TRENDS IN GROUND-WATER LEVELS AND USE IN GEORGIA: 1950-1987

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INTRODUCTION

As part of a study on land use changes in the state of Georgia, 1935 - 1985--funded by the Kellogg Foundation--trends in ground-water use and ground-water levels were investigated. Our objectives were to document trends in ground-water use and changes in water levels of the four major aquifers in the Coastal Plain of Georgia. We attempted to relate ground-water consumption and yearly rainfall to predict possible future problems of drought and offer some suggestions to solve these perceived problems.

METHODS

The four major aquifers to be considered extend from the fall line along the coastal plain, to the coast (Figure 1). They are the Floridan, Claiborne, Clayton, and Cretaceous Aquifers. Withdrawals and location of withdrawals from these aquifers vary. The Floridan is used throughout the coastal plain, the Claiborne and Cretaceous aquifers are used in a band from southwest to north central Georgia along the fall line, and the Clayton aquifer is used primarily in the southwest corner of the state, the Dougherty Plain (Figure 2).

In order to get composite estimates of trends for each aquifer, wells were selected within each aquifer that had water level records extending back at least ten years (Clarke et al., 1987). The high, low, and mean yearly water level for each well were provided by John Clarke of the United States Geological Survey (USGS) in Doraville, GA. Additional data were obtained from annual reports (Joiner et al., 1988). We calculated yearly changes for each well by subtracting the water level in one year by the level in the previous year. These results allowed direct comparisons of well data within each aquifer. For each aquifer, or aquifer section, we averaged the yearly changes and added them to give cumulative changes over time. These cumulative averages gave a general overall trend in water level changes within each aquifer, and reduced the variability caused by individual wells which experienced a cone of depression.

Information on estimated groundwater withdrawals in Georgia were provided by Bob Pierce of the U. S. G. S. in Doraville Georgia. Yearly rainfall averages in the southwest section of Georgia were obtained from Climatological Data for Georgia: Annual Summaries, 1950 - 1987 (U. S. Department of Commerce, 1951 to 1988).

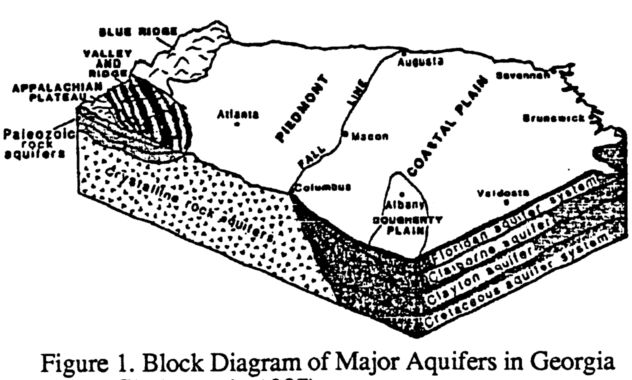

Figure 1. Block Diagram of Major Aquifers in Georgia (From Clarke et al., 1987)

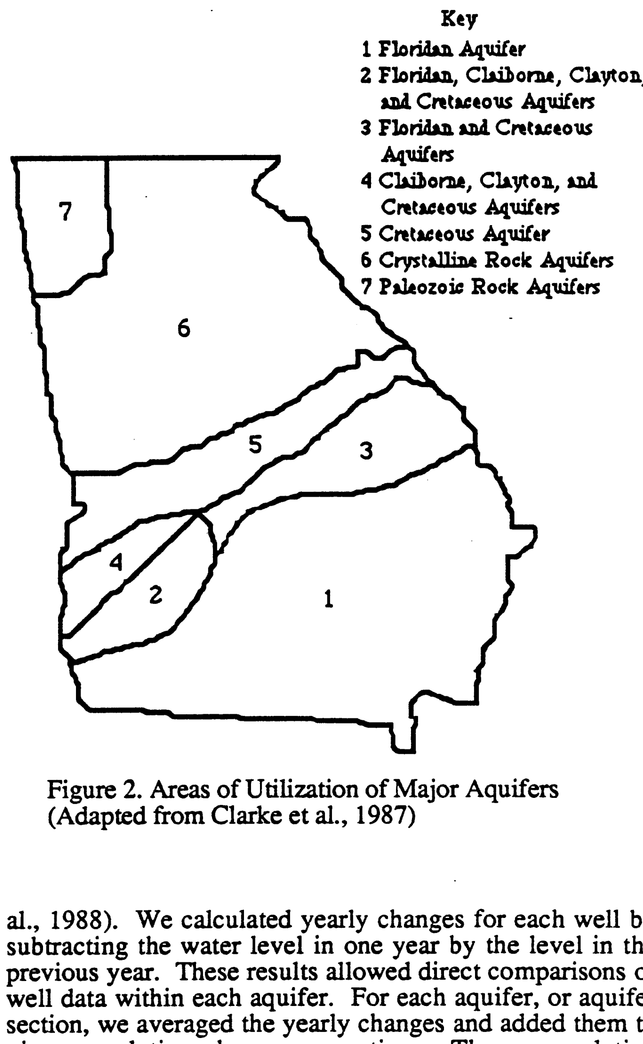

Figure 2. Areas of Utilization of Major Aquifers (Adapted from Clarke et al., 1987)

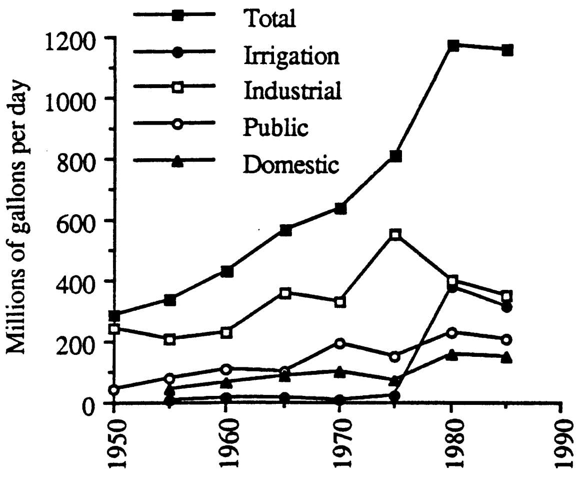

Figure 3. Estimated Ground-Water Withdrawals in Georgia.

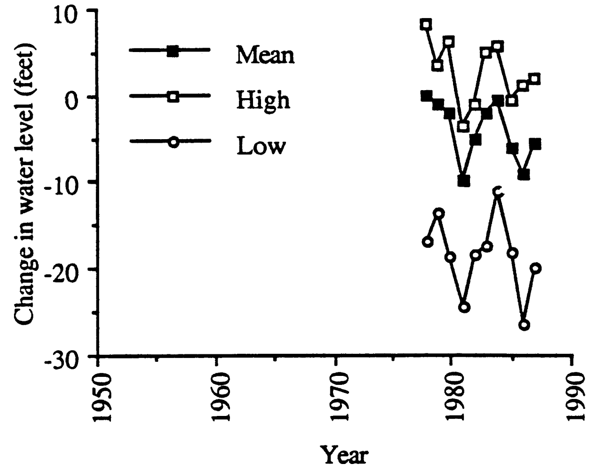

Figure 4. Claiborne Aquifer, Cumulative Average Ground-Water Level Change in Three Wells.

RESULTS AND DISCUSSION

The four main uses of ground-water are 1) irrigation--which is expanding in the coastal plain of Georgia, 2) industrial--both along the coast and inland, 3) public--which includes municipal water systems, and 4) domestic--private wells for home use (Figure 3). Estimates for uses are included in reports issued every 5 years by the U. S. Geological Survey (Solley et al., 1983). The major change in the past decade is the dramatic increase of irrigation beginning in 1975 and peaking in 1980. Industrial use has been the largest consumer of ground-water since estimates were first made. Industrial withdrawals peaked in 1975 and have declined ever since. Both public and domestic use have steadily increased from the early 1950s.

The Claiborne Aquifer is mainly utilized in the area of recharge. Because of good recharge and the lack of any long term data, we cannot define any long term trends of water levels in this aquifer (Figure 4). However, irrigation use from this aquifer is increasing and monitoring should be intensified.

Water levels in the Cretaceous aquifer have steadily declined about 12 feet since the mid 60s (Figure 5). High and low readings in the aquifer are very close to the mean, suggesting that there is a steady withdrawal over time, primarily from municipalities and industries (Clarke et al. 1987). The decline has been steady indicating that withdrawals have been out pacing the recharge by about 1/2 foot per year.

Water levels in the Clayton aquifer declined from 1956 to 1981 by almost 60 feet (Figure 6). Before 1975 the rate of decline was approximately 1 foot per year. The dramatic increase in this rate of decline to 6 feet per year, between 1975 and 1980, coincided with increased irrigation withdrawals. Such a rapid decline indicated that water was being mined and not replaced. Fortunately, since 1981 the water level has remained constant and even increased, indicating that withdrawals now equal recharge.

The Floridan Aquifer is the most utilized of the four aquifers. Different trends in water levels were observed in different sections of this aquifer, moving from west (near the recharge area), to east. In the southwest region of the aquifer, no defined trends were observed indicating good recharge (Figure 7). Some of the water level fluctuations can be directly related to changes in rainfall (Figure 8). The high water levels of the 1960s and 1980s occurred during years of high rainfall, while low water levels in 1970, 1981, and 1986, occurred during drought years. In the south central region the year to year water level variability is much less (Figure 9). This may be attributed to a damping effect caused by the longer period of time that it takes ground-water to reach this region from the recharge zone. Again most of the variation seems related to changes in rainfall, with high ground-water levels occurring in wet years and

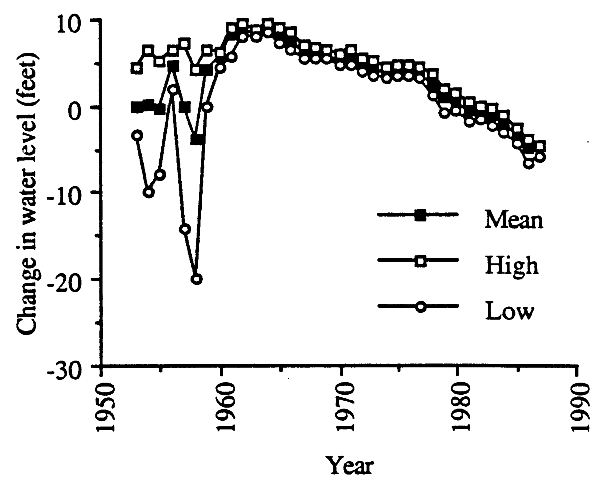

Figure 5. Cretaceous Aquifer, Cumulative Average Ground-Water Level Change in Three Wells.

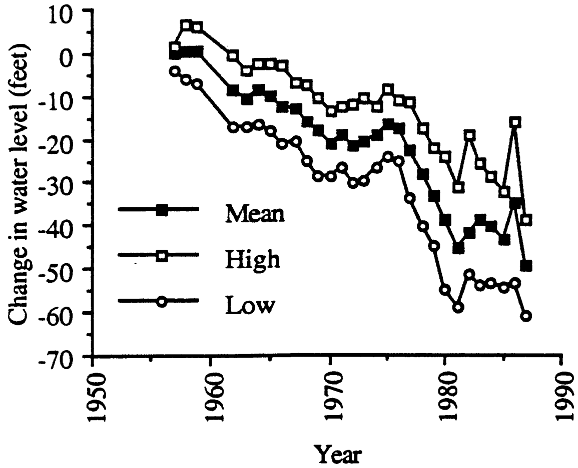

Figure 6. Clayton Aquifer, Cumulative Average Ground-Water Level Change in Four Wells.

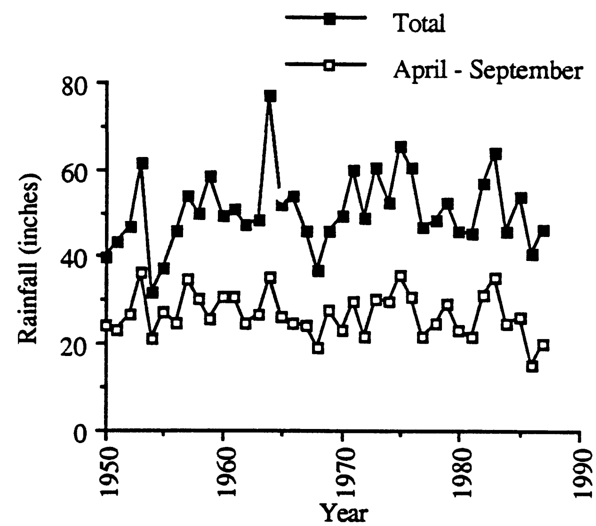

Figure 8. Rainfall in Southwest Georgia.

low ground-water levels occurring in dry years. After 1975 water levels began to decline as irrigation increased. A decline is more evident in the east central region of the Floridan aquifer (Figure 10). The variability between yearly lows and highs is greater than in the southwest region (Figure 7), and is presumably caused by irrigation in the summer followed by recharge in the winter (Clarke et al., 1987). Finally, in the Savannah area water levels have declined from 1955 onward (Figure 11). The decline was rapid from 1955 to 1964 at a rate of about 3 feet per year. Since 1965 the decline has slowed to about 1/2 foot per year. The increased use of ground-water in the Floridan Aquifer has clearly led to declines in water levels (withdrawals exceeding recharge) going from west to east. Further declines in ground-water levels from increased population and industrial development could increase chances of salt water intrusions, disaster for coastal cities that must be avoided at all costs.

CURRENT REGULATION AND NEEDS FOR THE FUTURE

The use of ground-water for all purposes needs to be monitored and controlled more closely so that the valuable resource of this water will be available for years to come. Recent changes in the permitting requirements for ground-water use are a step in the right direction. Municipalities and industries that withdraw 100,000 gallons of groundwater per

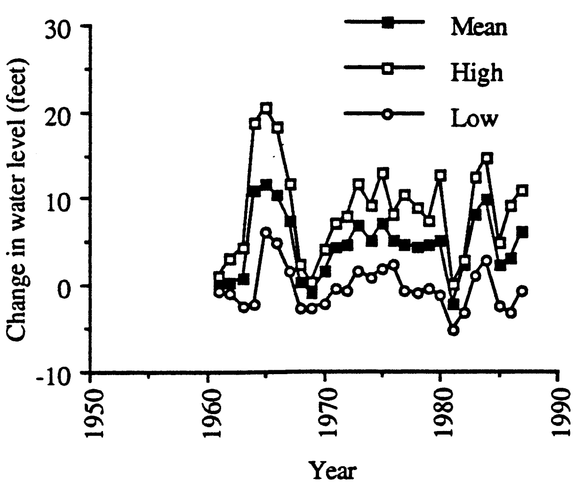

Figure 7. Floridan Aquifer, Southwest Region, Cumulative Average Ground-Water Level Change in Six Wells.

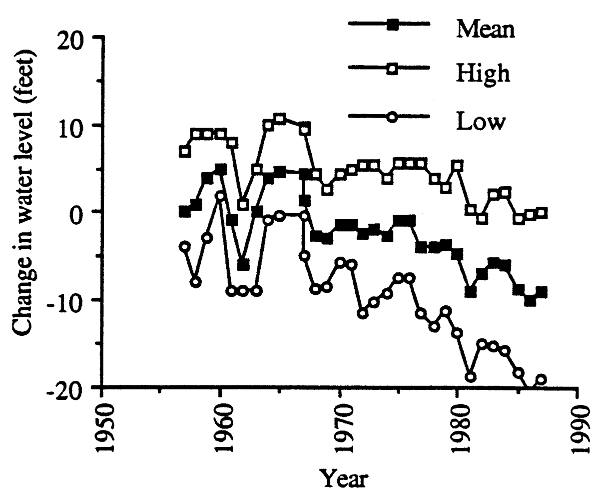

Figure 9. Floridan Aquifer, South Central Region, Cumulative Average Ground-Water Level Change in Four Wells.

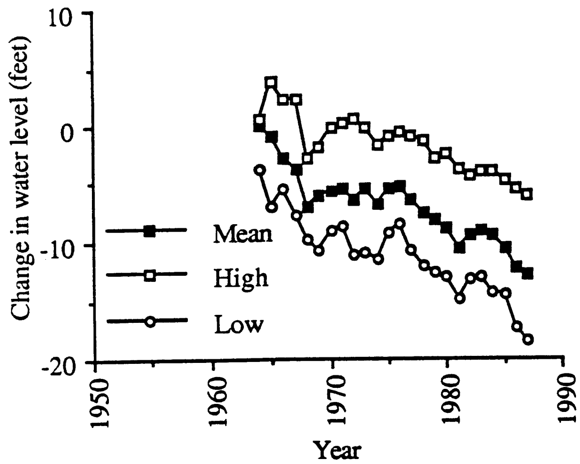

Figure 10. Floridan Aquifer, East Central Region, Cumulative Average Ground-Water Level Change in Three Wells.

day from a single well must apply for a permit. Prior to 1989 no permit was needed if ground-water was used for irrigation, even if the amount withdrawn exceeded 100,000 gallons per day. Recent changes in the law now encourage farmers with existing wells to apply for permits, and also require permits for new irrigation wells that exceed the 100,000 gallons per day withdrawal limit. Permitting helps provide a basis for assessing use but does nothing to promote conservation.

Maintaining aquifer levels is especially urgent at this time when droughts are becoming more frequent because of global warming, and the demand for irrigation increases. Improving regulation is part but not all of the answer. Reducing current wasteful use is equally important. Large

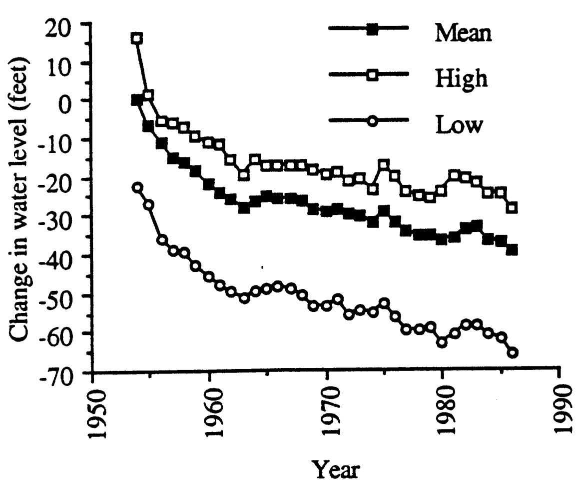

Figure 11. Floridan Aquifer, Savannah Area, Cumulative Average Ground-Water Level Change in Three Wells.

users such as paper mills should be encouraged to use more surface water, and to recycle water. Conservation of ground-water for domestic, agricultural, and municipal use should also be stressed. Now is the time to consider various options that are both "carrot" (incentives) and "stick" (regulation), before the situation becomes really critical. Prevention is worth millions of dollars of cure. Georgia's underground water is one of its most valuable resources--more valuable in the long run, than oil.

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