Revision of Design Rainfalls for Australia: a Pilot Study – Part 2

Karin Xuereb, Brian Taylor, Dörte Jakob

Bureau of Meteorology, Melbourne, Victoria, Australia

Introduction

The design of hydraulic structures such as bridges, stormwater drains, dams and roof gutters, requires design rainfalls. Design rainfalls are expressed in terms of depth or intensity for a given duration and they have associated with them a return period or probability. The current design rainfalls provided by the Bureau of Meteorology were published in Chapter 2 of Australian Rainfall and Runoff in 1987 (Institution of Engineers, 1987). It is of interest to explore how design rainfalls would differ with the extra 20 years or so of data available since the publication of Australian Rainfall and Runoff, Chapter 2 and with the evolution of techniques used in producing design rainfalls.

The Hydrometeorology Section of the Bureau of Meteorology commenced a pilot study in 2002 covering southeastern Queensland and northern New South Wales to explore new methods in producing design rainfalls (Jakob et al, 2005).

Data

To produce design rainfalls for periods shorter than 24 hours, it is necessary to have available digitised up-to-date pluviograph data. One problem has been the large backlog in digitising the data by Data Services Section of the National Climate Centre owing to lack of resources. The backlog is now diminishing at a very rapid rate compared with a few years ago. All data within the pilot area has been digitised. The Tully region, the Sydney area have also been digitised. Currently Victoria and the southern New South Wales/Victoria regions are being digitised. (Refer Figure 1). The aim is to have pluviograph data for the entire country digitised within a few years.

For the pilot area, pluviograph data was supplemented with ALERT (Automated Local Evaluation in Real Time) data used by the Bureau of Meteorology Flood Warning network, as well as data supplied by Department of Infrastructure Planning and Natural Resources, NSW (DIPNR) and the Department of Natural Resources and Mines, Queensland (DNRM).

Regional frequency analysis

For each standard duration, the annual maximum series at each site is used to calculate L-moments. (The L in L-moments stands for linear combinations of ordered data values). Site frequency analysis is unreliable when the period of record is short, particularly for larger ARIs, say 50 years. Regional frequency analysis overcomes this limitation by using data from within a region to calculate regional L-moments for each site. Regional L-moments are then used to derive the regional growth curve, which, when scaled using a scaling factor, such as the mean or median, gives the variation in rainfall depth with probability or return period for a location.

One technique commonly used in regional frequency analysis is the so-called ‘region of influence’ or ‘circles’ approach. At each site, data from sites within a circle of a specified...
radius is pooled together and a regional growth curve constructed. By pooling the data together in this way, it is assumed that all the sites within the region are statistically similar. To test this assumption, homogeneity tests are applied to each region.

Figure 1. Progress in digitisation of Bureau of Meteorology pluviograph data.

Application of regional frequency analysis to the pilot area for a duration of 24 hours

For the pilot area, at a duration of 24 hours, the circles approach was applied and a regional frequency curve derived at each site. Using the homogeneity measure, H1 (Hosking and Wallis, 1997) homogeneity was satisfied in 512 of 547 cases. For the 35 cases where homogeneity tests failed, a so-called ‘modified circles’ approach was tested. In this approach, sites were selected and pooled together if they were in a similar topographic rainfall regime to the site of interest. Figure 2 shows different selections of sites using the circles approach (white dots) and modified circles approach (dark stars) for station 041387.

All 35 cases which had initially failed the homogeneity test using the ‘circles’ approach, passed the homogeneity test when the technique of ‘modified circles’ was applied to them.

The performance of the two regionalisation approaches was then assessed to determine whether the improvement in homogeneity would translate to an improvement in the quantile (or rainfall) estimates. The quantiles for 10 and 20 year ARIs were compared with quantiles obtained using site frequency analysis, the assumption being that at low ARI, the quantiles obtained using site data only should approach the true values. It was found that both approaches performed similarly. Since the ‘modified circles’ approach is much more time consuming than the ‘circles’ approach, it was decided to apply the ‘circles’ approach also to the 48 and 72 hour durations.
Mapping the results for the 24 hour duration

Figure 3a shows the 24 hour 100 year rainfall field gridded using the technique of thin-plate spline smoothing (Hutchinson, 2004). Figure 3b shows the 24 hour 100 year rainfall field from Australian Rainfall and Runoff Chapter 2. Dark shading indicates high values.

Figure 3a has been gridded using Anusplin 4.3 which is an objective analysis technique. Figure 3b from Australian Rainfall and Runoff 1987, was analysed by hand using meteorological judgement in data sparse areas. Generally design rainfalls using the new technique are higher along the coast between 27.5 and 29.0 degrees South by about 50 mm.
The feature between 28.0 and 28.5 degrees South and 153.0 and 153.5 degrees East is analysed differently in Figures 3a and 3b. The high values in Figure 3a are more strongly correlated with regions of high elevation than in Figure 3b. The centres of high rainfall in Figure 3b occur eastward of the elevated areas. The density of observations is not high enough to determine conclusively which analysis is superior. Further investigation into the best approach for gridding the design rainfall field needs to be carried out.

**Further work**

The regionalisation process is being repeated for the other standard durations of 1, 2, 3, 6, 12, 48, and 72 hours. The differences between the results for the new method and the design rainfalls from Australian Rainfall and Runoff, 1987 need to be reconciled. Confidence intervals will be constructed and comparison with site estimates will also be carried out.

**References**


