Analysis of Rainfall in the Gammon Ranges of South Australia: 1992 to 2002

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Abstract:

This paper is the result of a study of temporal and spatial rainfall distribution patterns in the Gammon Ranges, and is an attempt to relate the observed distributions with causative climatic factors. The study is based on rainfall data obtained from four pluviometers in the Gammon Ranges, and five others installed in adjacent catchments southwest of the Gammon Ranges, recorded over a continuous period of more than nine years from November 1992 to January 2002. This is intended particularly as a follow-up study from a similar study based on rainfall data from the years 1989, 1990, 1992 and 1993. An important finding of the current study is the great variability in both temporal and local rainfall distribution patterns from one year to another in this region of South Australia, due to the climate patterns typical of the region. Findings of this study highlight the need to continue rainfall recording in the Gammon Ranges for many years to come if it is desired to reliably determine any effects of local topographic conditions on rainfall patterns in the Gammon Ranges. In contrast to earlier findings, this study demonstrates that summer rainfall has a notably greater significance than winter rainfall in the Gammon Ranges. This accords with local experience in the region, and is a result of both the occurrences of heavy localised falls due to late spring and summer thunderstorm activity, and the infrequent but important influences of slow-moving tropical low-pressure systems, which can produce extended periods of well-above-average rainfall during mid to late summer. This study also questions the importance of orographic uplift on rainfall distribution during the winter months within the Gammon Ranges, because, unlike in the earlier study, rainfall data analysis for this study does not show evidence for this.

1. Introduction

This paper is the result of a study of observed temporal and spatial rainfall distribution patterns in the Gammon Ranges over the period November 1992 to January 2002, and is an attempt to relate the observed distributions with causative climatic factors. The study is intended as a follow-up to a similar one conducted by Holger Maier and Chris Wright (Maier and Wright, 1995), who analysed available rainfall data from the years 1989, 1990, 1992 and 1993. It was considered desirable to determine whether more extensive rainfall data records from the Gammon Ranges would show similar trends to those observed in the earlier study. Results could possibly lead to a better understanding of the environmental conditions that influence the ecology of the region.

The rainfall-monitoring project arose as a part of the Scientific Expedition Group's Gammon Ranges Scientific Project, out of an interest in learning about the rainfall patterns that are in part responsible for shaping the environmental and ecological features of the semi-arid Gammon Ranges region in South Australia. Rainfall monitoring in the Gammon Ranges officially began with the installation of a pluviometer on the Gammon Plateau in September 1988, and has continued since with the installation of a further three pluviometers in the Arcoona Creek catchment, as well as a calibrated flow meter at a particular location in Arcoona Creek. For a more detailed history and description of the project, the reader is recommended to refer to Maier and Wright (1995).

Maier and Wright (1995) compared rainfall data records obtained from three pluviometers installed within the Gammon Ranges National Park, with data obtained from five other recording stations located in the Windy Creek and Emu Creek catchments southwest of the Gammon Ranges. These other recording stations were set up by the former Engineering and Water Supply Department and are now monitored by the South Australian Department for Water, Land, and Biodiversity Conservation, for the purpose of enabling the Electricity Trust of South Australia to monitor water supply to Aroona Dam for Leigh Creek South. This study is based upon data obtained from the same recording stations, to enable reliable comparisons in results, as well as that available since August 1997 from a new pluviometer installed within the Gammon Ranges National Park at Arcoona South.

The reason for carrying out a follow-up study is that due to technical problems in data collection and the relatively short monitoring period, the 1995 study was based only upon data available for the years 1989, 1990, 1992 and 1993. It was considered highly desirable to carry out this present study to determine whether the data used in the previous study could be regarded as reliably representative of the typical rainfall conditions in the Gammon Ranges. Following from this, it was hoped that the hypotheses and conclusions drawn in the 1995 paper could be tested in the light of the availability of more extensive data records.

2. Rainfall Data Collection

Rainfall has been collected at all stations by means of standard tipping-bucket pluviometers equipped with electronic data loggers. Regular trips to the region have been required to recover data, maintain equipment and carry out various other environmental monitoring activities.

Figure 1 shows the locations of the rainfall monitoring stations from which data have been used in this study. The following notes provide a brief summary of the pluviometer locations:

Gammon Ranges – Arcoona Creek Catchment:

- ***Gammon Plateau***, Station No. AW004517. Latitude 30:27:53S, longitude 139:02:53E, elevation approx 930 m (AHD). Installed September 1988 in a highly exposed position between North Tusk Hill and Four Winds Hill, and likely to be subject to wind effects.
- ***Exclusion Zone***, Station No. AW004518. Latitude 30:26:22S, longitude 138:58:08E, elevation 540 m (AHD). Installed April 1990 to enable rainfall monitoring in an experimental grazing exclusion zone for the purpose of investigating vegetation regeneration. The pluviometer is located in the Arcoona Creek valley close to the point of creek discharge to the western plains.
- ***Sambot Waterhole***, Station No. AW004519. Latitude 30:26:45S, longitude 139:02;03E elevation 660 m (AHD). Installed August 1991. The pluviometer is located near Lower Sambot Waterhole, in a valley running east-west along the northern flank of North Tusk Hill. It is well protected, though turbulence effects are quite possible in storm situations.
- ***Arcoona South***, Station No. AW004521. Latitude 30:28:26S, longitude 139:00:06E, elevation 650 m (AHD). Installed July 1997 in an open location between mallee outcrops in a valley running north-south in the southwestern Gammon Ranges.

Windy Creek Catchment:

- ***North Moolooloo***, Station No. AW510512. Latitude 30:37:28S, longitude 138:31:38E, elevation 315 m (AHD). Installed February 1986.
- ***Mocatoona***, Station No. AW510513. Latitude 30:41:30S, longitude 138:44:40E, elevation 615 m (AHD). Installed February 1986.
- ***Maynard's Well***, Station No. AW510514. Latitude 30:36: 8S, longitude 138:41:20E, elevation 495 m (AHD). Installed February 1986.

Emu Creek Catchment:

- ***Pfitzner's Well***, Station No. AW510515. Latitude 30:41:17S, longitude 138:33:59E, elevation 355 m (AHD). Installed February 1986.

Aroona Dam:

- ***Aroona Dam***, Station No. AW510516. Latitude 30:35:07S, longitude 138:21:33E, elevation 236 m (AHD). Installed February 1986.

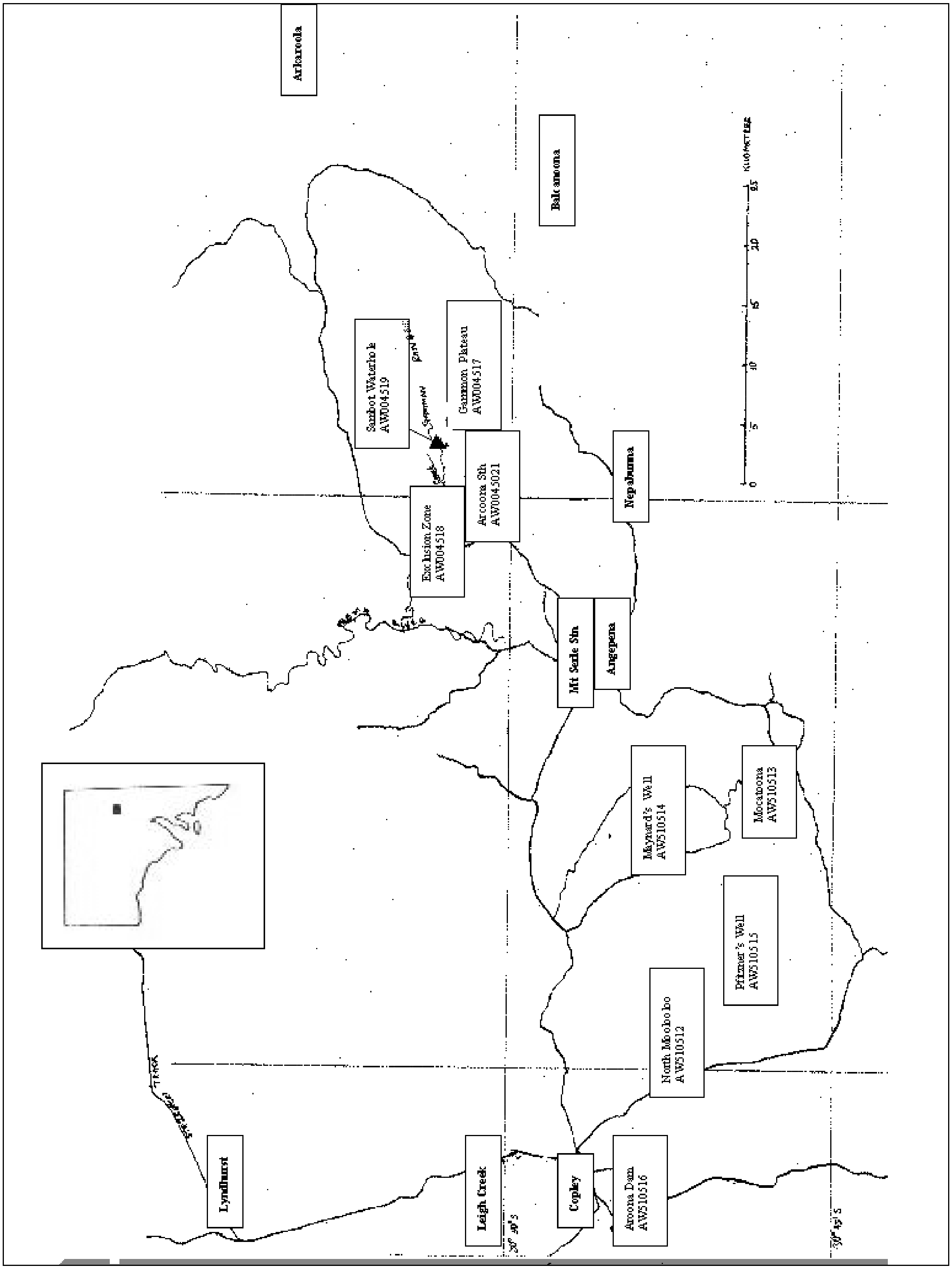

Figure 1 Pluviometer Location Map for Gammon Ranges Rainfall Monitoring Project. Inset: Location of Gammon Ranges in South Australia

3. Data Source and Handling

Data used in this study was obtained from two sources. The Gammon Ranges rainfall data were provided by the Bureau of Meteorology in Adelaide, South Australia, while the rainfall data from the Aroona Dam, and Windy Creek and Emu Creek catchment stations were kindly made available by the Department for Water, Land, and Biodiversity Conservation.

The data were provided in comma-separated variable format, with the information provided including date, time, rainfall increment and data quality coding for each recorded rainfall sum. Data analysis was carried out using Microsoft Excel, but it is important to note that there is a possibility of human error in the entry of data during the initial analysis procedure.

Initial data analysis involved the determination of the number of rain days, and rainfall totals, for each month over the study period of November 1992 to January 2002, for each of the nine pluviometers listed in section 2. This entailed checking the rainfall records for missing data (usually a result of equipment failure at some of the recording stations), totalling monthly rainfalls and tallying numbers of rain days, taking into account the standard Australian definition that a rain day ends at 9 a.m. local time. It is quite possible that numbers of rain days in the cooler months of the year have been slightly exaggerated because heavy dews of at least 0.2 mm may well have been registered as rainfalls by the automatic recording pluviometers, and it is impossible to tell from the data records where this has been the case. Spreadsheet summaries of the data analyses are provided in Appendix A.

The study period of November 1992 to January 2002 was chosen because it represented the longest available continuous period of complete data records for most of the pluviometers. Exceptions were that complete records for Sambot Waterhole were available only up to the end of September 2001, Arcoona South readings were not available until August 1997, and blocks of data were missing from the earlier records from the Maynard's Well and Pfitzner's Well stations. In order to obtain the most accurate average rainfall statistics from the available data, it was deemed essential that the study period be as long as possible.

In order to check the consistencies of gauge readings, double mass curve analysis was carried out on the monthly rainfall records for some of the stations. This involved plotting cumulative rainfall totals from rain gauges of interest against averaged cumulative totals of other stations in similar hydrological conditions. Significant variations of slope are indicative of inconsistencies caused by factors such as calibration errors or changes in gauge exposure.

The results of a cursory investigation suggested that there were minor inconsistencies in some of the earlier data from the Gammon Ranges stations. As the gauges have not been relocated during the recording period, nor does there appear to have been any significant change in gauge exposures, early calibration problems are suspected. The Gammon Ranges pluviometers were calibrated to within 3% before installation, but it is known that accuracies dropped to about 10% at two of the sites, and data were probably not corrected to compensate. Because of these uncertainties, it was decided that the unadjusted raw data provided by the Bureau of Meteorology should be used for this current study.

Double mass curve analysis was, however, used to infill missing data records from the Maynard's Well and Pfitzner's Well stations. By plotting the cumulative rainfall totals from these stations against the average cumulative totals from the North Moolooloo, Mocatoona and Aroona Dam stations, it was possible to demonstrate a clear linear relationship between the rainfall records, and to use this to appropriately interpolate missing data (see Appendix B). In addition, minor slope adjustments of the double mass curves were carried out to revise some early data records from these stations, where it appeared that gauge inconsistencies were evident.

4. Data Evaluation

4.1 Annual Data

The average annual rainfall for each of the stations was calculated by summing the averages for each month. The results are shown in Figure 2, which appears to illustrate a general trend of increasing average annual rainfall with altitude. The data for the Gammon Plateau were a notable exception, suggesting that altitude alone is only one of many factors in estimating average annual rainfalls. This observation is significant, because the rainfall analysis conducted by Maier and Wright (1995) showed that over the years of the study, the Gammon Plateau consistently received the highest rainfalls and numbers of rain days of all of the stations studied. The differences in the results obtained in the two studies raise a number of questions, including whether or not the physical landforms at the gauge locations, in addition to altitude, may be contributing factors to rainfall patterns observed in the Gammon Ranges. Figure 3 shows the number of average annual rain days for each of the stations, and shows a similar trend to the rainfall patterns, with the exception that the relationship between altitude and number of rain days observable between the Gammon Ranges stations is indefinite – given the short period of data record.

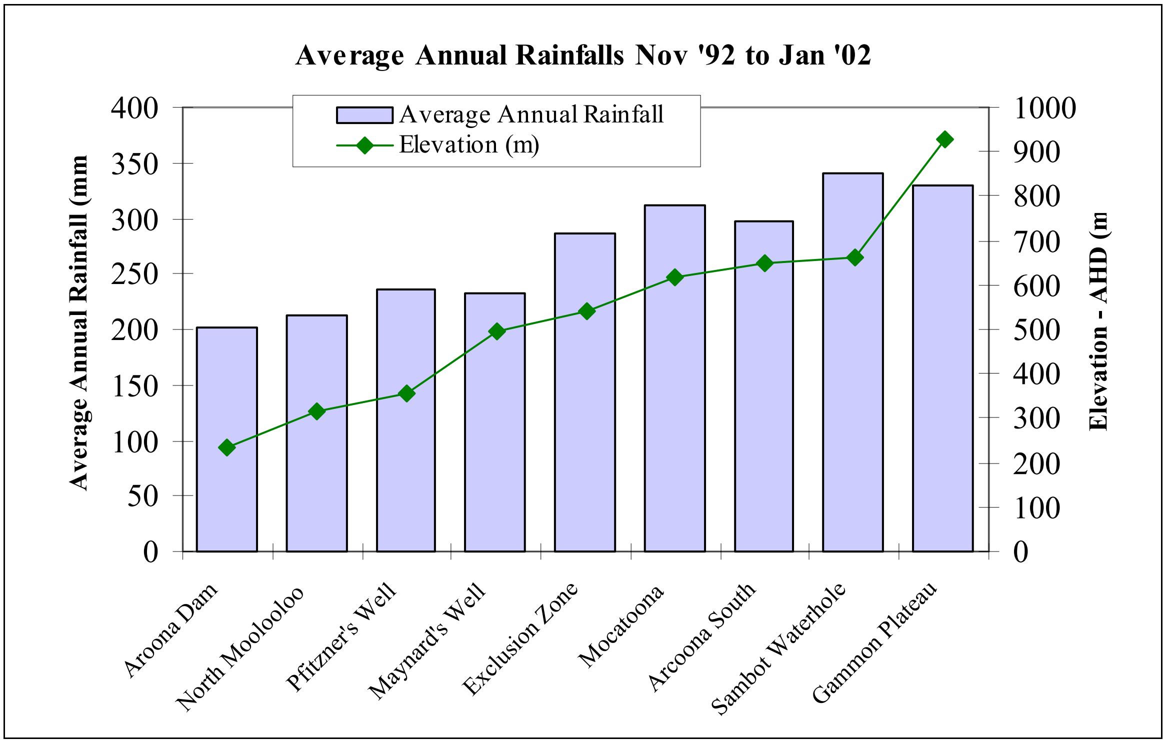

Figure 2 Average Annual Rainfalls (Nov '92 to Jan '02)

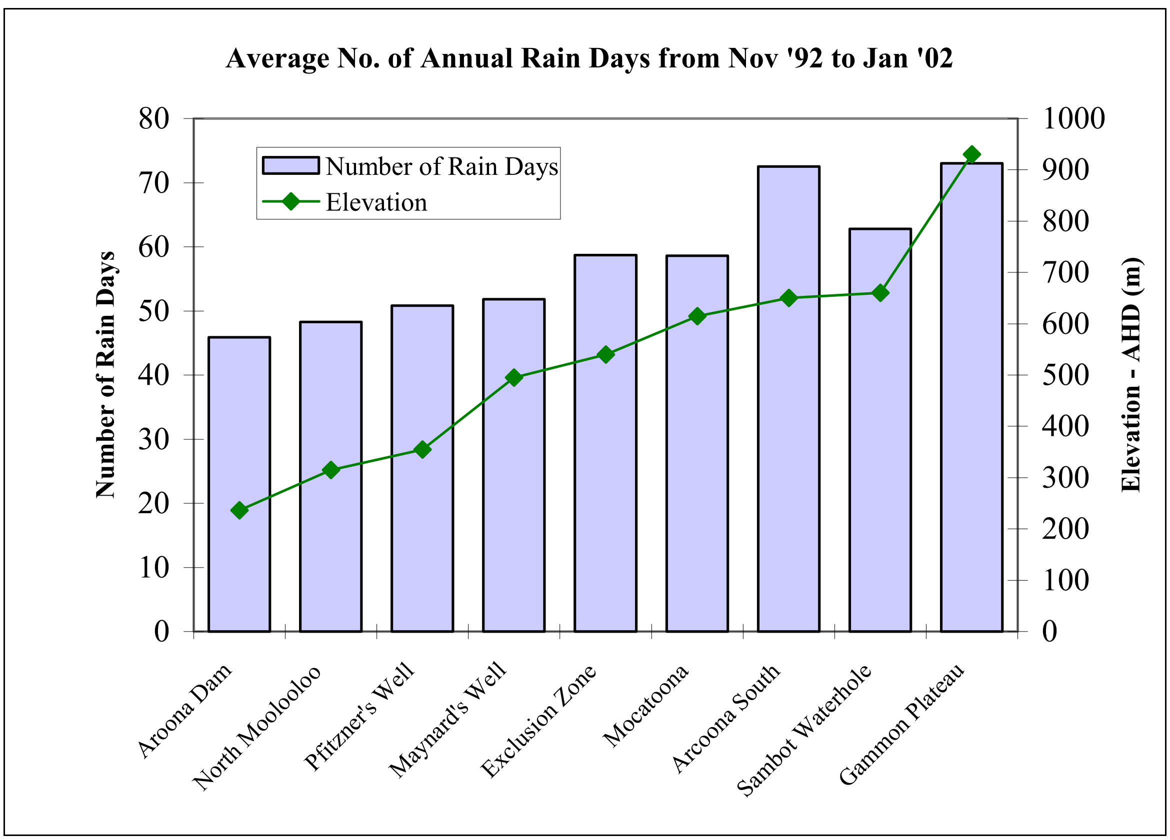

Figure 3 Average Number of Annual Rain Days (Nov '92 to Jan '02)

Figure 4 illustrates how the rainfall over the period November 1992 to October 2001 compared with averages predicted for the region by the Bureau of Meteorology (Burrows, 1994 – see map in Appendix C). For all stations except Mocatoona, it was found that the actual average rainfalls over the above-mentioned period were very close to the estimated long-term averages. This would suggest that the estimates were fairly reliable for all stations (except possibly Mocatoona), and that the data used in this study is probably more representative of the true rainfall patterns of the Gammon Ranges region than the more limited rainfall data from the years 1989, 1990, 1992 and 1993. Maier and Wright (1995) found the averages from those years to be significantly higher than the long term averages.

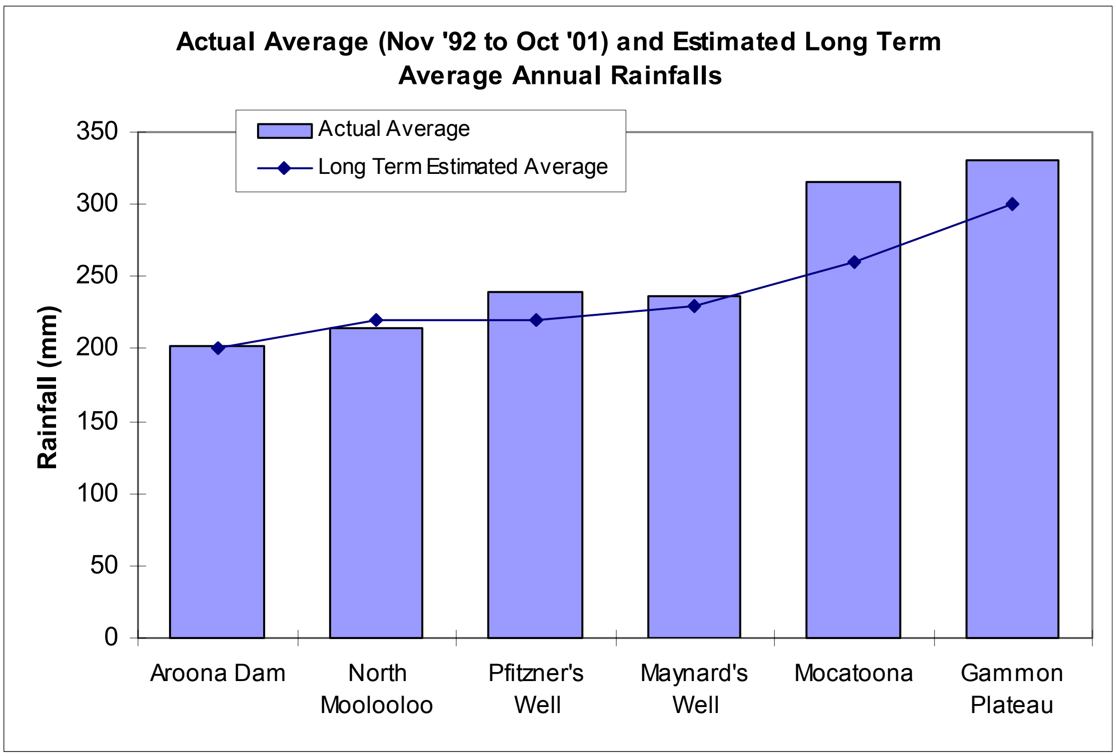

Figure 4 Comparison of Actual Average Rainfalls (Nov '92 to Oct '01) with Estimated Long Term Average Annual Rainfalls

4.2 Seasonal Data

As discussed by Maier and Wright (1995), there is a significant difference in the general rainfall mechanisms in the summer and winter months in the northern Flinders Ranges. Winter rainfall events are typically of low intensity, triggered by orographic or convergence uplift of cool, moist air masses from the Southern Ocean, and commonly associated with the movement of cold fronts across the southern part of the Australian continent. Summer rainfall events in the northern Flinders Ranges are commonly of much higher intensity, and are typically shorter in duration and more localized. These rainfall events are usually the result of thunderstorms produced by convective uplift of warm moist air inflows. Summer rainfall events are typically irregular and randomly distributed, and can sometimes be of extreme magnitudes, causing flash flooding.

Another mechanism for summer rainfall is the highly erratic and infrequent occurrence of a slow-moving tropical low-pressure system. This is commonly the result of a large monsoonal trough drifting southwards from northern Australia, and can result in a period lasting up to several weeks of well-above-average rainfall, and extensive flooding (Brooks, B., Szkup, R., pers. comm.).

Despite the irregularity of summer rainfall, its significance can clearly be observed in Figure 5, which compares the average monthly rainfalls for seven of the stations, including the Gammon Plateau, Sambot Waterhole and Exclusion Zone in the Gammon

Ranges. The rainfall monitoring stations have been ordered from right to left according to elevation, so that comparisons may readily be drawn. It can be seen that:

- In terms of its contribution to average annual rainfalls, summer rainfall appears to be appreciably more important in the Gammon Ranges than in the regions further southwest.
- March, April, May and August seem to be characterized by low rainfalls across all stations, but in the other months, there is generally a tendency for higher rainfalls at higher elevations.
- It is interesting to note that the effects of orographic uplift appear to be more pronounced at Mocatoona than in the Gammon Ranges during the winter months.

A comparison of Figure 5 with Figure 6, which shows average monthly rain day numbers for the same stations, indicates that:

- There appears to be a more pronounced correlation between altitude and number of rain days across all stations, particularly during the winter months. It must be remembered, though, that the rain day numbers in the winter months are likely to be slightly exaggerated due to heavy dews, as discussed in section 3. This may explain in part why average numbers of rain days are higher in May than in March and April despite the fact that average rainfalls are very similar across these months at all stations.
- The Gammon Ranges stations show notably higher average numbers of rain days in June and July than in the summer months, despite the fact that summer rainfalls are commonly more significant in volume. This gives a good indication of the relative intensities and durations of summer and winter rainfall events, and is readily explainable by the typical rainfall mechanisms during the different seasons as discussed above.

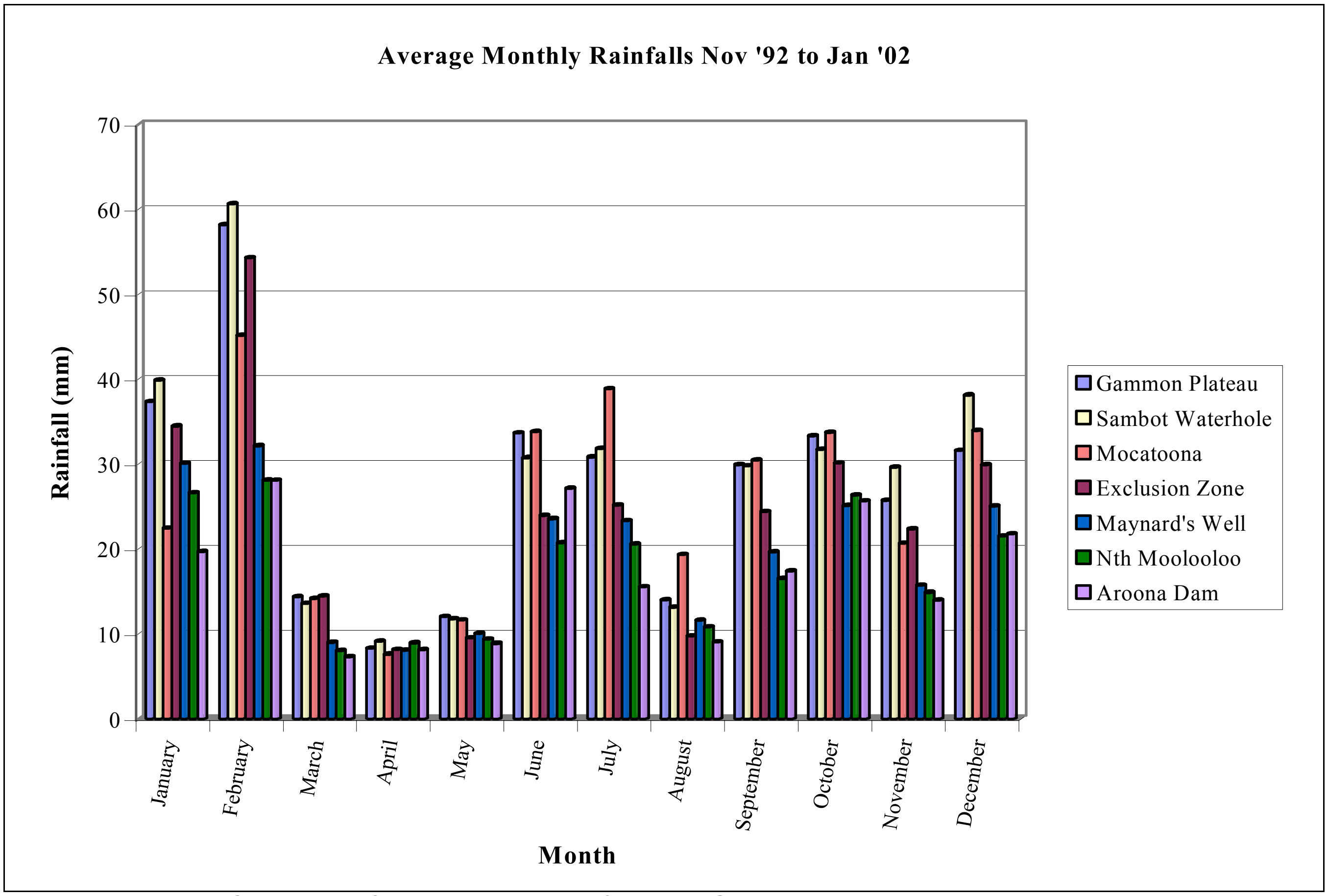

Figure 5 Comparison of Average Monthly Rainfalls in the Gammon Ranges and Nearby Locations

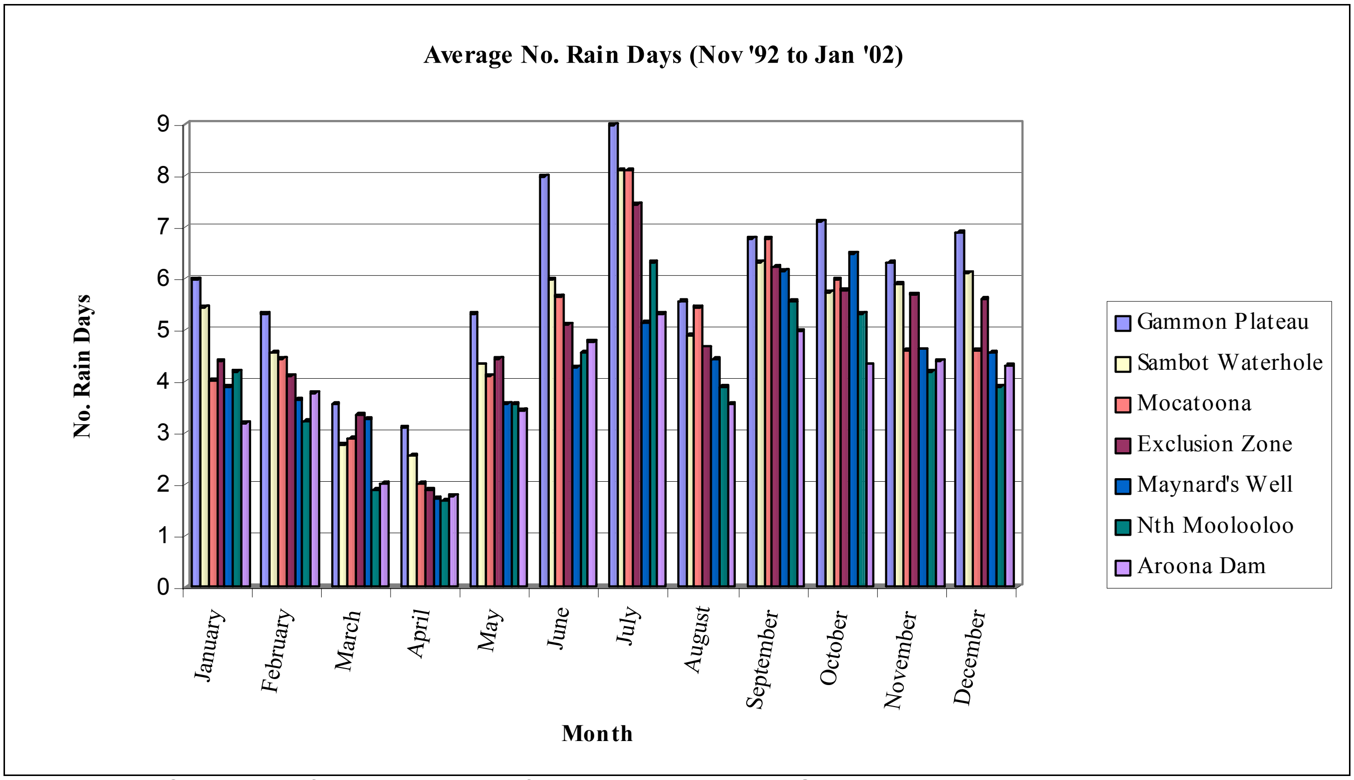

Figure 6 Comparison of Average Numbers of Monthly Rain Days in the Gammon Ranges and Nearby Locations

The differences between the summer and winter rainfall patterns in the Gammon Ranges and northern Flinders Ranges can perhaps be illustrated more clearly in Figures 7 and 8. In this case, summer months have been defined as November, December, January and February, while the winter months are taken to be May, June, July and August. It is important to note that these graphs do not show the significant spring rains in September and October, which are observable in Figures 5 and 6.

The following comments summarise some important information that may be gained from Figure 7.

- During the period November 1992 to January 2002, average summer rainfalls were higher for all stations than winter rainfalls. This is the opposite of what was found by Maier and Wright (1995).
- The Gammon Ranges stations showed significantly greater differences between summer and winter rainfalls than the other stations.
- There is little evidence of correlation between altitude and average rainfall in the winter months, with the possible exception of Mocatoona in the Windy Creek catchment, which has a significantly higher average winter rainfall than the stations at lower altitudes in that catchment. This again is the opposite of what was observed by Maier and Wright (1995).
- It appears that there is quite possibly a correlation between altitude and average rainfall in the summer months. This is not as would be expected, considering the typical mechanisms and commonly localized distribution patterns of summer rainfall events. It would be desirable to be able to check rainfall data from a much longer period of time to determine whether this is a general trend, or the apparent pattern is simply a result of a number of localised extreme summer storm events. Maier and Wright (1995) found the orographic effect to be far less dominant in summer months.
- Despite the relatively higher altitude of the Gammon Plateau, there does not appear to have been a significantly higher winter rainfall at the Plateau than at Sambot Waterhole, which is less than three kilometres away from the Plateau monitoring station. However, Sambot's average summer rainfall is higher than that of the Plateau. It is quite likely that this is a distortive effect due to at least one localized extreme storm event. This is illustrated by a case in December 1999, when Sambot received 72 mm while the Gammon Plateau received only 15 mm and Arcoona South 26 mm.

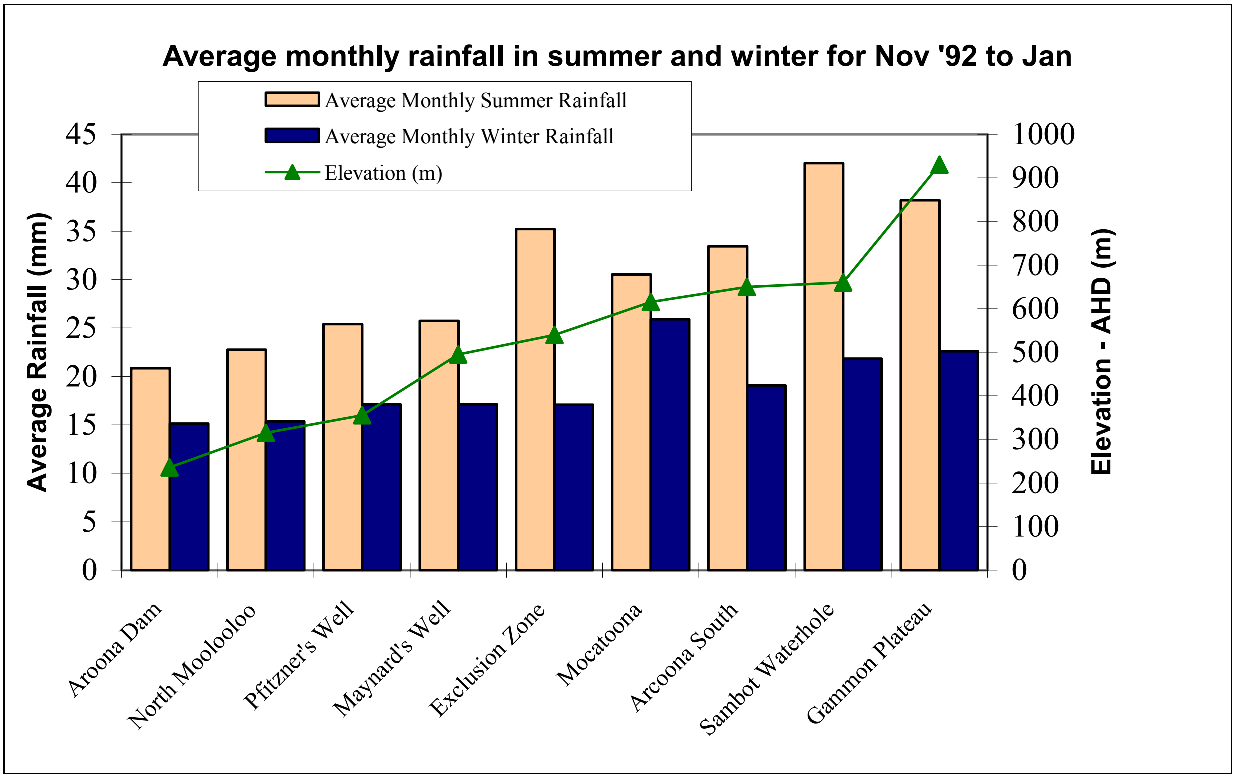

Figure 7 Comparison of Average Monthly Rainfalls in Summer and Winter (Nov '92 to Jan '02)

The following is a summary of information gained from the comparison of seasonal rain day averages in Figure 8 below.

- There appears to be some evidence of a correlation between the average number of rain days in the winter months and altitude. This is as might be expected because of the typical nature of winter rains in the Gammon and Flinders Ranges, in which orographic uplift is an important trigger for rainfall.
- At all but one of the stations (Arcoona South in the Gammon Ranges) the average number of winter rain days is higher than that of summer rain days. This trend is the same as was observed by Maier and Wright (1995), but significantly less pronounced.
- Despite the fact that Sambot Waterhole received approximately the same average winter rainfall as the Gammon Plateau over the period November 1992 to January 2002, it averaged fewer rain days per winter month. This could suggest that physical landform and/or altitude are significant factors in the determination of rainfall patterns within the Gammon Ranges.
- For all stations the differences between numbers of summer and winter rain days are small. When a comparison is made with the differences between average summer and winter rainfalls, it becomes apparent that for all stations, particularly those in the Gammon Ranges, the relative intensities of summer events are considerably higher than of winter events.
- In the summer months there is no significant variation in the number of rain days at the sites at lower altitudes, but it is evident that the Gammon Ranges stations recorded higher average numbers of summer rain days. It would appear therefore that summer rainfall in the Gammon Ranges is more important in terms of its contribution to annual rainfall, than in the Windy Creek / Emu Creek catchments.
- Rain day distribution patterns in the Gammon Ranges do not appear to be readily explained by station altitude differences alone. This would suggest that there might be other relevant factors such as physical locations of the gauges, the spawning sites and the tracks of convective showers, in the determination of the rainfalls in different parts of the Gammon Ranges.

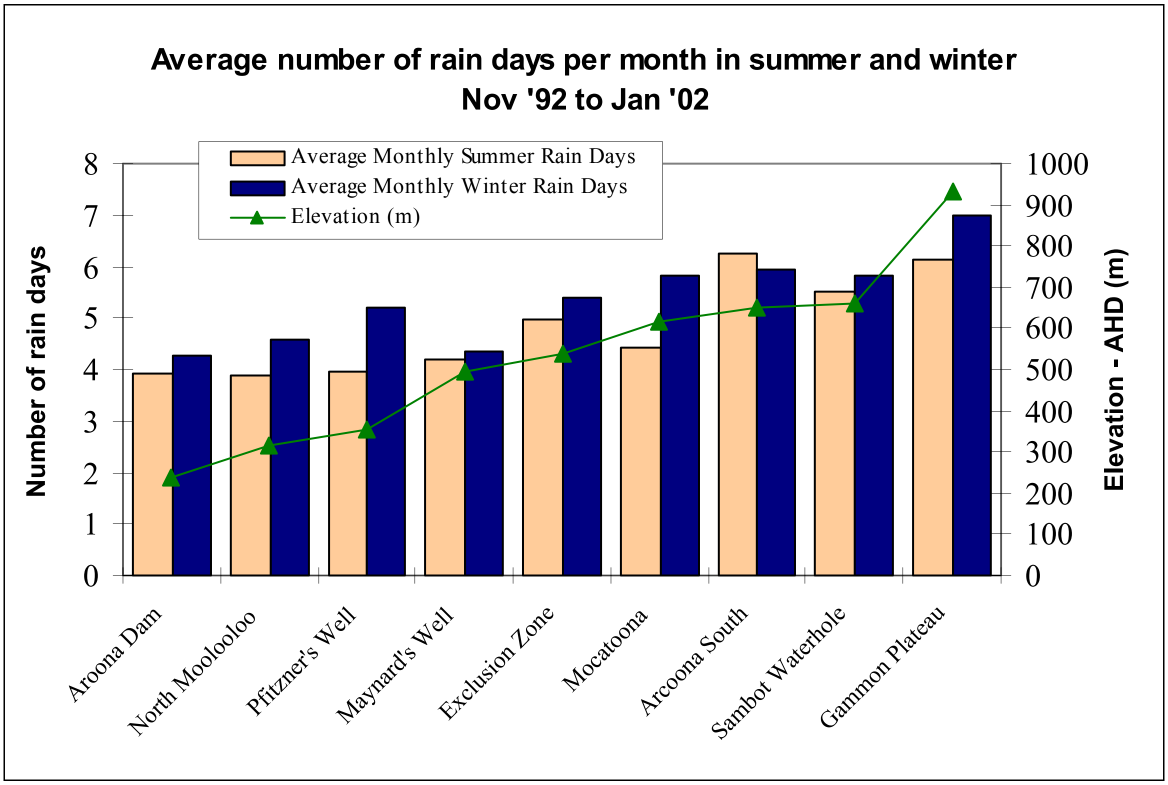

Figure 8 Comparison of Average Numbers of Monthly Rain Days in Summer and Winter (Nov '92 to Jan '02)

4.3 Data Analysis Summary

Based on an investigation of the rainfall data from the Gammon Ranges and nearby stations obtained from November 1992 to January 2002, and a comparison with the results obtained by Maier and Wright (1995), the following comments and conclusions can be made:

- The average annual rainfalls at the stations studied for the period November 1992 to January 2002 were similar to the estimated long-term averages (see Figure 4 and map in Appendix B). By contrast, the average annual rainfalls at the same stations were found to be significantly higher for the years 1989, 1990, 1992 and 1993. This difference in average annual rainfalls could well be explained by the large variability in rainfall in the arid climate of South Australia. (Brooks, B., pers. comm.).

- Estimates for the Mocatoona rainfall were inferred from Bureau of Meteorology data at the nearby station of Warraweena (WMO 17051) where rainfall data was collected for 33 years until 1963. In this period the mean rainfall was 219.2mm. For the period between 1938 and 1963, there are overlapping rainfall records at Arkaroola (WMO 27099) and Warraweena and these show mean rainfalls of 210.9 and 215.6 mm respectively. Over the past decade the mean rainfall at Arkaroola has been 245.5 mm, which would suggest a higher estimate of Mocatoona rainfall than is shown in Figure 4.

- The above observation indicates the need to analyse rainfall data from a much longer recording period in order to be able to give a more accurate representation of average conditions in the Gammon Ranges. An example of the variability of averages can be seen in Arkaroola (WMO 27099) rainfall data where mean annual rainfall between 1930 and 1963 was 210.9 mm, whereas the mean annual rainfall since then has been 287.1mm. Both of these rainfall periods satisfy the Bureau requirement of 30 years for a reliable length of record, but this shows the variability in longer-term means. (Brooks, B., pers. comm.).

- Extreme events can skew rainfall statistics. Monthly rainfall totals at Arkaroola vary between 0 mm and 403.8 mm in March 1989. Because of the erratic occurrences of these extreme events, it is felt that it would be more meaningful to make comparisons of the median rainfalls The differences between these values are illustrated by the following, gleaned again from the Arkaroola records: *1938 to 2003 average – 258.3 mm, median – 225.2* (Brooks, B., pers. comm.).

•	Mean	Median
All years	*258.3 mm*	*225.2 mm*
1938-1963	*210.9 mm*	*178.9 mm*
1963-2003	*287.1 mm*	*248.2mm*

- Maier and Wright (1995) found a marked correlation between winter rainfall and altitude within the Gammon Ranges. It was concluded that this was because winter rainfalls were characterized by low intensity events triggered by orographic lifting. In this study, which was based on data from November 1992 to January 2002, little conclusive evidence for an increase in winter rainfall with altitude was found, although a general increase in numbers of winter rain days with altitude was observed. It is not possible to conclude from the short data records available whether the effects of orographic uplift are significant in the Gammon Ranges. If the effects are not significant, it would suggest that the data used by Maier and Wright (1995) happened by chance to fit the climatological predictions.
- As was observed by Maier and Wright (1995), there does not appear to be strong evidence for correlation between average rainfall and altitude in the summer months in the Gammon Ranges. However, summer rainfall is notably more significant in both frequency and amount in the Gammon Ranges than in the Windy Creek, Emu Creek and Aroona Dam catchments.

5. Conclusions

The most obvious result of this study has been the discovery of the need for very long rainfall data records (perhaps in the order of 100+ years) in order to produce reliable rainfall data comparisons for the Gammon Ranges. This is because of the significance of infrequent extreme rainfall events, which shift averages and are sometimes characterized by very localised distributions. As a result, it is difficult to draw conclusions on the effects of topography on rainfall distribution in the Gammon Ranges, based on the data available at present.

An important finding of this study, not observable from the data analysis carried out by Maier and Wright (1995), is the relative importance of summer rainfall in the Gammon Ranges. This is in accord with local knowledge, and the finding supports what is known about the climatological conditions in this part of Australia, and has been outlined earlier.

Comparisons of average annual rainfalls would suggest that, as found by Maier and Wright (1995), there is evidence for orographic uplift in general producing higher rainfalls at higher altitudes in the Windy Creek and Emu Creek catchments and the Gammon Ranges. However, within the Gammon Ranges themselves, there was no evidence of a correlation between altitude and rainfall. This would suggest either that there are other local factors influencing rainfall readings, or simply that the short data records do not show expected patterns because of the effects of a number of extreme local rainfall events.

6. Recommendations for Further Study

As a result of this study, it has become obvious that it would be extremely desirable to continue collecting rainfall data from the Gammon Ranges for as many years as possible. Because rainfall in regions of Australia like the Gammon Ranges is extremely variable and is characterized by extended dry periods and infrequent extreme events, it is difficult to draw reliable conclusions from rainfall comparisons between stations, using the relatively short data records available. Thus it is not possible at this stage to determine conclusively whether orographic uplift does have an important effect on summer and winter rainfall patterns within the Gammon Ranges.

It might be valuable in this study if there were more pluviometers installed and monitored over the long term across a wider range of locations within the Gammon Ranges. This would enable an investigation into any landform and/or altitude effects on rainfall distribution within the Ranges.

A study that might produce more meaningful results would be a comparison of data medians rather than averages. Due to time constraints, this has not been done in this study, but as discussed in Section 4.3, it could reveal some interesting differences.

It would be an interesting and perhaps quite useful exercise to carry out analyses of rainfall event intensities across the Gammon Ranges and the other stations, and hence determine the trends that may be observed. It is possible to carry out such analyses quickly using the software package HYDSYS, which can handle raw rainfall data files, thus eliminating the need for the Excel spreadsheet work done for this study.

Because water level monitoring is being carried out on Arcoona Creek, an interesting study would be to relate rainfall intensity and distribution in the Arcoona Creek catchment with flow data. This could be carried out using runoff-routing software to enable prediction of design flows, based on rainfall event records.

7. References

- Burrows, Kevin (1994), Climate Services, Bureau of Meteorology, Adelaide.
- Maier H.R. and Wright C.J., (1995) *Rainfall monitoring in the Gammon Ranges of South Australia: 1988-1993,* Gammon Ranges Scientific Project, Scientific Expedition Group.

8. Acknowledgments

The following are gratefully acknowledged for providing the rainfall data records used in this study:

- Department for Water, Land, and Biodiversity Conservation, South Australia.
- Johnson, Linton, Bureau of Meteorology, SA Hydrology Section, Adelaide.

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- Brooks, Bruce (2003), Climate and Consultancy, Bureau of Meteorology, Adelaide.
- Szkup, Richard (2003), Climate and Consultancy, Bureau of Meteorology, Adelaide.

APPENDIX A

Rainfall and Rain Day Records and Analyses, November 1992 to January 2002

MONTHLY RAINFALLS, NOV 1992 TO JAN 2002									
	Station								
Month	Gammon Plateau	Exclusion Zone	Sambot Waterhole	Arcoona South	Nth Moolooloo	Mocatoona	Maynard's Well	Pfitzner's Well	Aroona Dam
Nov-92	27.2	18.6	28.6		4.0	15.2	9.2	11.0	5.8
Dec-92	30.8	34.6	27.8		57.2	103.2	48.0	77.7	72.2
Jan-93	62.2	48.2	74.8		35.6	30.2	37.2	26.6	41.2
Feb-93	27.6	6.4	16.0		2.2	15.0	0.6	12.3	1.2
Mar-93	9.0	4.2	3.4		5.0	4.0	3.0	1.3	4.0
Apr-93	0.8	0.2	0.2		0.0	0.0	0.2	0.0	0.0
May-93	28.0	23.2	25.0		14.8	13.0	15.2	9.3	10.8
Jun-93	23.4	10.0	16.4		11.4	21.6	11.0	17.3	10.6
Jul-93	77.2	63.0	67.6		39.2	71.2	43.2	36.5	37.4
Aug-93	19.6	14.0	17.2		4.8	22.0	9.4	9.9	3.6
Sep-93	21.8	15.0	20.2		1.6	6.6	5.0	3.8	3.4
Oct-93	61.8	51.4	60.8		43.2	50.8	43.1	46.0	47.4
Nov-93	13.4	9.0	13.4		3.6	18.0	4.8	8.0	5.4
Dec-93	111.4	106.2	110.2		61.8	95.4	68.8	55.2	35.8
Jan-94	0.6	10.2	2.0		0.0	1.2	2.7	2.4	0.0
Feb-94	94.2	108.0	109.4		75.4	85.6	70.8	77.0	58.2
Mar-94	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0
Apr-94	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0
May-94	2.8	4.0	3.2		0.6	4.8	1.6	2.0	0.0
Jun-94	92.0	51.6	68.0		50.4	86.8	52.6	71.4	77.4
Jul-94	1.4	8.2	10.8		10.8	25.0	10.0	13.7	6.0
Aug-94	1.8	0.6	1.8		1.4	1.2	0.2	0.2	0.0
Sep-94	2.0	0.6	0.8		3.2	6.0	2.3	4.2	5.6
Oct-94	0.0	0.0	0.0		0.2	0.0	6.8	4.2	0.4
Nov-94	3.4	2.4	4.6		3.0	2.8	2.1	0.6	0.0
Dec-94	3.0	3.2	8.2		0.0	1.0	1.3	0.2	0.4
Jan-95	142.8	137.2	132.8		53.8	57.6	117.4	53.6	59.0
Feb-95	18.0	14.2	15.8		15.8	22.6	19.8	22.2	16.2
Mar-95	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0
Apr-95	14.2	15.2	18.4		22.6	18.0	19.3	27.8	22.2
May-95	14.8	13.4	15.0		36.4	34.4	32.9	27.6	36.2
Jun-95	30.2	36.6	34.2		42.2	55.4	42.9	54.0	42.0
Jul-95	18.8	20.0	20.8		20.8	41.2	24.8	24.6	18.8
Aug-95	3.6	1.2	4.0		0.4	0.4	0.4	0.2	0.4
Sep-95	12.6	9.6	12.0		12.4	15.4	10.9	7.2	7.6
Oct-95	43.8	55.8	53.0		40.8	56.8	41.2	43.0	38.8
Nov-95	36.4	29.8	35.2		12.2	21.0	15.8	10.6	8.4
Dec-95	30.6	32.0	34.4		24.4	27.2	31.2	40.4	23.2
Jan-96	8.2	23.8	8.8		7.0	7.2	4.8	8.6	5.6
Feb-96	10.2	6.6	4.6		16.6	41.4	18.9	2.8	3.4
Mar-96	70.6	77.0	66.6		22.6	42.0	22.3	20.4	7.8
Apr-96	0.2	0.0	0.0		0.4	0.4	0.3	0.4	0.2
May-96	8.4	4.0	5.8		3.6	5.0	3.4	3.8	2.6
Jun-96	17.8	14.4	16.8		17.4	42.6	23.3	31.6	15.8
Jul-96	42.6	44.0	59.4		40.4	94.4	50.3	51.8	28.8
Aug-96	6.2	8.4	9.0		10.6	16.4	12.4	12.8	13.4
Sep-96	41.5	67.8	59.4		25.4	74.0	40.4	39.6	32.2
Oct-96	2.2	3.2	3.6		4.4	20.4	8.5	6.0	2.8
Nov-96	7.0	9.4	10.0		9.6	6.4	7.3	10.8	7.8
Dec-96	8.5	7.6	8.6		12.0	10.4	5.2	11.6	6.6
Jan-97	34.9	27.8	47.0		43.2	27.8	40.4	19.4	28.6
Feb-97	190.7	205.6	214.4		85.4	135.6	97.4	120.0	101.8
Mar-97	2.0	3.0	4.0		0.0	0.0	0.0	0.0	0.0
Apr-97	0.0	0.0	0.7		0.0	0.0	0.0	0.0	0.0
May-97	23.8	17.4	27.8		8.8	14.0	14.8	8.8	9.0
Jun-97	5.0	4.0	5.4		2.4	5.0	3.4	4.4	2.6
Jul-97	2.8	0.4	3.6		0.0	0.2	0.0	0.0	0.0
Aug-97	30.4	24.4	30.0	24.4	21.0	39.4	20.8	25.8	18.2
Sep-97	39.5	31.4	42.4	32.2	33.0	38.2	30.6	33.0	28.4
Oct-97	8.2	3.8	6.8	6.0	6.2	13.2	9.2	5.6	10.6
Nov-97	23.6	28.2	22.7	45.0	7.4	21.6	12.0	23.6	10.2
Dec-97	15.0	15.2	20.9	12.6	6.6	10.8	7.1	8.8	5.8
Jan-98	43.4	17.0	48.8	25.4	32.6	64.6	72.2	57.2	25.0
Feb-98	20.0	19.6	19.8	17.6	6.4	7.4	8.0	6.0	4.6
Mar-98	2.0	1.2	2.0	2.6	0.0	1.0	4.2	4.2	3.2
Apr-98	19.8	11.4	19.2	13.4	6.6	9.8	7.2	5.8	7.8
May-98	5.4	6.8	4.8	12.4	6.2	4.4	0.0	0.4	2.4
Jun-98	8.0	1.6	8.2	4.6	3.0	6.0	2.8	5.0	5.4
Jul-98	95.2	64.4	88.2	71.2	53.4	74.8	55.4	43.4	30.8
Aug-98	5.2	4.2	5.4	3.6	3.6	2.8	6.8	3.2	6.2
Sep-98	53.6	40.4	56.6	50.4	25.4	44.0	23.8	39.6	25.6
Oct-98	24.2	23.0	23.6	19.0	14.6	12.0	13.4	10.8	10.4
Nov-98	74.0	75.8	87.6	70.4	51.8	44.8	50.6	50.6	39.0
Dec-98	13.2	9.6	15.8	9.6	4.8	16.4	6.2	5.6	4.4
Jan-99	1.8	4.2	1.8	10.8	2.6	0.8	0.6	0.0	0.0
Feb-99	52.0	47.8	55.6	64.6	7.2	32.0	3.2	17.0	17.0
Mar-99	16.8	20.0	20.6	9.4	25.6	50.6	28.2	22.8	26.2
Apr-99	0.0	0.0	0.0	0.0	0.6	0.0	2.6	0.0	0.0
May-99	0.2	0.0	0.0	0.0	1.8	2.4	1.0	3.8	2.8
Jun-99	10.8	6.4	8.2	8.8	4.6	12.6	6.0	5.0	3.2
Jul-99	12.8	10.6	10.6	12.0	4.2	9.2	7.4	5.0	3.4
Aug-99	17.2	10.2	11.4	10.8	8.2	18.4	9.0	7.2	3.8
Sep-99	14.4	10.2	12.0	10.8	7.4	8.6	12.4	5.4	17.2
Oct-99	23.2	36.8	43.2	39.0	34.8	32.8	30.2	47.6	30.4
Nov-99	16.2	16.6	25.4	19.2	6.0	10.2	6.6	10.4	17.4
Dec-99	15.0	17.4	72.0	26.0	3.4	21.0	17.6	10.8	4.0
Jan-00	2.8	3.0	2.4	4.6	2.0	3.4	3.6	3.2	2.8
Feb-00	98.0	78.2	100.4	120.0	38.6	59.8	61.8	42.4	47.2

Mar-00	15.6	14.8	13.6	14.6	7.8	17.8	13.4	11.0	16.0
Apr-00	38.6	45.2	42.4	42.0	49.4	39.4	42.6	51.0	42.0
May-00	13.2	10.2	15.2	12.4	7.4	12.2	11.0	6.0	6.8
Jun-00	1.8	1.2	1.2	0.8	4.2	3.6	3.0	3.2	1.4
Jul-00	8.6	8.0	11.8	8.4	2.8	7.0	3.8	4.4	1.4
Aug-00	40.0	22.8	37.8	30.2	45.8	66.4	41.2	41.0	33.8
Sep-00	23.6	15.6	19.6	15.8	7.2	20.4	15.2	13.0	8.6
Oct-00	72.6	41.6	62.6	50.4	34.8	37.0	20.4	25.6	37.8
Nov-00	48.6	28.6	38.8	48.8	42.8	50.0	38.8	46.0	35.8
Dec-00	45.2	35.2	45.0	31.2	21.4	34.8	35.2	18.4	16.8
Jan-01	43.4	44.6	40.2	29.8	84.0	28.2	19.8	52.8	33.6
Feb-01	12.6	1.8	9.6	5.0	5.2	6.8	8.6	17.2	3.0
Mar-01	13.2	9.8	12.0	12.6	11.0	11.8	9.6	10.8	8.4
Apr-01	1.0	1.2	1.0	1.4	0.6	0.6	0.2	0.6	0.8
May-01	11.6	6.6	8.8	9.6	4.6	14.2	10.4	7.6	9.0
Jun-01	113.6	89.4	118.0	96.8	50.8	70.6	66.8	57.4	85.8
Jul-01	17.8	7.6	13.6	10.6	13.4	26.6	15.0	14.0	13.0
Aug-01	1.8	1.8	1.4	2.6	1.4	7.0	4.0	3.8	1.8
Sep-01	60.0	28.8	44.8	34.2	32.8	60.8	36.2	41.0	27.8
Oct-01	63.6	55.2		56.6	57.8	80.2	53.0	59.6	52.2
Nov-01	7.2	4.8		6.4	8.2	16.6	9.8	15.8	9.6
Dec-01	43.0	37.8		43.2	23.4	19.0	29.6	22.0	48.4
Jan-02	33.2	28.4		26.4	5.2	3.0	1.8	2.6	1.0

Note: Data in red denotes corrected or infilled missing data - corrections carried out using double mass plotting

AVERAGE MONTHLY RAINFALLS NOV 1992 TO JANUARY 2002

	Station								
Month	***Gammon Plateau***	***Exclusion Zone***	***Sambot Waterhole***	***Arcoona South***	***Nth Moolooloo***	***Mocatoona***	***Maynard's Well***	***Pfitzner's Well***	***Aroona Dam***
January	37.3	34.4	39.8	19.4	26.6	22.4	30.1	22.6	19.7
February	58.1	54.2	60.6	51.8	28.1	45.1	32.1	35.2	28.1
March	14.4	14.4	13.6	9.8	8.0	14.1	9.0	7.8	7.3
April	8.3	8.1	9.1	14.2	8.9	7.6	8.0	9.5	8.1
May	12.0	9.5	11.7	8.6	9.4	11.6	10.0	7.7	8.8
June	33.6	23.9	30.7	27.8	20.7	33.8	23.5	27.7	27.1
July	30.8	25.1	31.8	25.6	20.6	38.8	23.3	21.5	15.5
August	14.0	9.7	13.1	14.3	10.8	19.3	11.6	11.6	9.0
September	29.9	24.4	29.8	28.7	16.5	30.4	19.6	20.8	17.4
October	33.3	30.1	31.7	34.2	26.3	33.7	25.1	27.6	25.6
November	25.7	22.3	29.6	38.0	14.9	20.7	15.7	18.7	13.9
December	31.6	29.9	38.1	24.5	21.5	33.9	25.0	25.1	21.8
Average Annual Rainfall (mm)	**329.0**	**286.2**	**339.7**	**296.8**	**212.2**	**311.5**	**233.1**	**235.8**	**202.4**

Location	**Average Annual Rainfall**	**Elevation (m)**	**Location**	**Average Monthly Winter Rainfall**	**Average Monthly Summer Rainfall**	**Elevation (m)**
Aroona Dam	202.4	236	Aroona Dam	15.1	20.9	236
North Moolooloo	212.2	315	North Moolooloo	15.4	22.8	315
Pfitzner's Well	235.8	355	Pfitzner's Well	17.1	25.4	355
Maynard's Well	233.1	495	Maynard's Well	17.1	25.7	495
Exclusion Zone	286.2	540	Exclusion Zone	17.1	35.2	540
Mocatoona	311.5	615	Mocatoona	25.9	30.5	615
Arcoona South	296.8	650	Arcoona South	19.1	33.4	650
Sambot Waterhole	339.7	660	Sambot Waterhole	21.8	42.0	660
Gammon Plateau	329.0	930	Gammon Plateau	22.6	38.2	930

Total Rainfall in Gammon Ranges (1998)

Location	**Rainfall**	**Elevation**
Exclusion Zone	275.0	540
Arcoona South	300.2	650
Sambot Waterhole	380.0	660
Gammon Plateau	364.0	930

Total Rainfall in Gammon Ranges (1999)

Location	**Rainfall**	**Elevation**
Exclusion Zone	180.2	540
Arcoona South	211.4	650
Sambot Waterhole	260.8	660
Gammon Plateau	180.4	930

Total Rainfall in Gammon Ranges (2000)

Location	**Rainfall**	**Elevation**
Exclusion Zone	304.4	540
Arcoona South	379.2	650
Sambot Waterhole	390.8	660
Gammon Plateau	408.6	930

Total Rainfall at Comparable Elevations

Location	**Rainfall**	**Elevation**
Maynard's Well	250.6	495
Exclusion Zone	275.0	540
Mocatoona	288.0	615
Arcoona South	300.2	650

Total Rainfall at Comparable Elevations

Location	**Rainfall**	**Elevation**
Maynard's Well	124.8	495
Exclusion Zone	180.2	540
Mocatoona	198.6	615
Arcoona South	211.4	650

Total Rainfall at Comparable Elevations

Location	**Rainfall**	**Elevation**
Maynard's Well	290.0	495
Exclusion Zone	304.4	540
Mocatoona	351.8	615
Arcoona South	379.2	650

MONTHLY RAIN DAYS, NOV 1992 TO JAN 2002

	Station								
Month	***Gammon Plateau***	***Exclusion Zone***	***Sambot Waterhole***	***Arcoona South***	***Nth Moolooloo***	***Mocatoona***	***Maynard's Well***	***Pfitzner's Well***	***Aroona Dam***
Nov-92	6	7	7		2	4	6	5	3
Dec-92	13	8	11		9	13	12	10	14
Jan-93	9	8	8		8	6	5	6	6
Feb-93	3	4	3		3	9	1	3	2
Mar-93	3	3	2		2	3	2	3	3
Apr-93	2	1	1		0	0	1	0	0
May-93	7	4	7		7	7	6	4	6
Jun-93	9	4	6		3	7	4	4	3
Jul-93	13	10	10		9	16	10	7	9
Aug-93	6	4	5		3	5	4		3
Sep-93	6	4	6		4	6	6		6
Oct-93	9	9	10		8	10	9		7
Nov-93	4	4	4		3	5	4	4	4
Dec-93	12	8	11		5	5	6	5	5
Jan-94	2	3	3		0	2	1	1	0
Feb-94	9	7	8		6	6	6	5	6
Mar-94	0	0	1		0	0	0	0	0
Apr-94	0	0	0		0	0	0	0	0
May-94	1	1	2		1	2	1	1	1
Jun-94	9	5	7		5	5	7		6
Jul-94	1	2	2		2	3	3		2
Aug-94	2	3	2		1	3	1	1	0
Sep-94	2	0	2		3	3	3	3	3
Oct-94	0	0	0		1	0	1	1	1
Nov-94	1	2	2		1	1	1	3	0
Dec-94	3	1	3		0	1	1	1	1
Jan-95	9	9	10		7	8	6	7	8
Feb-95	2	2	2		1	3	2	3	3
Mar-95	0	0	0		0	0	0	0	0
Apr-95	4	3	3		3	3		3	3
May-95	8	8	7		6	6		5	5
Jun-95	14	7	10		8	7		6	7
Jul-95	11	8	6		9	7		9	5
Aug-95	3	2	3		1	2		1	1
Sep-95	5	4	5		4	5		4	2
Oct-95	6	5	5		7	8		6	7
Nov-95	10	6	8		5	5	5	5	5
Dec-95	5	4	4		3	5	3	3	3
Jan-96	3	3	3		2	2	2	2	2
Feb-96	3	3	3		3	3		2	3
Mar-96	3	3	1		1	3		2	1
Apr-96	1	0	0		1	1		1	1
May-96	5	3	4		3	2		2	2
Jun-96	9	7	7		7	9		6	8
Jul-96	15	13	14		13	17		14	11
Aug-96	9	7	10		7	7		9	6
Sep-96	7	5	5		6	9		6	6
Oct-96	5	3	5		4	4		3	2
Nov-96	3	2	4		3	2		3	3
Dec-96	5	4	4		3	3	3	3	3
Jan-97	6	4	6		6	3	5	5	2
Feb-97	8	6	7		6	6	6	6	6
Mar-97	2	3	2		0	0	0	0	0
Apr-97	0	0	1		0	0	0	0	0
May-97	8	6	6		5	5	7	6	5
Jun-97	1	1	1		1	2	1	2	2
Jul-97	2	1	3		0	1	0	0	0
Aug-97	7	7	6	6	4	7	5	4	4
Sep-97	10	11	12	11	8	9		7	6
Oct-97	5	2	3	4	3	3		2	3
Nov-97	5	5	5	5	4	4		4	4
Dec-97	5	5	4	6	4	3		4	4
Jan-98	9	4	8	9	7	5	9	5	5
Feb-98	6	4	5	6	3	4	5	4	4
Mar-98	3	3	3	3	0	1	3	2	1
Apr-98	8	6	8	6	5	5	5	6	5
May-98	5	5	3	4	2	1	0	1	1
Jun-98	5	4	5	7	4	5	5	6	6
Jul-98	15	17	16	17	13	15	14	15	12
Aug-98	4	4	3	4	4	4	3	4	6
Sep-98	12	9	9	10	9	10	10	9	6
Oct-98	8	6	6	8	6	6	8	6	4
Nov-98	10	10	8	9	8	9	6	7	7
Dec-98	3	3	3	3	2	2	2	1	1
Jan-99	3	3	2	3	3	2	1	0	0
Feb-99	6	3	4	4	2	3	2	2	4
Mar-99	10	8	7	6	7	10	13	6	7
Apr-99	0	0	0	0	1	0	1	0	0
May-99	1	0	0	0	2	3	2	4	3
Jun-99	5	5	4	3	4	6	6	3	2
Jul-99	6	3	5	4	1	1	1	2	1
Aug-99	3	4	3	3	3	3	3	3	2
Sep-99	8	10	8	8	6	7	6	3	7
Oct-99	12	11	9	9	6	7	6	6	4
Nov-99	6	7	5	8	3	4	4	4	6

Dec-99	10	10	10	12	3	4	6	4	3
Jan-00	3	2	2	3	2	2	2	2	1
Feb-00	8	6	6	7	3	4	5	5	4
Mar-00	7	6	5	4	5	6	5	3	3
Apr-00	10	6	7	5	4	7	4	5	5
May-00	5	5	4	5	4	4	5	5	5
Jun-00	6	4	3	3	3	3	2	3	3
Jul-00	6	6	7	5	4	5	3	6	3
Aug-00	11	8	8	9	9	10	10	11	7
Sep-00	6	6	5	7	5	5	6	6	3
Oct-00	9	7	8	8	6	7	7	7	6
Nov-00	13	10	10	11	9	8	7	8	8
Dec-00	5	5	5	6	4	5	3	3	3
Jan-01	13	5	7	9	4	7	6	5	6
Feb-01	3	2	3	2	2	2	2	2	2
Mar-01	4	4	4	4	2	3	3	2	3
Apr-01	3	1	3	2	1	2	1	2	2
May-01	8	8	6	8	2	7	4	5	3
Jun-01	14	9	11	8	6	7	5	10	6
Jul-01	12	7	10	8	6	8	5	7	5
Aug-01	5	3	4	7	3	8	5	4	3
Sep-01	5	7	5	7	5	7	6	6	6
Oct-01	10	9		9	7	9	8	7	5
Nov-01	5	4		7	4	4	4	4	4
Dec-01	8	8		7	6	5	5	6	6
Jan-02	3	3		3	3	3	2	3	2

MONTHLY AVERAGE RAIN DAYS NOV 1992 TO JANUARY 2002

	Station								
Month	***Gammon Plateau***	***Exclusion Zone***	***Sambot Waterhole***	***Arcoona South***	***Nth Moolooloo***	***Mocatoona***	***Maynard's Well***	***Pfitzner's Well***	***Aroona Dam***
January	6.0	4.4	5.4	5.4	4.2	4.0	3.9	3.6	3.2
February	5.3	4.1	4.6	4.8	3.2	4.4	3.6	3.6	3.8
March	3.6	3.3	2.8	4.3	1.9	2.9	3.3	2.0	2.0
April	3.1	1.9	2.6	3.3	1.7	2.0	1.7	1.9	1.8
May	5.3	4.4	4.3	4.3	3.6	4.1	3.6	3.7	3.4
June	8.0	5.1	6.0	5.3	4.6	5.7	4.3	5.0	4.8
July	9.0	7.4	8.1	8.5	6.3	8.1	5.1	7.5	5.3
August	5.6	4.7	4.9	5.8	3.9	5.4	4.4	4.6	3.6
September	6.8	6.2	6.3	8.6	5.6	6.8	6.2	5.5	5.0
October	7.1	5.8	5.8	7.6	5.3	6.0	6.5	4.8	4.3
November	6.3	5.7	5.9	8.0	4.2	4.6	4.6	4.7	4.4
December	6.9	5.6	6.1	6.8	3.9	4.6	4.6	4.0	4.3
Average Annual Rain Days	**73.0**	**58.7**	**62.8**	**72.5**	**48.3**	**58.6**	**51.8**	**50.8**	**45.9**
Elevation (m)	**930**	**540**	**660**	**650**	**315**	**615**	**495**	**355**	**236**

Location	**Average Annual Rain Days**	**Elevation (m)**
Aroona Dam	45.9	236
North Moolooloo	48.3	315
Pfitzner's Well	50.8	355
Maynard's Well	51.8	495
Exclusion Zone	58.7	540
Mocatoona	58.6	615
Arcoona South	72.5	650
Sambot Waterhole	62.8	660
Gammon Plateau	73	930

Location	**Average Monthly Winter Rain Days**	**Average Monthly Summer Rain Days**	**Elevation (m)**
Aroona Dam	4.3	3.9	236
North Moolooloo	4.6	3.9	315
Pfitzner's Well	5.2	4.0	355
Maynard's Well	4.4	4.2	495
Exclusion Zone	5.4	5.0	540
Mocatoona	5.8	4.4	615
Arcoona South	6.0	6.2	650
Sambot Waterhole	5.8	5.5	660
Gammon Plateau	7.0	6.1	930

Number of Rain Days in Gammon Ranges

Location	**Rain Days**	**Elevation**
Exclusion Zone	75	540
Arcoona South	86	650
Sambot Waterhole	77	660
Gammon Plateau	88	930

Number of Rain Days in Gammon Ranges

Location	**Rain Days**	**Elevation**
Exclusion Zone	71	540
Arcoona South	73	650
Sambot Waterho	70	660
Gammon Plateau	89	930

Number of Rain Days in Gammon Ranges

Location	**Rain Days**	**Elevation**
Exclusion Zone	64	540
Arcoona South	60	650
Sambot Waterhole	57	660
Gammon Plateau	70	930

Number of Rain Days at Comparable

Location	**Rain Days**	**Elevation**
Maynard's Well	70	495
Exclusion Zone	75	540
Mocatoona	67	615
Arcoona South	86	650

Number of Rain Days at Comparable

Location	**Rain Days**	**Elevation**
Maynard's Well	51	495
Exclusion Zone	64	540
Mocatoona	50	615
Arcoona South	60	650

Number of Rain Days at Comparable

Location	**Rain Days**	**Elevation**
Maynard's Well	59	495
Exclusion Zone	71	540
Mocatoona	66	615
Arcoona South	73	650

APPENDIX B

Double Mass Plotting Used to Correct and Infill Missing Data from the Maynard's Well and Pfitzner's Well Stations

MW:

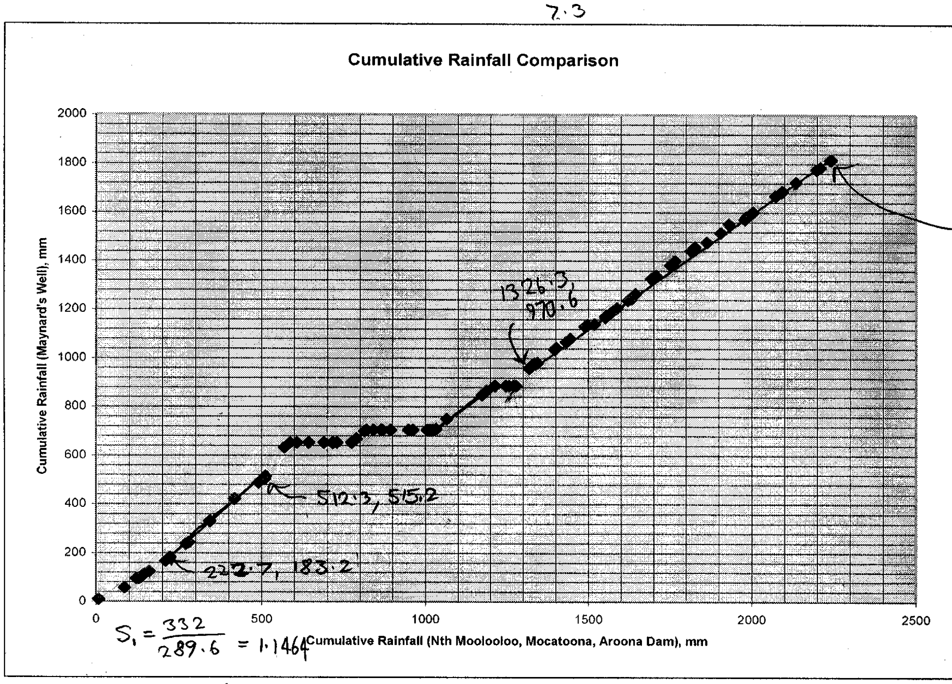
Sep 93 – Dec 94

5.0
43.1
4.8
68.8
2.7
70.8
0
0
1.6
52.6
10.0
0.2
2.3
6.8
2.1
1.3

Apr 95 – Sep 95: 19.3, 32.9, 42.9, 24.8, 0.4, 10.9, 41.2

Feb 96 – Nov 96: 18.9, 22.3, 0.3, 3.4, 23.3, 50.3, 12.4, 40.4, 8.5, 7.3

Sep 97 – Dec 97: 30.6, 9.2, 12.0, 7.1



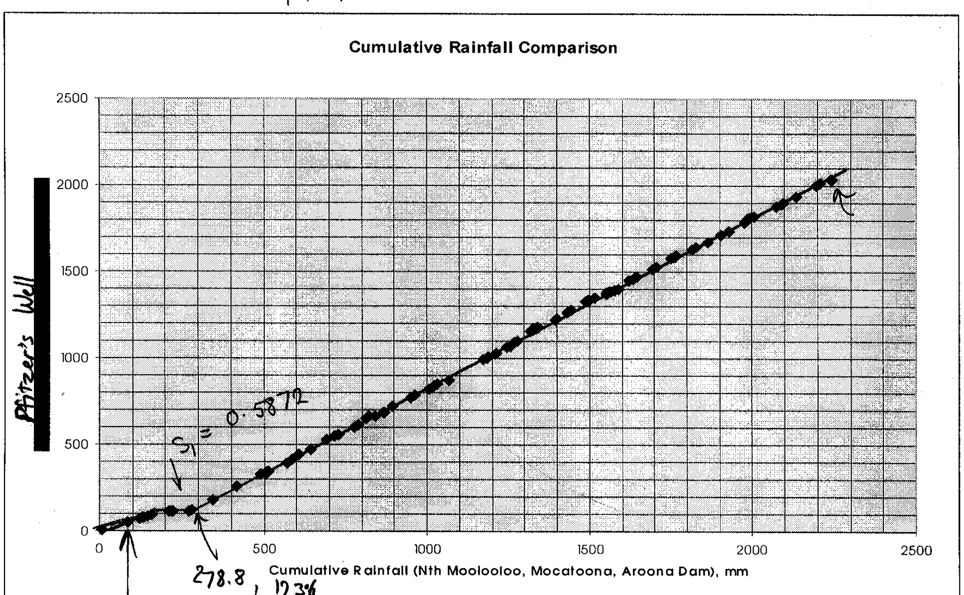
2243.4, 1816.4

$S_2 = \frac{845.8}{917.1} = 0.922$

$MW' = \frac{0.922}{1.1464} MW = 0.804\ MW$

Pfitzner's Well July 94

Interpolation: 13.7



2243.4, 2039.0

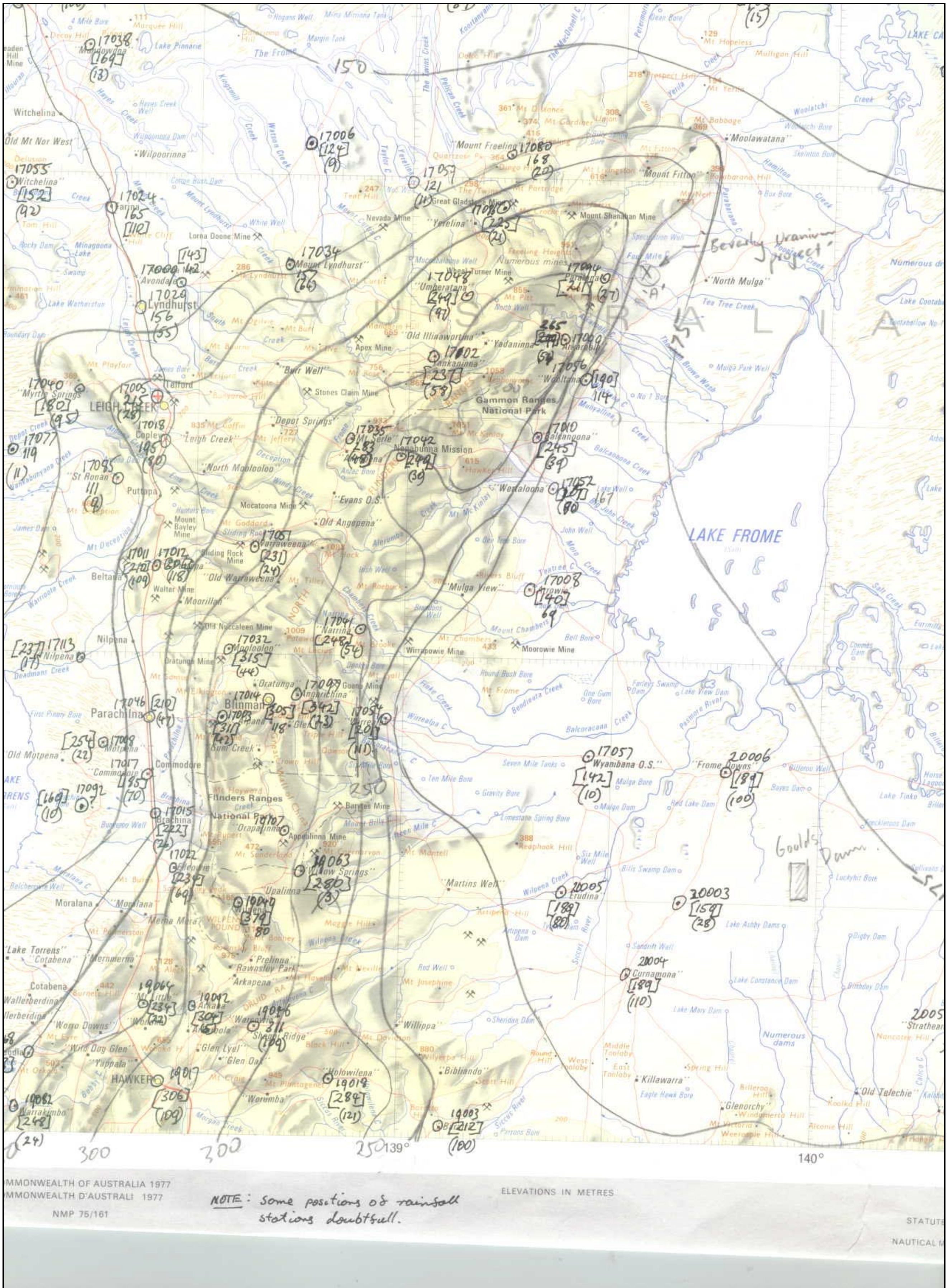
$S_2 = \frac{1915.4}{1964.6} = 0.9750$

Correcting slope: $PW' = \frac{0.9750}{0.5872} PW = 1.6604\ PW$

11.0
77.7
26.6
12.3
1.3
0.0
9.3
17.3
36.5
9.9
3.8
46.0

APPENDIX C

Long-Term Estimated Rainfall Map (Source: Broken Hill 1977 map – hand annotated by Kevin Burrows, Climate Services, Bureau of Meteorology, Adelaide, 1994)


Gammon Ranges
National Park
Flinders Ranges
National Park
LAKE FROME
Leigh Creek
Lyndhurst
Copley
Parachilna
Blinman
HAWKER
Arkaroola
Mount Freeling
Beverly Uranium Project
Goulds Dam
MMONWEALTH OF AUSTRALIA 1977
MMONWEALTH D'AUSTRALI 1977
NMP 75/161
ELEVATIONS IN METRES
NOTE: Some positions of rainfall stations doubtfull.
139°
140°