TRENDS IN STREAMFLOW AND RESERVOIR CONTENTS
IN THE RIO GRANDE BASIN, NEW MEXICO

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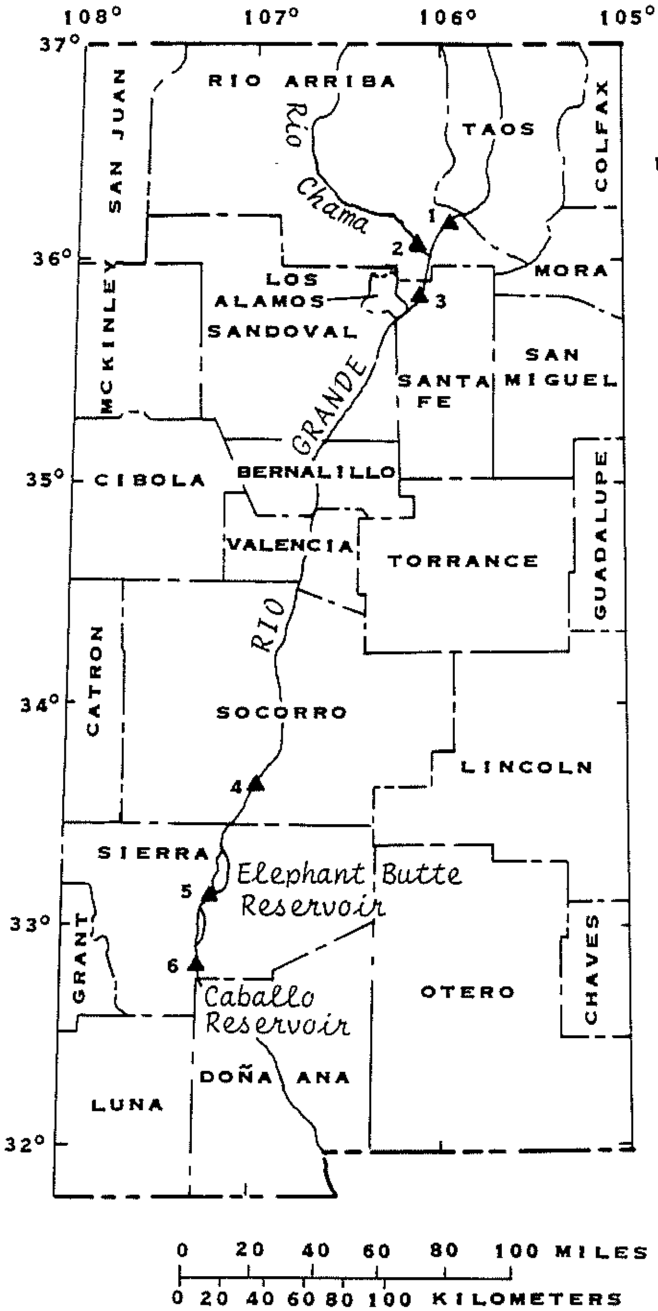
Introduction

Streamflow data have been collected in the Rio Grande basin since 1888 when the site of the gaging station near Embudo was chosen as the training center for the first hydrographers of the U.S. Geological Survey. Continuous records of discharge have been collected there since January 1889. Since then, numerous additional stations have been added to the network in order to gage the discharge the Rio Grande and its tributaries. In the New Mexico part of the Rio Grande Basin upstream from the gaging station below Caballo Dam, there are 18 streamflow-gaging stations on the Rio Grande and 60 stations on its tributaries (1984 figures). In addition, there are 12 stations on reservoirs where reservoir-stage and contents data are obtained. However, some data are collected by the U.S. Army Corps of Engineers and the U.S. Geological Survey.

Records collected at the gaging stations provide a continuous record of streamflow and reservoir contents from which long-term trends and changes can be evaluated and from which short-term water-management decisions can be made. This paper graphically presents the data for selected long-term stations in the basin from which fluctuations in streamflow and water levels may be seen and trends may be inferred. No attempt has been made to evaluate the causes for any changes that might be indicated by the record.

Although more than 70 gaging stations are operated in the Rio Grande Basin, many of the stations have a relatively short period of record, the records have not been collected continuously over the years, or the records have not been collected during winter months. This evaluation of records was limited to stations that had a long continuous record, that provided a representative sample of conditions in the basin as a whole, and that provided as broad an areal coverage as possible. Location of the stations selected is shown in figure 1.

Streamflow varies greatly from year to year. For example, figure 2 shows the variations in annual mean discharge for the period 1913-1985 for the Rio Grande at Embudo. As shown, large changes occur with discharges going from well above the long-term average discharge to well below the average from one year to the next. These wide variations in discharge make the record difficult to analyze visually. For this reason, the five year moving average of the annual mean discharges was used to present streamflow trends. The five year moving average is the average of five years of data plotted at the midyear. For example, the average of the annual mean discharges for the five water years 1950-54 is plotted at 1952. Similarly, the average



EXPLANATION

1▲ GAGING STATION AND MAP NUMBER

Map number	Gaging-station name
1	Rio Grande at Embudo
2	Rio Chama near Chamita
3	Rio Grande at Otowi Bridge
4	Rio Grande at San Marcial
5	Elephant Butte Reservoir
6	Rio Grande below Caballo Dam

Figure 1. Location of gaging stations.

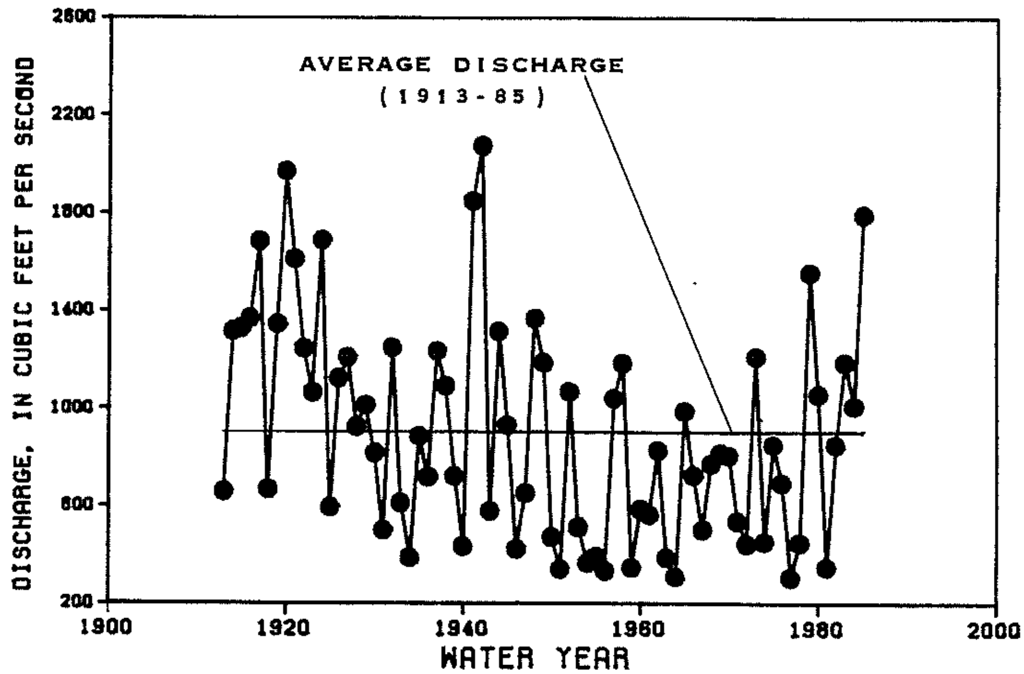


Figure 2. Annual mean discharge of Rio Grande at Embudo, 1913-85.

for 1951-55 period is plotted at 1953. For each successive year, a new five year average is determined and plotted at the midyear of the five year period. The five year moving average does not show the discharge for any given year, but is a smoothing technique for illustrating streamflow patterns and for detecting trends in streamflow.

The five year moving average of annual mean discharges for the Rio Grande at Embudo is shown in figure 3. Comparison of figure 3 and figure 2 illustrates the application of the five year moving average. As shown in figure 3, the earlier years of record (around 1920) and those around 1940 were higher than the long-term average. Discharges during recent years that have been above average (figure 2) are not reflected in figure 3 except as a rising trend since about 1980. Here, the averaging technique dampens the impact of the high discharge of 1985 (figure 2). If the above-average discharge pattern continues, the weight of additional years of high discharge will be reflected in a continued upward trend in the five year moving average (figure 3). It will be noted for example that the mean discharge for 1985 was about 1,800 cubic feet per second. This is higher than any peak shown in the five year moving average.

The hydrograph of the five year moving average for the Rio Chama near Chamita, a tributary of the Rio Grande, is

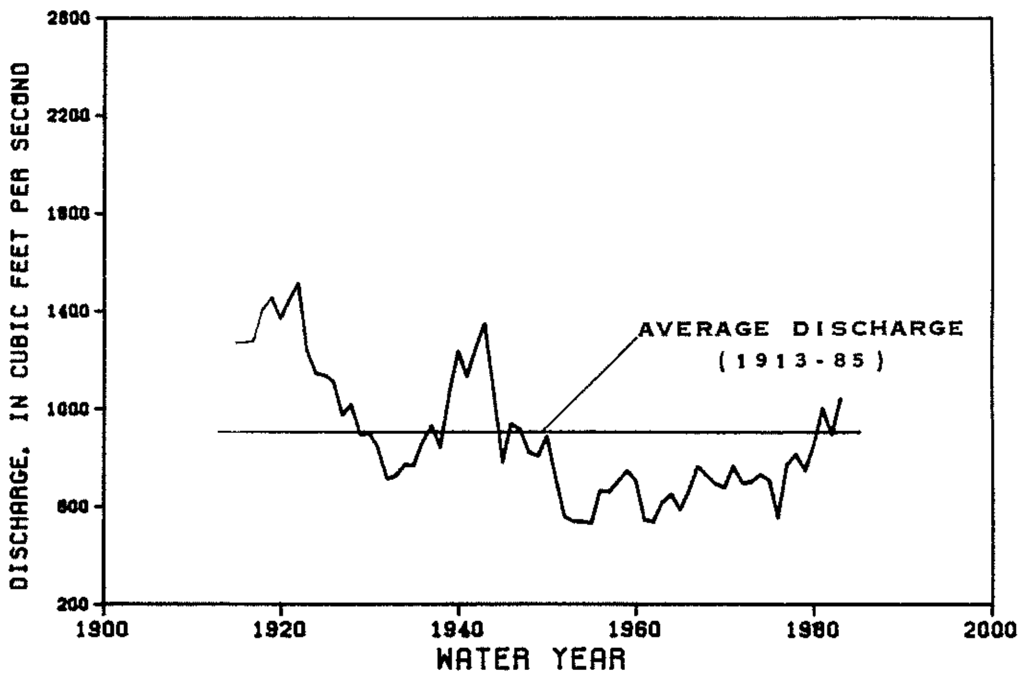


Figure 3. Five year moving average of annual mean discharge of Rio Grande at Embudo.

shown in figure 4. Hydrographs of the five year moving average for the Rio Grande at Otowi Bridge and Rio Grande at San Marcial are shown in figures 5 and 6, respectively. Although the periods of record for each gaging station are not the same, the patterns for concurrent periods reflect similar trends. In general, the hydrographs indicate high discharge around 1920 and 1940 and a somewhat lower discharge during the intervening years. From about 1945 to 1978, annual mean discharge generally was low; as reflected by the hydrographs, discharge was less than the long-term average (figures 4 - 6). Since 1978, streamflow has generally been increasing to well above average discharge.

The five year moving average of annual change in contents in Elephant Butte Reservoir is shown in figure 7. In general, the trends shown are similar to those for the streamflow-gaging stations with increases to decreases in contents following above and below average streamflow. The pattern, however, is somewhat more irregular probably due to releases or gains in storage.

The five year moving average for the Rio Grande below Caballo Dam, the most downstream streamflow-gaging station summarized, is shown in figure 8. The hydrograph does not show as much above-average streamflow after about 1980 as noted for the other streamflow-gaging stations. Some of this is primarily due to patterns of release from Elephant Butte and Caballo Reservoirs.

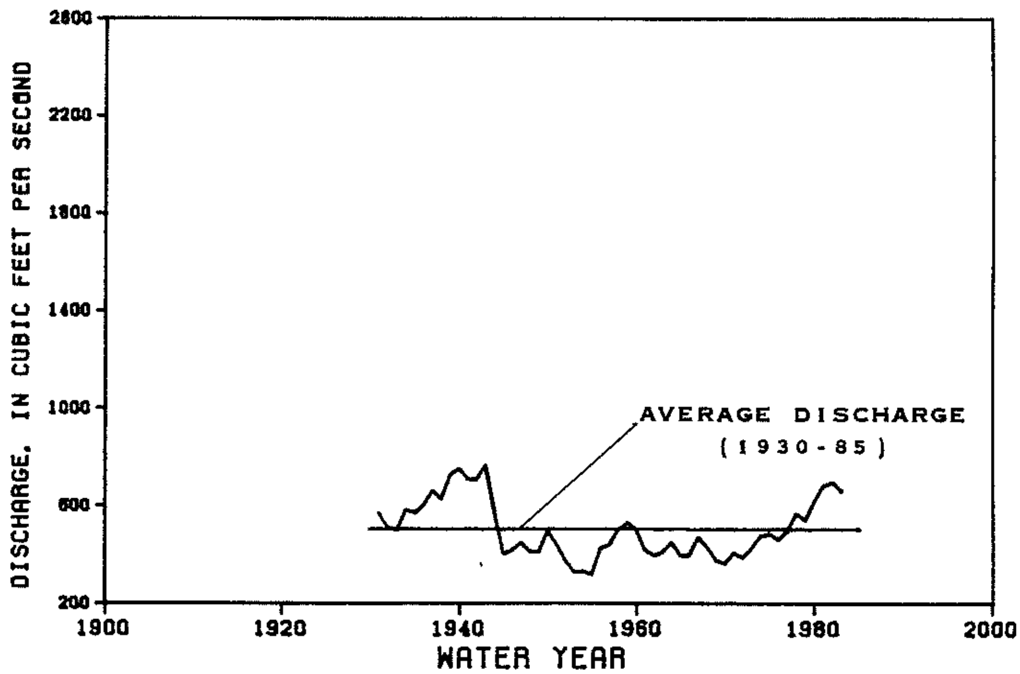


Figure 4. Five year moving average of annual mean discharge of Rio Chama near Chamita.

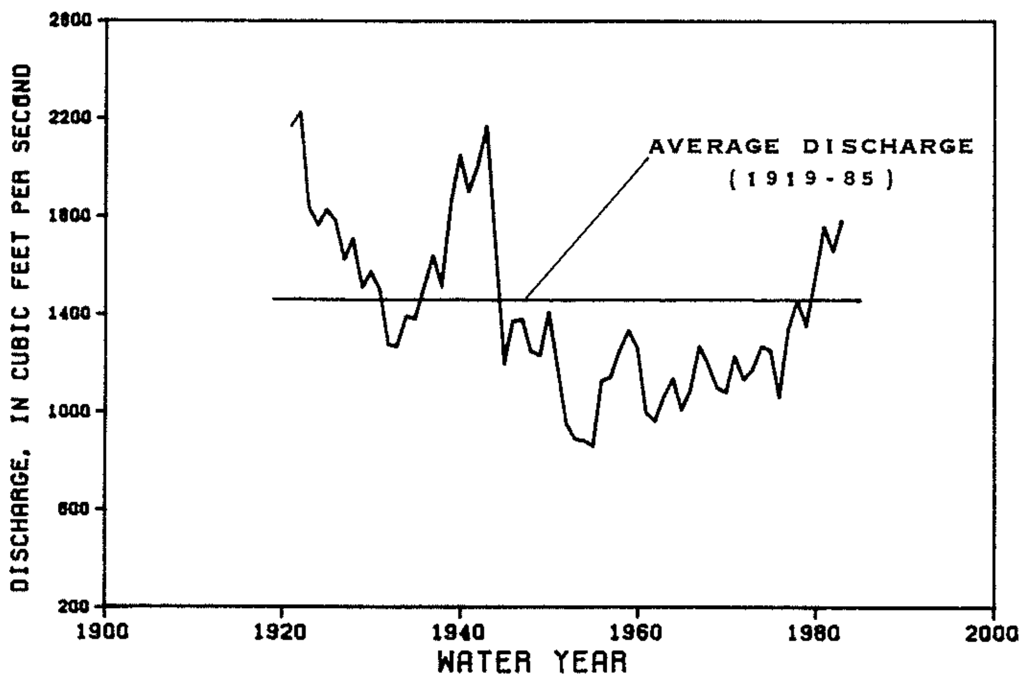


Figure 5. Five year moving average of annual mean discharge of Rio Grande at Otowi Bridge.

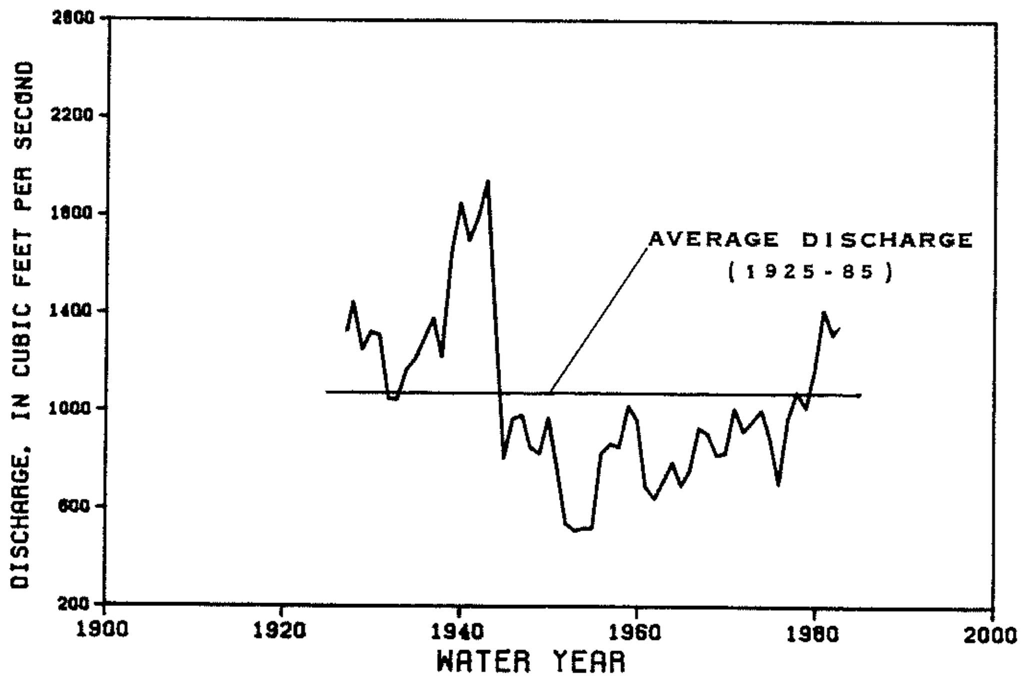


Figure 6. Five year moving average of the annual mean discharge of Rio Grande at San Marcial.

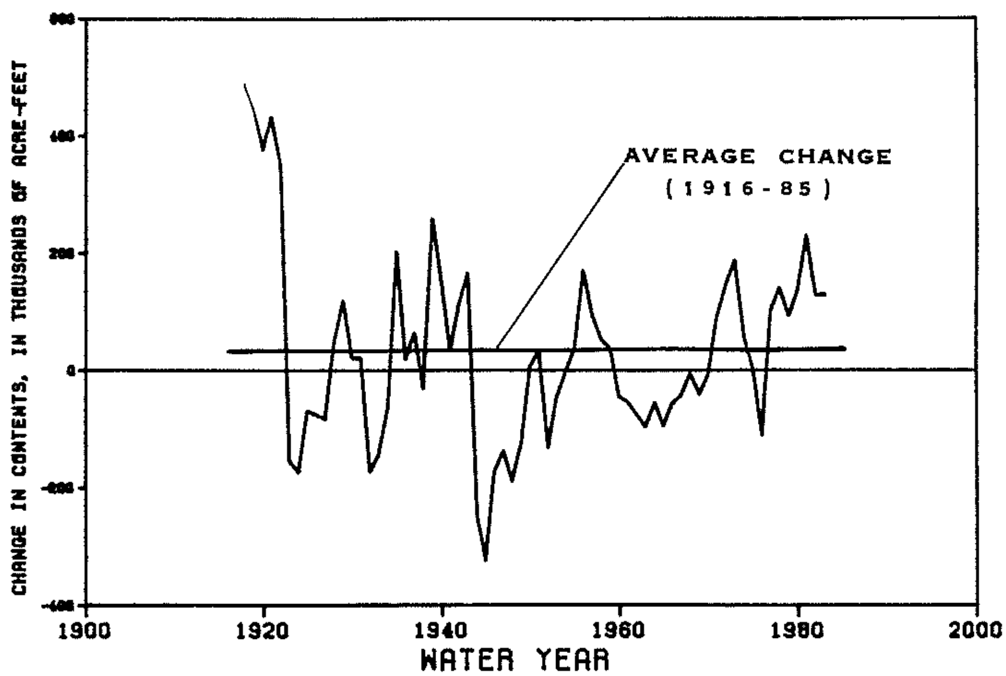


Figure 7. Five year moving average of annual change in contents of Elephant Butte Reservoir.

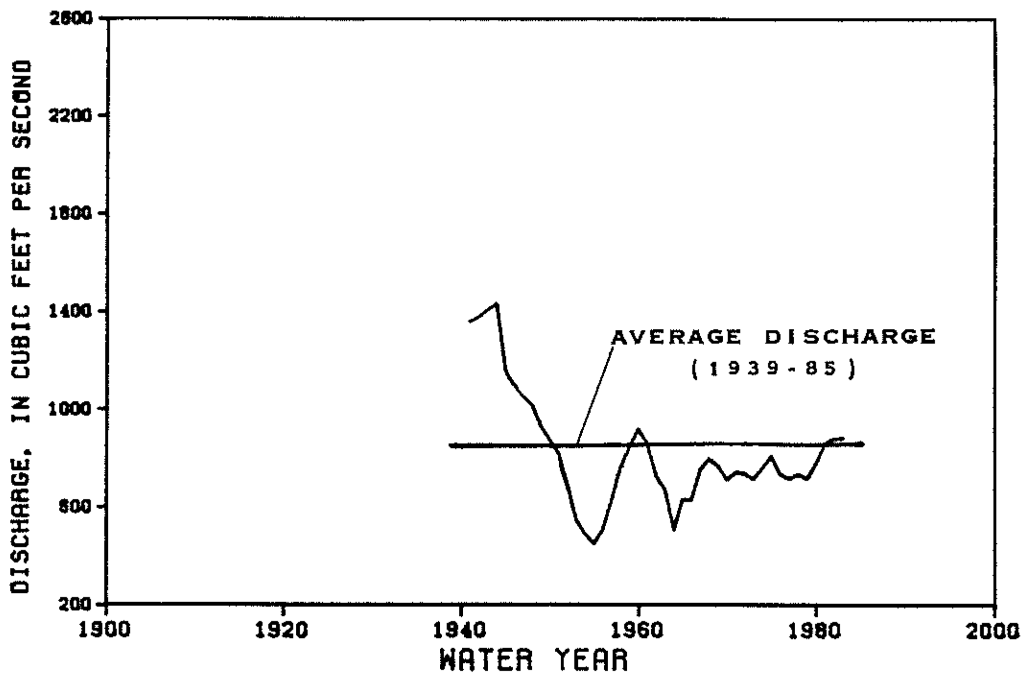


Figure 8. Five year moving average of the annual mean discharge of Rio Grande below Caballo Dam.