Weather and Climate (1994) 14: 22-25

ASSESSMENT OF THE SIGNIFICANCE OF THE 1994 DROUGHT IN AUCKLAND

Anthony Fowler

Department of Geography, University of Auckland

Mid-1994, near the height of Auckland's water supply "crisis", statements were being made to the effect that the region was in the midst of a 100-year drought. This claim surprised some climatologists and hydrologists and prompted a number of investigations into the magnitude of the drought. Results from analysis of the longest rainfall record available in the region (Albert Park) are presented here; results which raise some rather interesting questions.

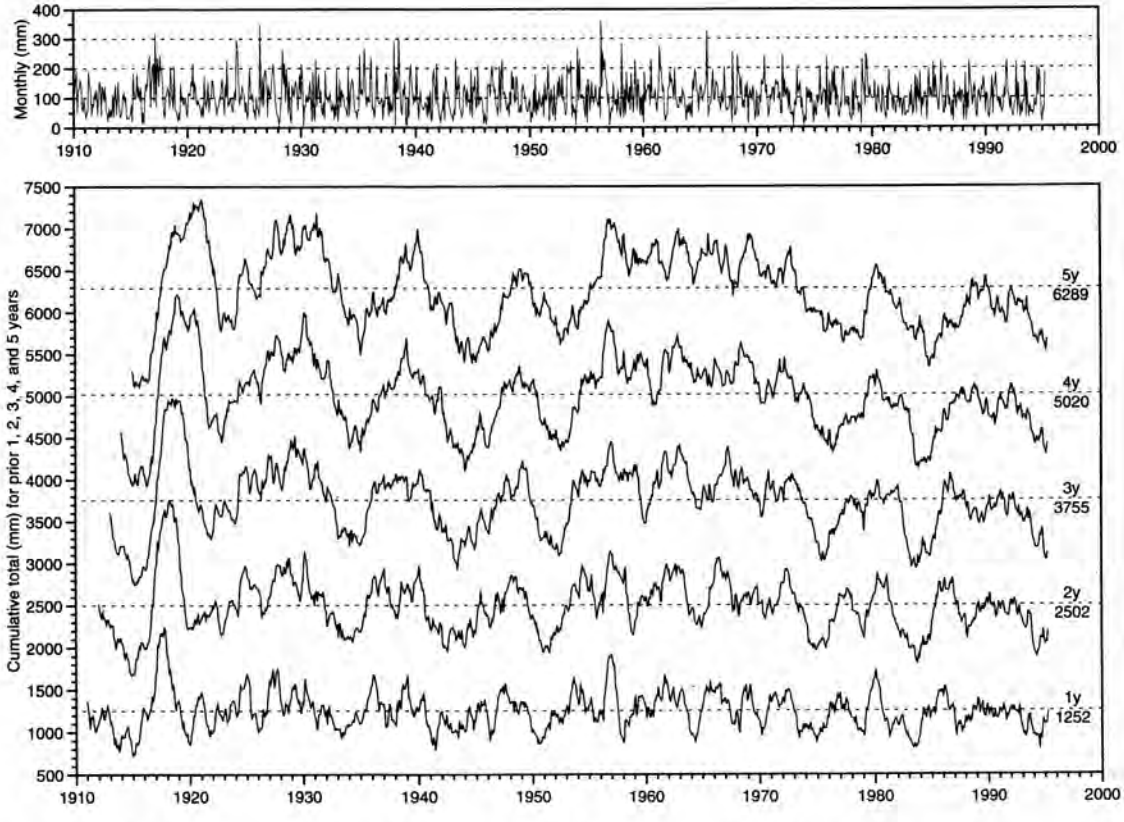

Figure 1: Rainfall totals for Albert Park (1910-1995) summed over the preceding 1 through 5 years. Totals are calculated from monthly totals and assigned to the end of the last month of record. Thus, the 5-year total 1990-1994 rainfall is plotted at the end of 1994. Dashed lines give mean total rainfall for the respective periods, calculated for the period 1920-1990. Wetter than mean 1920-1990 conditions plot above this line, drier below.

Closer inspection of the 100-year drought claim reveals that it was based on analysis of rainfall records in the Hunua Ranges, dating from 1928. As with all droughts, assessment of severity (hence return period) is in part a function of the duration being considered. In this case the drought was most significant for durations of about two years, with total rainfall over 20 months reported to be the lowest on record (NZ Herald 30.7.94).

The Hunua Ranges are the main water source area for Auckland - hence the focus on rainfall records available for that region. Droughts though are regional-scale phenomena and much useful information can often be gleaned from analysis of longer-term records available for more distant sites. This is especially so when assessing the significance of relatively rare events, as in this case.

Figure 1 shows 1 through 5 year rainfall totals for Albert Park, calculated from monthly data from January 1910 to March 1995. Interestingly, there are drier periods in the 1910-1995 record than the 1994 drought for all five durations plotted. Particularly noteworthy is the 1913-15 drought which stands out clearly as the most severe drought on record.

Also evident from Figure 1 is the significance of duration when assessing drought severity. For example, minimum rainfall totals associated with the 1994 drought for durations of one and two years exceed minimums recorded during two other droughts. For durations of three, four, and five years, there were respectively five, three and four more significant droughts in the period 1910-1990 than that experienced in 1994.

Contrary to the Albert Park results presented here, rainfall records in the Hunua Ranges apparently indicate that the 1994 drought was more significant than that in 1983, for durations around 2 years. However it is reasonable (and prudent) to assume that the 1913-15 drought was regionally the most significant event since 1910. It follows that, at worst, the 1994 drought is only the second largest event in 85 years. If durations of three or more years are most relevant, as indicated by ARA (1988), then a return period of about 30 years is suggested.

Although the Albert Park rain-gauge has been in its present location only since late 1909, rainfall data nominally assigned to

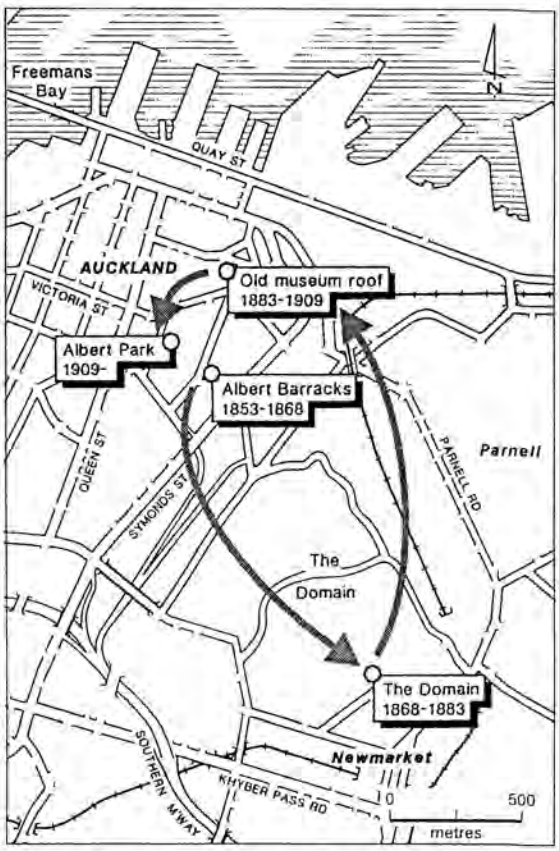

Figure 2: Albert Park site location changes. Modified after Hessell (1988).

"Albert Park" goes back to 1853 at three other nearby sites (Figure 2). Between 1853 and 1868 rainfall was recorded at "Albert Barracks", quite close to the current gauge location. In 1868 the recording site was moved about 2.5 km to the "Auckland Domain" where it remained until 1883. Between 1883 and 1909 the recording site was at the "Old Museum" location. It moved less than half a kilometre to its present location in 1909.

Hessell (1988) notes that rainfall observations from the three earlier sites are "rather unsatisfactory", especially between April 1883 and August 1909 when the rain-gauge was located on a roof! Probable homogeneity problems are confirmed by the simple mass curve analysis of the monthly rainfall data shown in Figure 3. Specifically, breaks in slope and differences in slope corresponding to different recording sites

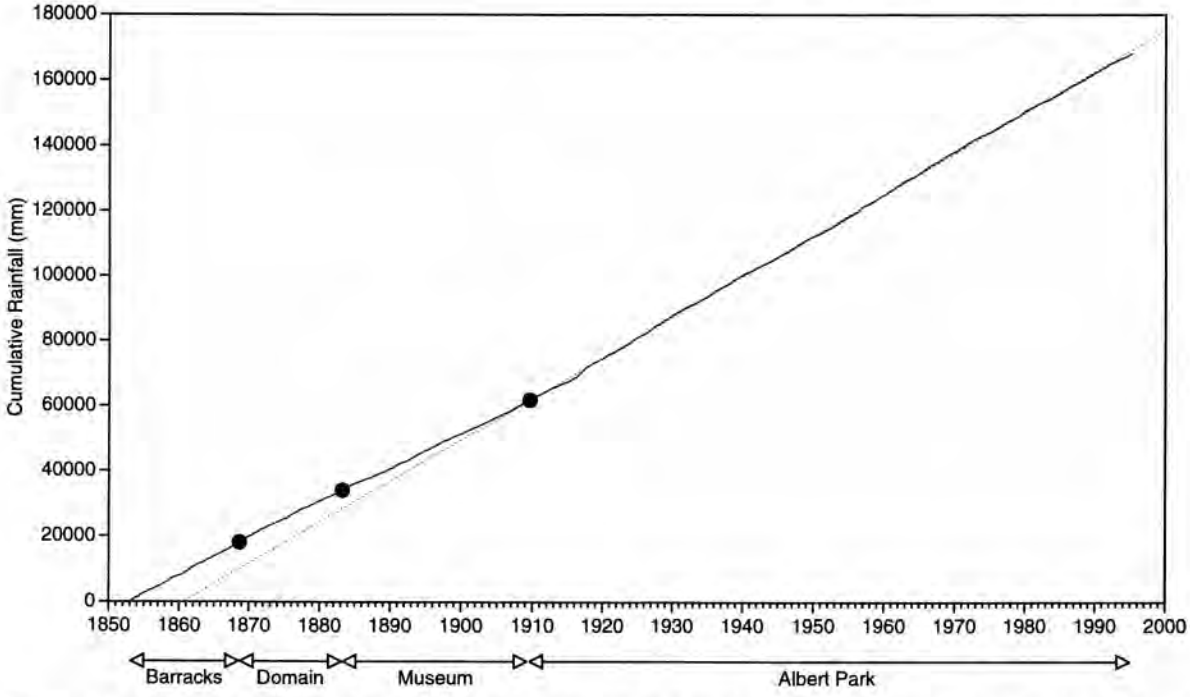

Figure 3: Mass curve analysis of Albert Park rainfall 1853-1995. The solid line shows cumulative rainfall calculated and plotted month by month. Solid dots denote sites changes, labelled at the bottom of the graph and described in the text. The dashed line is the best-fit least-squares linear regression line fitted to the data for the current Albert Park site (September 1909-).

suggests that the 1853-1995 daily rainfall time series should not be treated as a single homogeneous record.

In the case of the "Old Museum" record, under-measurement of rainfall would be expected to result from rooftop exposure of the rain-gauge. Wind-field deformation by rain-gauges typically leads to under measurement of rainfall, a feature which increases with wind speed and hence exposure of the gauge (Sevruk 1982). A 20% upward adjustment of the rainfall data from the museum site is required to "correct" for under measurement (Hessell 1988).

Dealing with the data from the Auckland Barracks and Domain sites is more problematic. Again, slopes in Figure 3 are less than for the 1909-1995 period as a whole, suggesting possible under-measurement relative to the latter period. The difference is most pronounced for the Domain record and noteworthy given that mean annual rainfall maps, such as that presented by Hessell (1988) show an increase in rainfall south of Albert Park. On the other hand, closer inspection of Figure 3 also indicates periods since 1909 when the slope is comparable to these earlier periods (since about 1980 and especially 1909-1915). It is plausible then that these earlier records are in fact indicative of a period of lower rainfall of the order of 10-17% rather than a homogeneity problem.

In the context of water resource planning, the problem caused by uncertainties about the quality of the pre-1909 rainfall record is clearly demonstrated in Figure 4. Here the plot shown in Figure 1 for a duration of two years has been extended back to 1853 using the additional data detailed above. The solid line is for the data as recorded while the dashed line is a revised plot for the April 1883 to August 1909 period following scaling up of the Museum Roof data by 20%. The upper dashed line is the mean rainfall total for two years, calculated over the period 1920-1990.

The lower dashed line in Figure 4 corresponds to the minimum rainfall over a 2 year period recorded during the 1994 drought

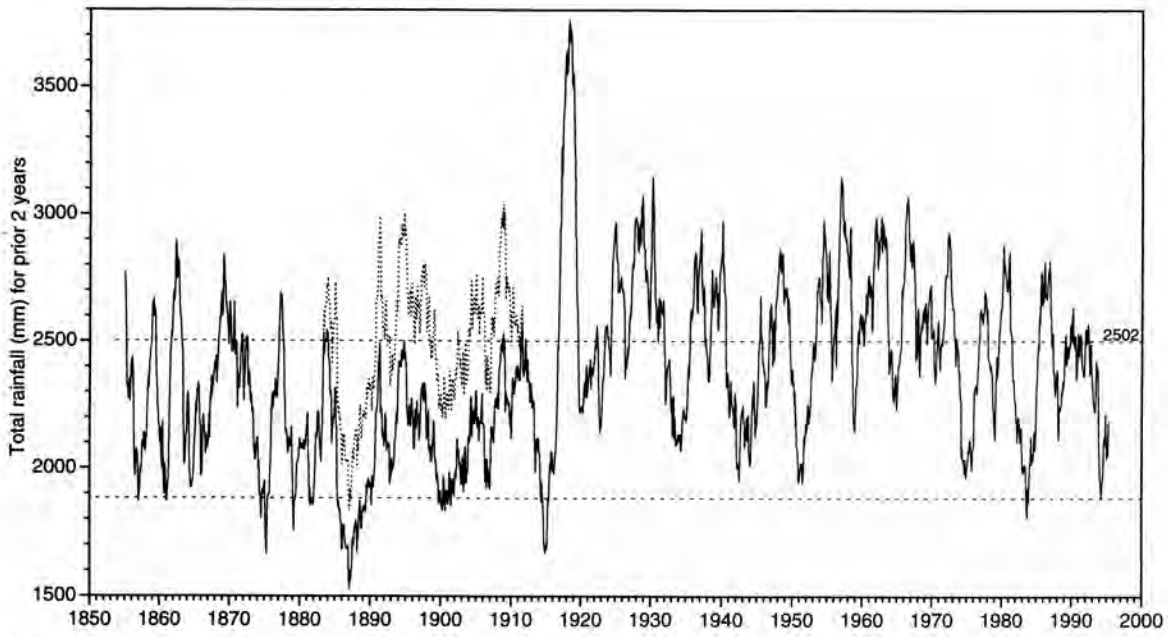

Figure 4: Rainfall totals for Albert Park (1853-1995) summed over the preceding 2 years. Totals are calculated from monthly totals and assigned to the end of the last month of record. The upper dashed line denotes mean total rainfall over two years, calculated for the period 1920-1990. The lower dashed line corresponds to the minimum rainfall over a 2 year period recorded during the 1994 drought (1885 mm).

(1885 mm). Using the adjusted data for the period 1883-1909, Figure 4 shows six droughts in the second half of the nineteenth century more significant than the 1994 drought. This would make the 1994 drought only the ninth most significant in 144 years (less than a 20-year event). However, if the pre-1883 data were also scaled up to give the same mean rainfall as 1909-1995 then only one further drought (ca. 1887) would be larger than the 1994 drought. Added to the two twentieth century droughts (ca. 1915, 1983), this would suggest a 30-year to 40-year event in 1994. Moreover, if one accepts that the 1994 drought was in fact more significant in the Hunua Ranges than the 1983 drought, then perhaps only the 1914/15 drought is more significant, which makes a 100-year event for a duration of two years more plausible.

Water resource planners are faced with a dilemma. Should they treat the late nineteenth century record as reasonable, indicative of a somewhat drier climate regime than experienced most of this century? Or should they treat the early rainfall data as suspect and either exclude it from consideration or adjust it upwards to conform with the pattern exhibited by more recent records. A precautionary approach would perhaps suggest the former, ensuring that planning is not based on what may be a recent atypical wet period. A rather more sophisticated analysis than that presented here is required to answer such questions. But, quite clearly, the result of any such analysis will be highly sensitive to the approach adopted and will have a major impact on any assessment of the significance of past and future droughts.

REFERENCES

ARA, 1988: Auckland Regional Authority future bulk water supply study: phase 4, scheme selection and environmental impact assessment. *Auckland Regional Authority*, Auckland.

Hessell, J.W.D., 1988: The climate and weather of the Auckland region. Miscellaneous Publication 115(20). *New Zealand Meteorological Service*, Wellington.

Sevruk, B., 1982: Methods of correction for systematic error in point precipitation measurement for operational use. *Operational Hydrology Report 21, World Meteorological Organisation*, Geneva.