be done by using float valve stands. Where this is not practical, loose fitting but rather air-tight covers placed on top of all stands should have somewhat the same effect. These should cut down on the circulation of air through an empty or partly full pipe, this permitting the building up of humidity in the pipe. Humidity without actual wetting is surprisingly effective in causing some wetting expansion. Expansion at constant temperature has even been observed when the relative humidity was increased from 32% to 48%.

As the pipe is laid, an initial backfill should proceed behind the pipe, say, not less than two sections nor more than five sections behind actual laying; this initial backfill to cover the pipe to a depth of at least six inches. If the weather is humid and somewhat overcast, or if the initial backfill soil is somewhat moist—above the permanent wilting percentage—no other precautions are necessary. Otherwise, the initial backfill soil should be wet—from a tank truck if necessary. Such precautions will take the peak off of wetting expansion, but a desirable amount will still be retained. The pipe should be dry at the time of laying.

Pipe lines should be plugged as much as possible to prevent air circulation during laying. Open ends should be plugged when the work stops for an hour or more, and should be kept plugged until water is placed in the pipe line four days to a week following laying.

Expansion joints and presoaking of the pipe before laying are to be avoided. Riprings imbedded in the pipe are ineffective.

More trouble is experienced in adobe clay soils than in other types. In such soils it is suggested that a 4-inch layer of sand or sandy loam be placed on the bottom of the trench, and, as much as possible, similar soil be used for the initial backfill. Such precautions should prevent most such trouble.

Other procedures and practices—such as uniform line and grade, at least two feet cover over pipe, banding—are more or less customary.

Plain concrete pipe lines have been and still are the most desirable and efficient means of distributing irrigation water on the farm for surface irrigation. Where water is scarce, as in southern California, their use is almost axiomatic. Previously there has always been a small percentage of failure of such systems. Recent investigations of the College of Agriculture point the way to slight modifications in

Continued on page 16