Arcoona Creek Flood January 2017

Introduction

The Gammon Ranges are situated in the far northern Flinders Ranges and consist of a deeply dissected quartzite plateau with steep gorges and spectacular cliffs. The annual rainfall of the Arcoona Creek catchment area, which lies within the western Gammon Ranges varies from approximately 250mm to 330mm, based on the over 20 years of recorded data.

The Gammon Ranges project is managed by the Scientific Expedition Group (SEG), a volunteer organisation that aims to promote and run expeditions of a scientific, cultural and adventurous nature and to encourage knowledge and appreciation of the natural environment. This area was selected because it is less popular than the eastern part of the park which means that the scientific equipment is less likely to be disturbed and the data collection trip is in an area of near wilderness which adds to the experience for participants.

The program has gradually expanded to now include six activities:

- Servicing of pluviometers at eight sites,
- Botanical monitoring at six sites,
- Human impact monitoring at three sites,
- Stream-flow monitoring and electrical conductivity recording at one site,
- Yellow footed rock wallaby colony monitoring, and
- Feral animal counts and locations.

The project is described in detail in Kemp et al (2008), and on the SEG website http://www.communitywebs.org/ScientificExpeditionGroup/main.php?pid=14 .

All stream flow and rainfall data is stored on the DEWNR Water Connect website. The gauging station at Arcoona Creek (A0040520) now has 23 years of record.

The January 2017 Flood

In January 2017 a flood occurred that exceeded all previous recorded levels. This report places that 2017 flood in the context of the overall record, and provides an estimate of the potential frequency with which such a flood can occur. The peak depth in January 2017 at the gauging station was 2.16m, leading to a peak flow estimate of 113m^3/sec. To put this into context this means at the peak 113 tonnes of water were passing the gauging station every second.

Rainfall

The rainfall that occurred in January 2017 was very significant. Figure 1 shows the cumulative mean rainfall commencing on the 18th January at 00:00 hours. It was derived as a simple average of the recorded rainfall at four stations, the Exclusion Zone, Arcoona Bluff, Arcoona South and The Plateau. It shows that until 10:00pm on the 19th, there was about 5mm of rain. From 10:00pm on the 19th until 6:00am on the 20th about 45mm of rain was recorded. There was then a break until 11:00pm on the 23rd, when a very intense storm occurred that caused the flood, which peaked in Arcoona Creek at 2:00am on the 24th.

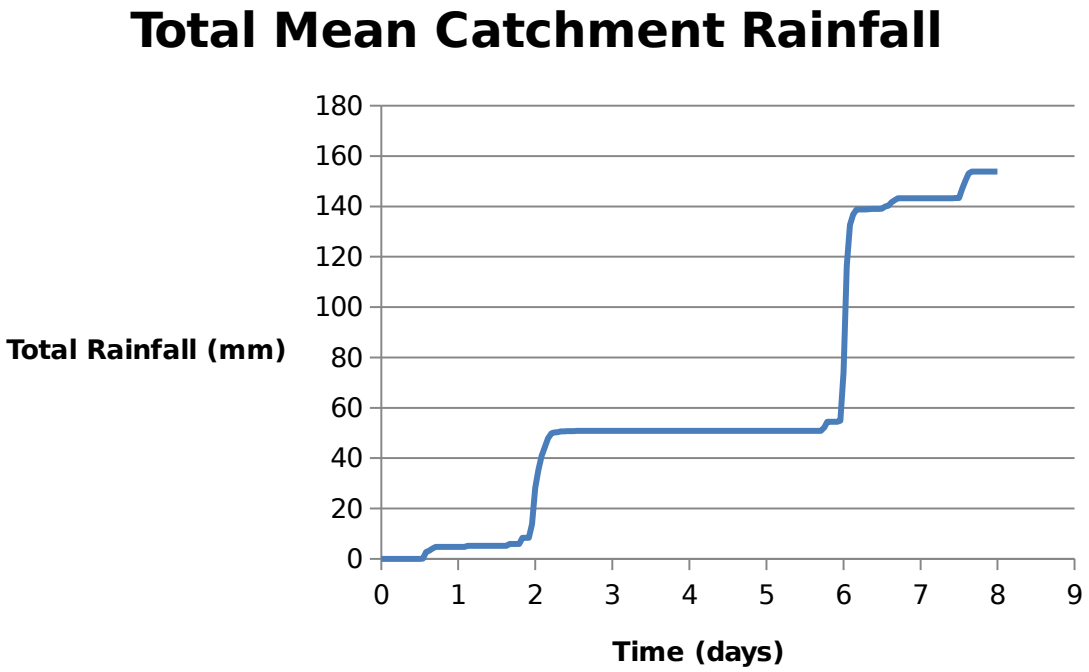

Figure 1 Total Mean Rainfall for January 2017 Commencing January 18th

Table 1 summarises the rainfall that occurred during the flood producing storm, and provides an estimate of the Annual Exceedance Probability of the rainfall recorded at the Plateau pluviometer. The Annual Exceedance Probability is the probability that the rainfall will occur in any given year for each of the durations examined. It can be seen from the table that for rainfall durations between 1 hour and 3 hours the rainfall probability is less than 1%. It was a very rare rainfall event.

Table 1 Rainfall Intensity for January 2017 Storm – The Plateau

Time period (hours)	Peak rainfall (mm)	Rainfall Intensity (mm/hr)	Annual Exceedance Probability (%)
0.25	22.8	91.2	10% - 5%
0.5	41.4	82.8	2%
1	68.8	68.8	<1%
2	91.8	45.9	<1%
3	96.4	32.1	<1%
6	102.6	17.1	5% - 2%

Flow

The gauging station on Arcoona Creek (number A0040520) commenced recording in December 1993. It records flow from a catchment area of 49.7km^2.

The station has no fixed control such as a weir, and the stream bed contains a significant gravel deposit. The catchment is quite mountainous, with an elevation range from 540m to 930m. The rating curve is theoretical, and is based on site survey. There has been no gauging (on site measurement of flow) carried out due to the site's remote location. Approximately 10% of the record is missing, most of which is in the early years of monitoring. The reliability of the instrumentation has improved over the years.

In the 23 years of record there have been only 12 flows exceeding 3m^3/sec. There have also been 11 years with no recorded flow. Two day rainfalls of up to 70mm have occurred without stream flow.

Table 2 lists the highest recorded flows in the period of record.

Table 2 - 10 Highest Recorded Peak Flows in Arcoona Creek

Date	Peak Flow (m^3/sec)
24/01/2017	113
15/03/1996	55.4
16/01/1995	24.4
29/02/2012	16
4/11/2015	15.1
12/02/2010	11.2
8/09/2016	10.3
14/03/2011	9.3
6/02/2011	4.32
8/03/2011	4.23
20/02/2000	3.33
19/07/2016	3.1

With 23 years of record it is expected that a reasonable idea of the flood frequency can be found. With so many years of zero flow it can be expected that a partial series, which takes account of every significant flow and the time between them will be more reliable than an annual series analysis, which only uses the peak flow from every year. Figure 2 shows the partial series plot of Average Recurrence Interval vs. flow. A distribution was fitted to the high flows, using the power law (Malamud and Turcotte, 2006) for flows above 3.0m^3/sec. Table 3 shows a summary of the estimated flow for each recurrence interval, based on the analysis. The 2017 flow using this has a recurrence interval of between 20 and 50 years.

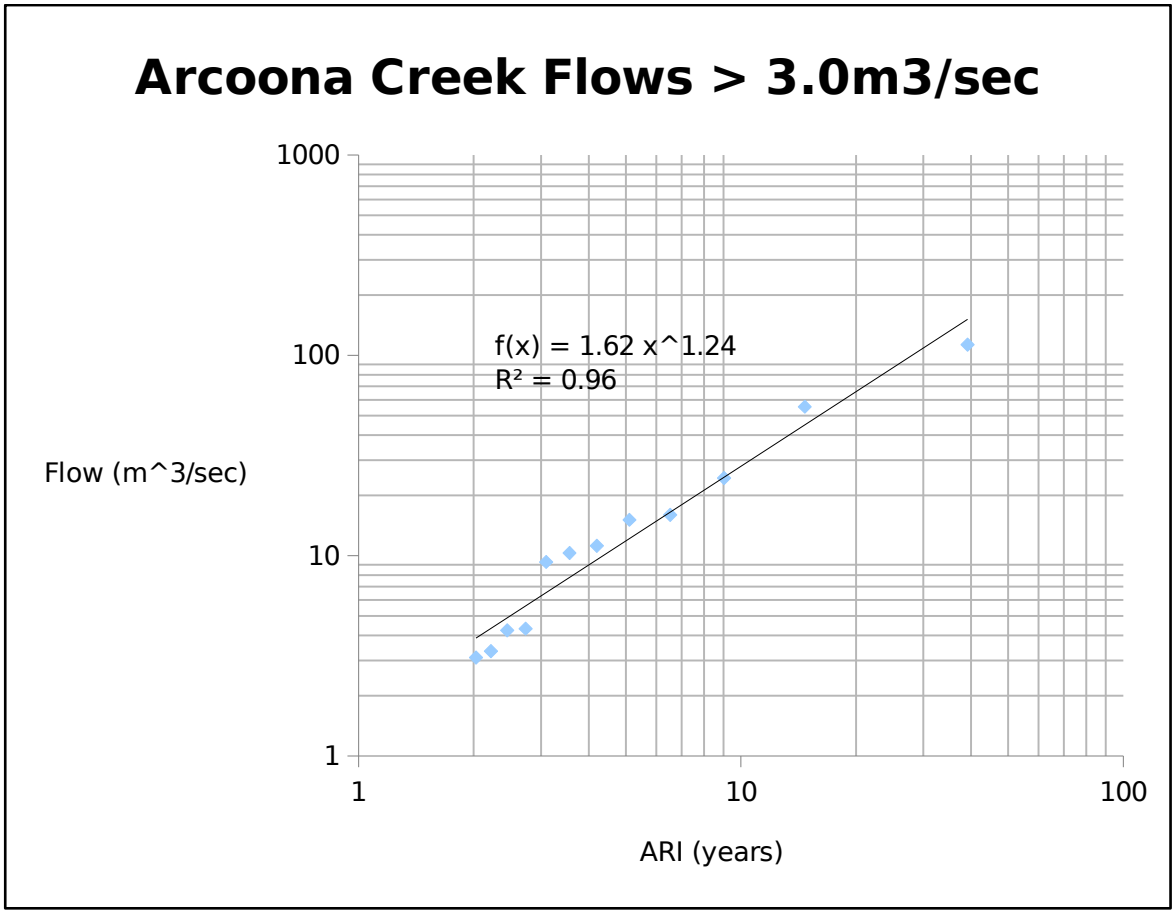

Figure 2 Arcoona Creek Flood Frequency Plot (Partial Series)

Table 3 Arcoona Creek Flood Frequency

ARI (years)	Arcoona Creek (m^3/sec)
10	27.9
20	65.8
50	204
100	482

It is also of interest to see how the 2017 flood has changed the estimate of the flood frequency. The frequency analysis has been carried out in exactly the same manner, but assuming that the 2017 flood did not occur. Table 4 shows that the flood estimates would be much less, with the January 2017 flood now having a recurrence interval of between 50 and 100 years. This shows the sensitivity of the estimate to the few floods that have occurred during the period of record, and the need to continue monitoring.

Table 4 Arcoona Creek Flood Frequency without January 2017 Flood

ARI (years)	Arcoona Creek (m^3/sec) without 2017 flood	Arcoona Creek (m^3/sec) Including 2017 flood	Relative change in flow estimate %
10	17.7	27.9	157%
20	35.1	65.8	187%
50	87.0	204	234%
100	173	482	279%

Discussion

The flood in Arcoona Creek peaked at 2:00am on the 24th January 2017. The estimated peak flow was 113m^3/sec. It was caused by a storm that produced nearly 100mm of rain at the Plateau within 3 hours.

Design rainfall intensities for the estimation of the frequency of the rainfall that occurred are given by the Bureau of Meteorology, as an Annual Exceedance Probability (AEP), which is a probability of occurrence in any year, and cannot therefore be directly compared with the Annual Recurrence Interval (ARI) that has been derived by analysis of the peak floods of record. This is an estimation of the time between peaks of the same magnitude.

However for rare events such as the 2017 flood it can be said that the AEP of the rainfall being less than 1% indicates that the flood produced, having an ARI between 20 and 50 years occurs more frequently than the rainfall that produced it.

This discrepancy may be as a result of:

- The rainfall not being of the duration that produces the highest flood.
- Catchment conditions prior to the storm event (antecedent rainfall) not being as wet as when the largest flood will occur as a result of a given rainfall
- Errors in the estimation of design rainfall intensities
- Errors in the translation from flow depth to estimated flow for the gauging station (the rating), and
- Uncertainty caused by the limited time that flow and rainfall have been recorded.

Of these the greatest uncertainty is probably caused by the length of record, followed by the rating of the gauging station. Inclusion of the January 2017 flood in the flood frequency analysis has resulted in a significant change in the flood estimates, particularly for rare events. A longer period of record, with more floods will result in more certainty. It indicates why it is necessary to continue this monitoring if the behaviour of arid area streams such as Arcoona Creek is to be understood.

Summary

The January 2017 flood in Arcoona Creek was caused by a very intense storm, which produced nearly 100mm of rainfall within 3 hours on the Gammon Plateau. The resultant flood was the highest in the 23 years of record at the Arcoona Creek gauging station, and is estimated to have a recurrence interval of between 20 and 50 years.

The mismatch of the estimated frequency of the rainfall and resultant stream flow is significant. The continuation of monitoring will provide a better understanding of the frequency of flows, and the behaviour of the catchment. Only in this way will it be possible to improve the prediction of the magnitude of flood flows in arid zone catchments.

References

Kemp, D.J, Wright, C and Jewell, S (2008) *The Gammon Ranges Project – Monitoring in a Remote Area* I.E.Aust Hydrology and Water Resources Symposium, Adelaide, April 2008.

Malamud, B.D and Turcotte, D.L. (2006) *The Applicability of Power-law Frequency Statistics to Floods* Journal of Hydrology vol 322, 168-180