

areas. In some places, the water table has risen to the crop root zone, or even to the surface, with the result that large cultivated areas have been and are presently being abandoned. In other places, waterlogging does not exist, but the water table is so close to the surface that water rises through the top soil by capillary conduction in the pores and evaporates, leaving a deposit of salts behind. The chemical composition of the salts corresponds to dissolved minerals in the river water and includes sodium, calcium and magnesium cations and sulphate, chloride, bicarbonate and carbonate anions. Moreover, the water remaining in the distribution system has been insufficient in amount when applied to the land. With low areal rates of application virtually all the irrigation water evaporates and none is left to wash the salt residual downward to the subsoil below the root zone. The continued evaporation from thinly spread irrigation water and from the high water table caused by distribution system leaks has resulted in high salt accumulations in the soil in many regions especially those in which irrigation has been practiced for many years. Thus the salinity problem is associated both with leakage and with inadequate rates of irrigation.

Many observation well records have been kept over the past 60 to 75 years, and these clearly show the changes in the water table with the passage of time. In the Punjab prior to 1900, before the extensive development of the present canal system, the ground water table lay at depths well below the zone of active evaporation, and losses to the atmosphere were small. With the construction of the canals and smaller diversion channels a steady rise in the water table began. This steady rise continued up to the decade of 1930 to 1940, when with increasing evaporation losses there was a deceleration in the rate of rise. More recently, the water table in most regions has tended to become stabilized. Stabilization occurs typically when a depth of about ten feet below the surface is reached. At this depth an unsteady equilibrium develops in which recharge is balanced by evapotranspiration. The water tables rise and fall with the seasonal irrigation and rainfall patterns and fluctuate from year to year because of variations in rainfall. Correspondingly, the size of the waterlogged areas fluctuates from season to season and from year to year.

The records show that the rate of rise of the water table was not uniform; generally the rate was smaller in the downstream ends of the doabs than in the upper areas. Recharge rates in Bari Doab and in Bahawalpur were markedly smaller than in other regions. The non-uniformity of recharge is due to several factors including differences in soil properties, rainfall, and the density of the water distribution network (area of channels per square mile). In our analysis, for reasons to be discussed, we have used an average potential recharge rate of 0.67 acre feet per acre per year to