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A statistical analysis of flood hydrology and bankfull discharge for the Daly River catchment, Northern Territory, Australia.

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Cover Photograph: Daly River channel in the vicinity of Daly River Crossing.
Photographer: Gary Caitcheon

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Acknowledgements

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Executive Summary

This report presents a flood frequency analysis for ten gauging stations within the Daly River catchment. A flood frequency analysis allows the estimation of the magnitude of selected flood quantiles, such as a 1 in 20 year flood, at particular gauging stations. A series of statistical relationships were developed to allow flood quantile estimation at ungauged locations. Finally, estimates of bankfull discharge and its corresponding recurrence interval were obtained from gauging station cross section, direct stream gaugings and rating curve data. Bankfull discharge in the Daly River catchment has a recurrence interval from less than two to more than eight years on average at the stations examined here.

1 Introduction

The Daly River, located in tropical northern Australia, has been identified as a river of high conservation value (see for example Blanch et al. 2005). It has the highest dry season baseflow of any Northern Territory river, a largely unmodified flow regime and a relatively undisturbed catchment (Faulks 1998). The river provides important habitat for aquatic flora and fauna (including the endangered pig-nose turtle, *Carettochelys insculpta*, Erskine et al., 2003) and is valued as an important recreational fishery (Harrison 2003). Managing water quantity and quality in this catchment is consequently of importance.

Project 4.2 (Regional scale sediment and nutrient budgets) of the Tropical Rivers and Coastal Knowledge (TRaCK) research hub is concerned with the identification of erosion sources in different parts of the Daly River catchment. One component of this research involves application of the SedNet model (Prosser et al. 2001) to model catchment sediment and nutrient budgets. A suite of hydrologic parameters, some of which relate to flood flows, are required to run the SedNet model (Wilkinson et al. 2006). This study presents a statistical analysis of flood hydrology in the Daly River catchment firstly as contribution to understanding the hydrology of a relatively undisturbed tropical river and secondly to derive some of the required hydrologic parameters for use in the modelling of catchment scale sediment budgets in the Daly River catchment.

2 Study Site

The Daly River catchment is located in the north of the Northern Territory, Australia (Figure 1) and flows to the Timor Sea via Anson Bay. The catchment is generally of low relief with a maximum elevation of less than 500 m above sea level. Rocky plateaus occur in the headwaters of the Katherine River (as part of the Arnhem Land plateau) and along the catchment's western margin. The central part of the catchment comprises generally flat to undulating terrain. The Daly River passes through the prominent Nancar Range (on the upstream side of which gauging station 8140040 is located) and a short distance downstream of this, the river is tidal under dry season flow. Chappell and Bardsley (1985) have analysed the hydrology of this reach of the river. Extensive alluvial and estuarine floodplains flank the river downstream of the Nancar Range. Floodplain geometry is variable upstream. The estuarine reaches of the Daly River are macrotidal, experiencing a maximum spring tide range of 6–8 m (Chappell and Ward 1985). Faulks (1998) describes Eucalypt woodland with grass understorey as the dominant catchment vegetation and estimates that roughly 6% of the catchment's original vegetation has been cleared for intensive agriculture. Much of the catchment presently experiences low intensity cattle grazing with more intensive agricultural landuse occurring in the vicinity of Katherine and along the Douglas River.

The catchment experiences a tropical savanna climate as defined by Stern et al. (2000) that is characterised by two distinct seasons: a dry season from May to September and a wet season from November to March. Approximately 90% of the catchment's rainfall falls during the wet season, usually in high-intensity falls (Faulks 1998) and maximum observed daily rainfalls are between 100 and 200 mm. A comprehensive description of the catchment can be found in Faulks (1998) whilst Chappell (1993) describes the evolution of the estuarine plains.

3 Methods

3.1 Flood frequency analysis

Daily maximum streamflow observations were obtained for stations listed in Table 1 from the Northern Territory Department of Natural Resources, Environment and the Arts. These stations represented the main gauging stations in the catchment with well rated sections and relatively complete, long duration records and all data were used from each station. Figure 1 is a map of the catchment and shows the gauge locations. A peaks-over-threshold analysis has been used to identify statistically independent flood peaks. This approach requires a threshold discharge to be selected to differentiate flood from non-flood conditions. As a single flood (or a single wet season) may have multiple peaks, the second step in a peaks over threshold approach is to specify a minimum time period for which discharge must be below the threshold value for a sequence of floods to be considered independent. We follow the recommendation of Lang et al. (1999) that a range of threshold values be explored and have, for each station conducted a peaks over threshold analysis using a stepped sequence of thresholds. Lang et al. (1999) recommend that the threshold be chosen such that the distribution of the mean exceedence of flood peaks above the threshold range is a linear

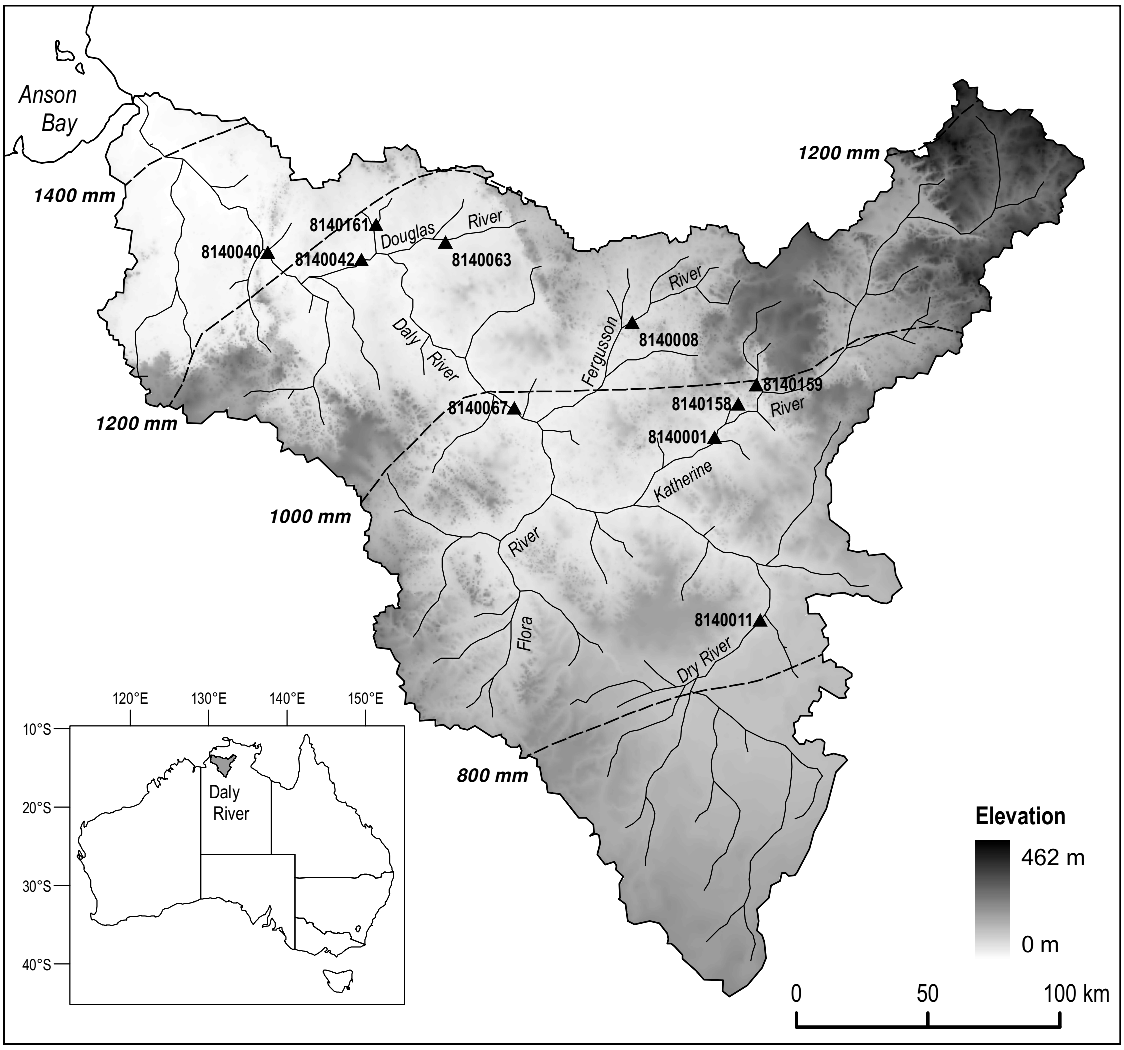

Figure 1: Map of the Daly River catchment showing gauging stations, main drainage lines, elevation and mean annual rainfall isohyets.

function of threshold magnitude and secondly, the selection of the largest threshold within this range that gives a mean number of floods per year greater than two. For the Daly River catchment, more emphasis was placed on identifying the peak in mean number of floods per year as the mean exceedence criteria was deemed to be of lesser use. A minimum inter-flood period of 30 days has also been selected. Note that the inter-flood period pertains to the period between the time of the falling limb of the previous flood crossing the threshold and the time when the rising limb of the next flood crosses the threshold, not the time between flood peaks. Using this approach, the mean maximum number of floods per year ranges from 1.18 to 1.52 for the selected stations (see Table 1. This value is less than the value of 2 recommended by Lang et al. (1999) but a similar result was obtained for a large number of other Australia gauges by Rustomji et al. (2009) suggesting this may be a common occurrence in Australian environments as opposed to the French streams studied by Lang et al. (1999). The peaks over threshold analysis was conducted within R (R Development Core Team 2005) using the “pot” (Peaks Over Threshold) and “decluster” algorithms in the Extreme Values in R package (McNeil 2007).

Station	Name	Area (km^2)	From	To	Q_{max} (m^3s^{-1})	Threshold (m^3s^{-1})	Mean number of floods per year
8140001	Katherine River at Railway Bridge	8640	1961-07-02	2007-05-31	9390	60	1.43
8140008	Fergusson River at Old Railway Bridge	1490	1957-06-19	2007-05-01	3127	31	1.47
8140011	Dry River at Manbulloo Boundary	6290	1967-11-22	2007-03-02	2671	7	1.18
8140040	Daly River at Mount Nancar	47100	1969-12-08	2007-07-02	8292	54	1.33
8140042	Daly River 2 km downstream of Beeboom Crossing	41000	1981-11-29	2007-08-21	7486	44	1.26
8140063	Douglas River downstream of Old Douglas Homestead	842	1957-09-07	2007-08-01	1941	5	1.27
8140067	Daly River upstream of Dorisvale Crossing	35800	1965-01-02	2007-07-23	8354	95	1.41
8140158	McAdden Creek at Dam Site	133	1962-11-16	2007-08-22	981	9	1.26
8140159	Seventeen Mile Creek at Waterfall View	619	1962-11-17	2007-08-17	1179	10	1.52
8140161	Green Ant Creek at Tipperary	435	1966-08-26	2007-08-19	434	3	1.45

Table 1: Gauging station details. Q_{max} denotes maximum observed instantaneous discharge, Threshold denotes the threshold value used in peaks over threshold analysis.

3.2 Plotting positions

Plotting positions for the observed flood series were calculated according to Cunnane (1978) using the formula:

$$t = \frac{n + 0.2}{r - 0.4} \tag{1}$$

where n is the number of years of record and r is the sample rank, and the flood with a recurrence interval of t years is denoted Q_t.

3.3 Probability density function selection

A critical issue in flood frequency analyses is the selection of an appropriate probability density function to represent the observed flood series. Both in Australia and north America, the Pearson Type-III distribution fitted to the log-transformed flood series (referred to as the log Pearson-III distribution) has traditionally been recommended for flood frequency modelling (see for example Pilgrim and Doran 1987). However, Vogel et al. (1993) and Rustomji et al. (2009) observed that other statistical distributions may potentially be more appropriate for Australian data. Here, L-moment ratio diagrams (Hosking 1990; Vogel and Fennessey 1993; Hosking and Wallis 1997) have been used to select a suitable probability density function.

A sample of flood peaks can be characterised by four statistical moments: the first and second moments are the mean value and standard deviation respectively, which essentially indicate the magnitude and variability of the distribution, yet provide no discrimination about which theoretical distribution is closest to the characteristics of the data. The third and fourth moments, being measures of skewness and kurtosis, allow for discrimination between the shapes of different probability density functions. Hence, they can be used to select a probability density function that most closely resembles the shape of the data. L-moments, being linear combinations of the sample data (as opposed to the exponentiated combinations of traditional moments) have also been argued to be more robust estimators of a distribution's shape as they are less sensitive to extreme events (Vogel and Fennessey 1993). L-moment ratio diagrams are plots of L-skewness versus L-kurtosis onto which the L-skewness and L-kurtosis values for each dataset (ie. selection of flood peaks) are plotted. Then, theoretical L-skewness and L-kurtosis values (as given in Hosking and Wallis 1997) for the contender probability density functions to be evaluated are also plotted (they may be shown as curves or points depending on the nature of the theoretical distribution). The theoretical distribution to which the observed values are closest can then be evaluated, either numerically or visually. In this case, a visual examination of the L-moment ratio diagram was used to select the distribution.

3.4 Flood quantile estimation

L-moments have also been used to estimate the parameters of the selected flood frequency distribution. As is shown in Figure 2, the Generalised Extreme Value (GEV) distribution appears to be a fair representation of the shape of the flood frequency distribution for gauging stations in the Daly River catchment. The GEV distribution has three parameters: ξ (location), α (scale) and κ (shape). The quantile function for the GEV distribution is:

$$x(F) = \begin{cases} \xi + \frac{\alpha}{\kappa}\{1 - (-\log F)^{\kappa}\}, & \kappa \neq 0 \\ \xi - \alpha \log(-\log F), & \kappa = 0 \end{cases} \tag{2}$$

where x(F) is the quantile for non-exceedance probability F, ξ is a location parameter, α is a scale parameter, and κ is a shape parameter. All parameters have been estimated from the sample L-moments (as per Hosking 1990, 1996; Hosking and Wallis 1997) using the "lmomco" package (Asquith 2007) in R (R Development Core Team 2005) and are listed for each station in Table 2.

Confidence intervals for the flood quantiles with return periods greater than 2 years have also been calculated using Monte Carlo simulation and an assumed normal error distribution around the fitted flood frequency curve, using the method described by Asquith (2007):

1. For nsim simulation runs (ideally a very large number, in this case nsim = 1000), samples of size n are drawn from Q(F,θ) using the randomly selected F values drawn from a uniform distribution with range 0 to 1 and θ is the parameter set estimated from the original data.

2. The L-moments of the simulated sample are computed and a GEV distribution is fitted to these simulated L-moments resulting in a slightly different parameter set θ^* from that determined from the original data.

3. The F-quantile of the synthetic distribution is computed and placed into a vector.

4. The process of simulating the sample, computing the L-moments, computing the distribution parameters, and solving for the F-quantile is repeated for the specified number of simulation runs.

5. This process is repeated for a sufficient number of non-exceedence probabilities F to draw smooth confidence limits around the main curve

The parameters of a normal distribution are estimated for each quantile F using L-moments and the 2.5th and 97.5th quantiles of this normal error distribution are used to provide a 95% confidence interval for the model fit.

3.5 Bankfull discharge analysis

Bankfull discharge is the discharge at which flow overtops the river banks and spills from the channel onto the floodplain. Understanding its occurrence within the catchment is critical for understanding hydrologic linkages between the channel and the floodplain. Bankfull discharge can be estimated through examination of the shape of a gauging station's rating curve with its cross section. Bankfull stage should be evident from the surveyed cross section and from an inflection in the rating curve for a given station. Consequently, rating curves (the relationship between stage height and discharge) and channel cross section data was obtained from the Northern Territory Department of Natural Resources, Environment and the Arts.

4 Results

4.1 Threshold selection for identification of flood events

For each gauging station, the results of the threshold identification algorithm are shown in the Appendices (see for example Figure 6). In general, reasonably well defined peaks were identified in the number of flood events/year statistic, with maximum values typically in the range 1.0–1.5 independent flood peaks per year. A clear peak was not evident for station 8140011 (Dry River at Manbullo Boundary, see Figure 14), however this is an ephemeral river draining a relatively dry catchment and the monotonic decrease in the "mean number of floods/year" simply reflects that the selected inter flood period is generally shorter than the interval between major flow events. The curve for station 8140158 (McAdden River at Dam Site, Figure 34) was similar, again reflecting the ephemeral nature of runoff generated by the small (133 km^2) catchment. The "mean threshold exceedance" curves are also reasonably linear in the vicinity of the peak in the "mean number of floods/yr" curve, consistent with the recommendations Lang et al. (1999). The specific thresholds identified for each gauging station (based on the peak in the "mean number of floods/year" curve) are listed in Table 1, with values ranging from 3 to 95 m^3s^{-1}. Not surprisingly threshold values scale with catchment area.

4.2 Identification of flood peaks

Each station's flood peaks, identified by the peaks over threshold analysis and derived using the thresholds listed in Table 1 are listed in the Appendix, along with their calculated plotting positions. Both linear and log-scaled hydrographs for each station are also given in the Appendix with the flood peaks identified by the peaks over threshold analysis shown by open diamond symbols.

4.3 Probability distribution selection using L-moment ratio diagrams

The L-moment ratio diagram for the peaks over threshold flood series' from the Daly River catchment are shown in Figure 2. For completeness, L-moment ratio diagrams for the annual maximum series and log-transformed annual maximum series are also shown. As mentioned above, the Generalised Extreme Value distribution appears a suitable distribution for modelling the distribution of flood peaks in the Daly River catchment as the curve for this distribution appears to bisect the distribution of L-moment ratios calculated from the peaks over threshold flood series.

4.4 Flood quantile estimation

The three parameters of the GEV distribution calculated from the sample L-moments (based on floods with an estimated return period $>$ 1 year) are listed in Table 2. Figure 3 shows the fitted flood frequency curves for all stations and equivalent, larger plots are shown for each station in the appendix along with estimates of 7 selected flood quantiles. The fitted

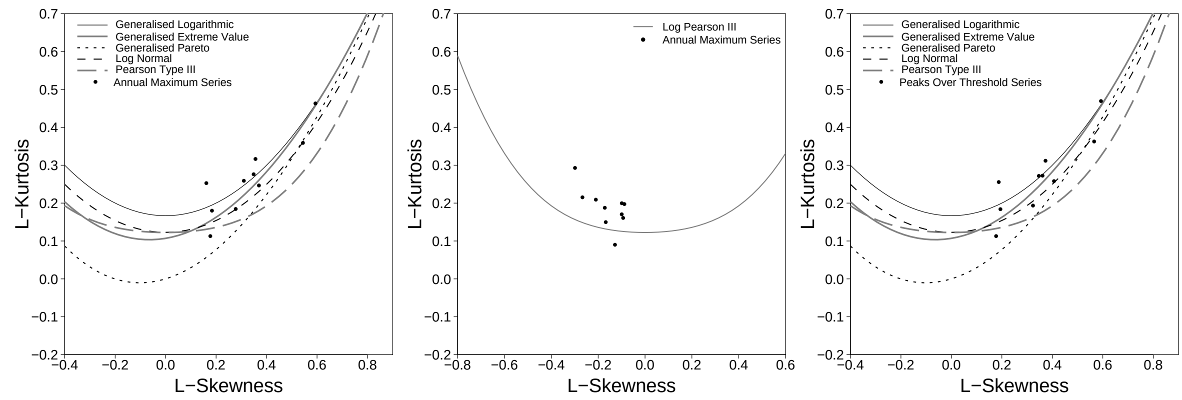

Figure 2: L-moment ratio diagrams for flood peak data from the Daly River catchment. The three panels show L-moment ratios for the annual maximum series, log-transformed annual maximum series and peaks over threshold flood series.

flood frequency curves generally fit the observed data well, though poorer (yet still arguably acceptable) fits are evident for stations 8140011 and 8140063.

Station	ξ	α	κ
8140001	914.5	585.8	-0.2933
8140008	468.1	285.2	-0.2576
8140011	76.53	91.6	-0.5695
8140040	1820	1300	-0.03758
8140042	1708	1052	-0.02746
8140063	112.7	120.6	-0.5373
8140067	1887	1369	-0.01118
8140158	106.8	90.63	-0.3381
8140159	157.6	114.5	-0.2255
8140161	58.03	45.95	-0.2775

Table 2: Fitted parameters for the generalised extreme value distribution. Values have been reported to four significant digits.

It is clear from both the time series plot of discharge and fitted flood frequency curve figure for station 8140001 (Katherine River at Railway Bridge) that the largest observed flood on record (in 1998, 9390 m^3s^{-1}) was a highly anomalous event and indeed caused significant flooding around the Katherine township (Anonymous 2000). It plots well beyond the range of the other flood peaks (of which there are a number around 3000 m^3s^{-1}, see Figure 7). It also plots beyond the 95% confidence interval for the fitted flood frequency curve (Figure 9). Moreover it exerts significant leverage on the fitted curve and estimated flood quantiles

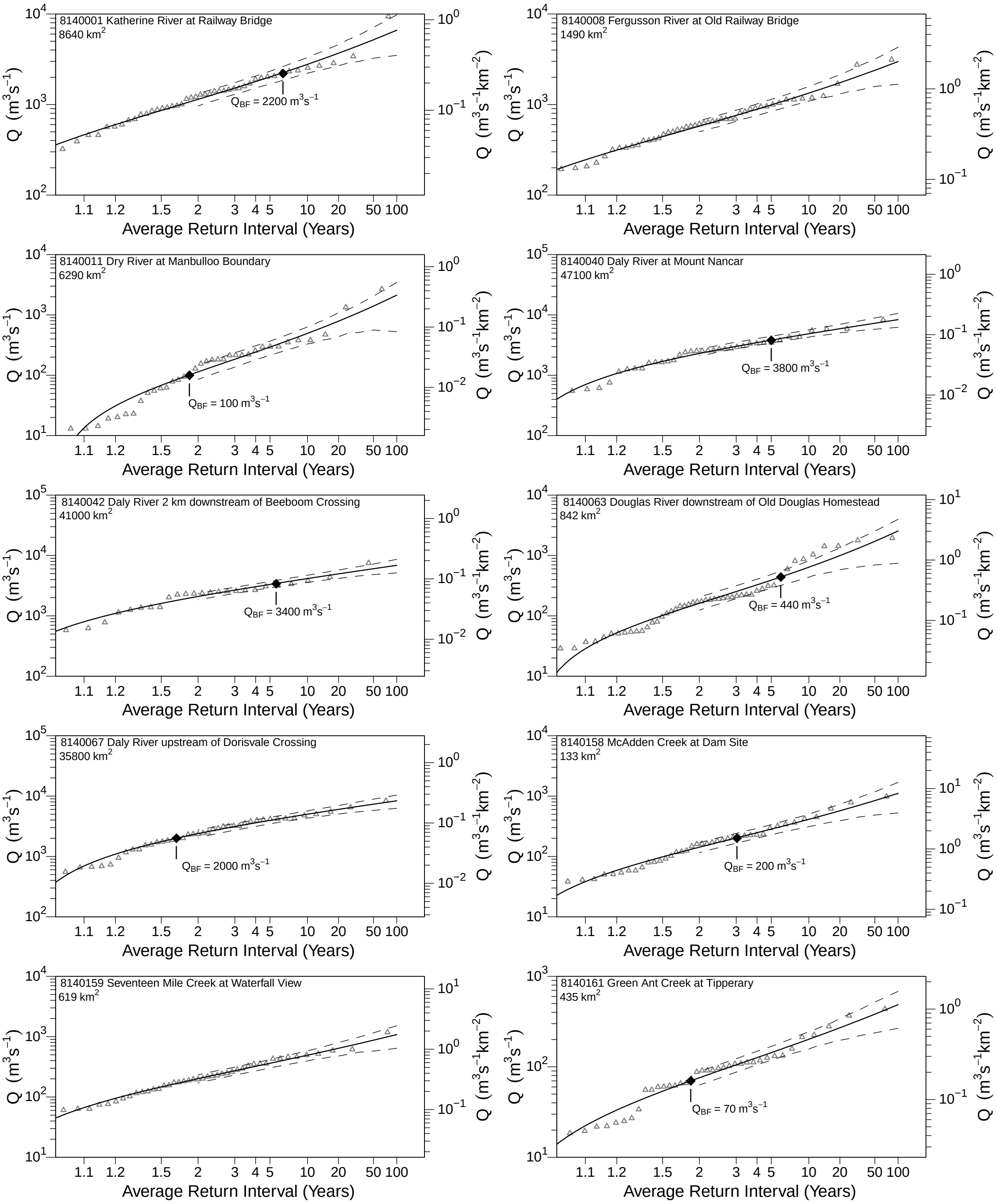

Figure 3: Fitted flood frequency curves (solid line) and 95% confidence intervals (dashed line) for the Daly River catchment. The observed flood peaks are shown with open triangle symbols, the black diamond shows bankfull discharge for stations where it was able to be calculated.

for events with recurrence intervals greater than 20 years would be substantially lower if this event were removed from the curve fit. The question of whether to remove this observation is debatable - removing it would result in a better statistical fit to the remainder of the data (particularly events with recurrence intervals $>$ 5 years). However this could potentially result in a significant underestimate of the likely magnitude of events with recurrence intervals $>$ 50 years. It is noted that Anonymous (2000) present an alternative (and arguably more comprehensive) flood frequency for gauging station 8140001 which incorporates some additional historic observations of large floods before the period when stream gauging commenced. The effect of incorporating these additional observations is that the flood quantile estimates contained in Anonymous (2000) for events with recurrence intervals greater than 5 years are approximately 20% larger than those estimated here.

4.5 Regional flood quantile estimation

The capacity to predict flood quantiles at ungauged locations is valuable for a range of issues including modelling of floodplain inundation. Using a selection of flood quantiles derived from the flood frequency analysis described above, a series of regional regression relationships have been developed. After some experimentation, it was found that the following model provided a good fit to the observed flood quantiles:

$$Q_x = b \times \sqrt{area} \times rain \tag{3}$$

where Q_x is the flood quantile with an average return period of x years, b is a parameter estimated by least squares regression and area and rain are upstream catchment area (km^2) and mean annual upstream rainfall (mm) respectively. The gridded mean annual rainfall surface derived by Jeffrey et al. (2001) has been used in this case. Note that this is an empirical, statistically based relationship not one based closely on physical hydrology. Figure 4 shows the observed versus predicted plots of the model fits along with the fitted values of b. The 95% confidence intervals of the GEV flood frequency curves are shown along with the 95% prediction interval of the regression relationship for each return period. The fitted relationships and b values were all highly statistically significant and the models explain a very large portion of the observed variance (adjusted $R^2 \geq 0.96$ in all cases). Whilst there is congruence between observed and predicted values for almost all data points when their uncertainties are considered, there is the suggestion of systematic under prediction of flood magnitude for small magnitude ($< 1000 m^3 s^{-1}$) floods with 2 and 5 year mean recurrence interval events, though this under-prediction disappears for events with a longer recurrence interval.

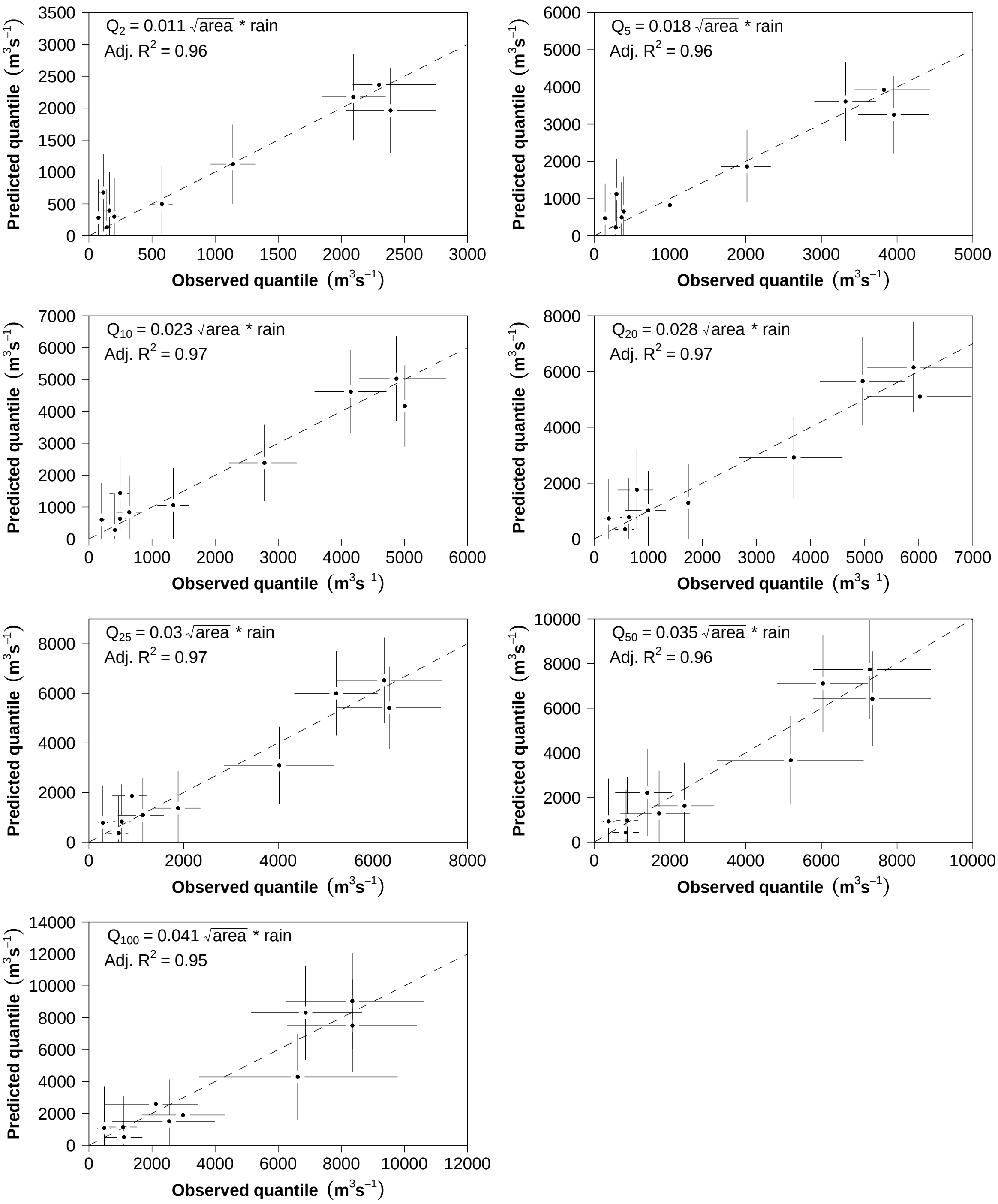

Figure 4: Observed versus predicted plots of selected flood quantiles for the Daly River catchment using upstream catchment area (km^2) and mean annual upstream rainfall (mm) as predictive variables.

4.6 Bankfull discharge and its recurrence interval

Figure 5 shows surveyed channel cross sections at the six gauging stations in the catchment where well defined, alluvial river banks were present (ie. it excludes surveyed sections from bedrock gorges) from which the stage height corresponding to the bank top can be discerned. The corresponding and most recent stage height-discharge rating curve as used for streamflow calculation, is also plotted. As noted above the point at which bankfull discharge occurs can, in some cases, also be derived from a characteristic inflection in the rating curve defining the point where the rate of increase in discharge with increasing stage height decreases. Bankfull discharges for these six gauging stations are shown on Figure 5. Note for gauging station 8140001, a stage height of 17 m has been adopted based on the observations within Rajaratnam et al. (2004) that this is the stage height at the gauging station at which flow spreads beyond the channel.

Figure 3 shows that the mean return interval of bankfull discharge within the catchment varies from slightly less than 2 years (for stations 8140011, 8140067 and 8140161) to approximately 8 years for station 8140001. For the two lowermost gauging stations on the Daly River (8140042 and 8140040), the mean return interval of bankfull discharge is approximately 5 years. Note however that along the Daly River in the vicinity of gauges 8140042 and 8140040 there are numerous flood chutes and levee breaches that allow water to flow from the channel out onto the floodplain at lower discharges or stage heights. Thus the 5 year recurrence interval of bankfull discharge should be viewed as the recurrence interval of major, valley-wide overbank flooding along extensive reaches of the channel, not just the recurrence interval of flow through the levee breaches and flood chutes which most likely happens on a near-annual basis.

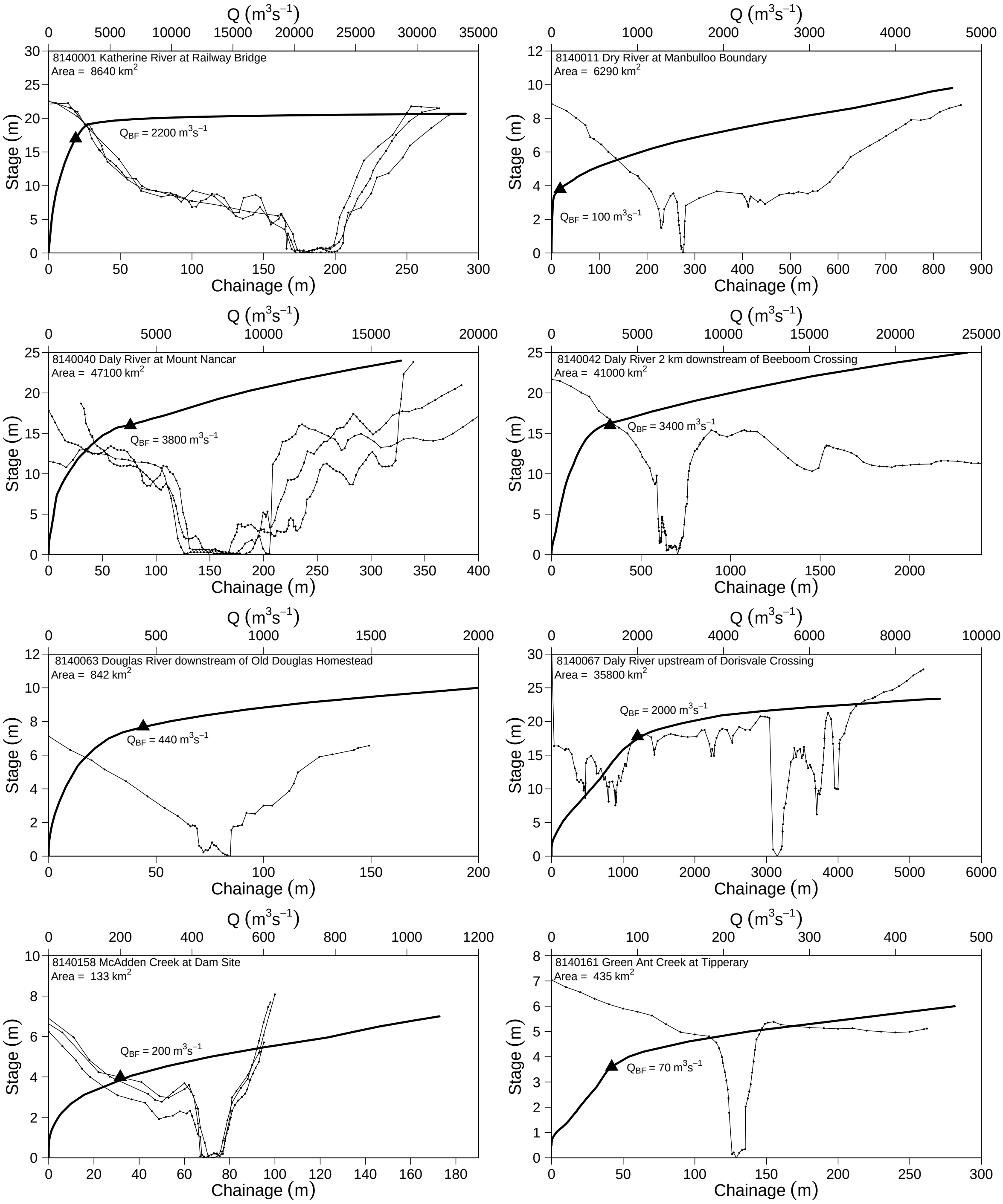

Figure 5: Surveyed channel cross sections and gauging station rating curves for the six gauging stations in the Daly River catchment with well defined alluvial banks. The solid triangle symbol show the position of the estimated bankfull discharge on the rating curve. Figure 3 shows the average recurrence interval of bankfull discharge.

5 Conclusions

This report presented a flood frequency analysis for 10 stations in the Daly River catchment. Flood peaks were identified using a peaks-over-threshold approach and the flood frequency distributions was modelled using the Generalised Extreme Value distribution. Fitted flood frequency quantiles were presented for a selected number of quantiles. Regional regression relationships were also developed allowing for the prediction of selected flood quantiles at ungauged locations using catchment area and mean annual upstream rainfall as predictive variables. Finally, bankfull discharge rates were estimated at eight gauging stations. Estimated return periods of bankfull discharge between less than two to approximately eight years, averaging 5 years across the catchment.

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Appendices

A 8140001 Katherine River at Railway Bridge

Return Period (years)	Q (m^3s^{-1})	Year	Water Year
0.70	61	2003	2003/2004
0.72	62	2000	2000/2001
0.73	64	1991	1991/1992
0.74	68	1970	1970/1971
0.75	70	1972	1972/1973
0.76	74	1998	1998/1999
0.78	76	1992	1991/1992
0.79	78	1966	1966/1967
0.80	85	1989	1989/1990
0.82	95	1963	1963/1964
0.83	104	1974	1974/1975
0.85	108	1988	1987/1988
0.86	113	1998	1997/1998
0.88	122	1992	1992/1993
0.90	137	1964	1963/1964
0.91	148	1984	1984/1985
0.93	160	1971	1970/1971
0.95	171	1969	1969/1970
0.97	171	1990	1989/1990
0.99	180	1986	1985/1986
1.01	271	1969	1969/1970
1.04	305	1986	1985/1986
1.06	322	1964	1963/1964
1.08	391	1962	1961/1962
1.11	459	1970	1969/1970
1.14	460	1965	1964/1965
1.17	563	1985	1984/1985
1.20	569	1996	1995/1996
1.23	600	1982	1981/1982
1.26	669	1983	1982/1983
1.30	688	2005	2004/2005
1.34	773	1981	1980/1981
1.38	785	1992	1991/1992
1.42	848	1988	1987/1988
1.46	873	1964	1964/1965
1.51	906	1978	1977/1978
1.56	922	1979	1978/1979
1.62	954	1967	1966/1967
1.67	969	1963	1962/1963
1.74	1004	1972	1971/1972
1.80	1150	1969	1968/1969
1.88	1191	1994	1993/1994
1.96	1214	1999	1998/1999
2.04	1284	2007	2006/2007
2.14	1293	1973	1972/1973
2.24	1304	1975	1974/1975
2.36	1400	1977	1976/1977
2.48	1405	2003	2002/2003
2.63	1414	1966	1965/1966
2.78	1454	1989	1988/1989
2.96	1501	1991	1990/1991
3.16	1509	1980	1979/1980
3.40	1587	1997	1996/1997
3.67	1701	2001	2000/2001
3.98	1895	1995	1994/1995
4.36	1968	2003	2003/2004
4.81	2027	1974	1973/1974
5.37	2060	1976	1975/1976
6.08	2234	2002	2001/2002
7.00	2322	1993	1992/1993
8.25	2375	2000	1999/2000
10.04	2544	1987	1986/1987
12.83	2673	1968	1967/1968
17.77	2860	1984	1983/1984
28.88	3403	2006	2005/2006
77.00	9390	1998	1997/1998

Table 3: Flood peaks identified by the peaks over threshold analysis for station 8140001.

Return Period (years)	Lower C.I. (m^3s^{-1})	Estimated Quantile (m^3s^{-1})	Upper C.I. (m^3s^{-1})
2	965	1141	1318
5	1683	2018	2329
10	2220	2782	3298
20	2684	3690	4587
25	2860	4021	5181
50	3251	5190	7112
100	3490	6616	9782

Table 4: Fitted flood quantiles for station 8140001. Values have been reported to four significant digits.

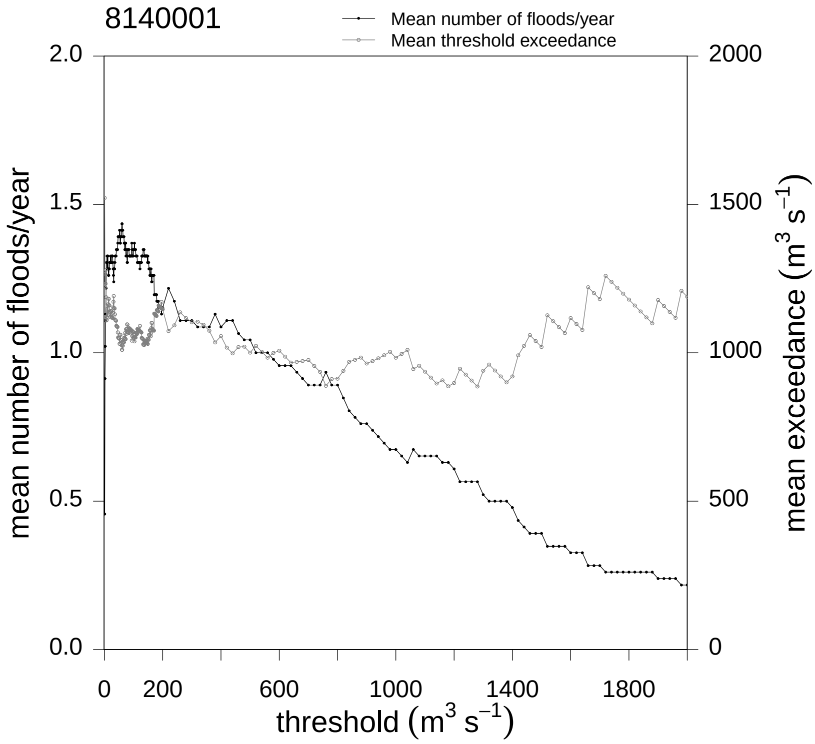

Figure 6: Threshold selection steps.

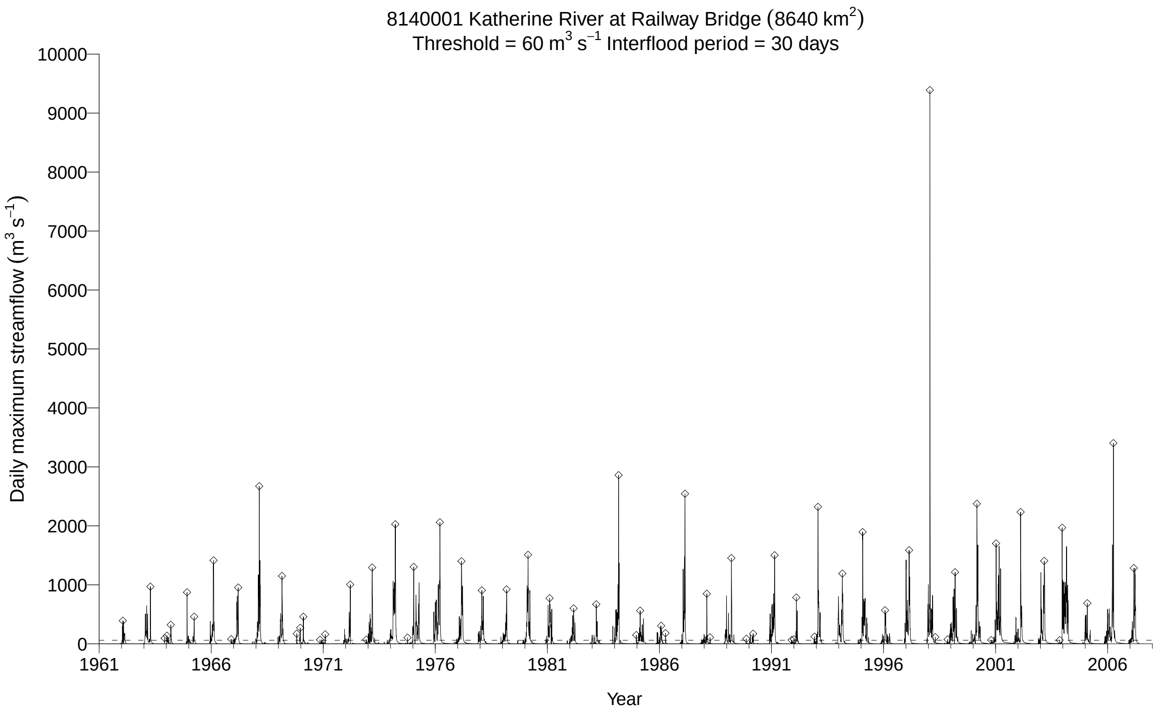

Figure 7: Linear-scale hydrograph showing peaks (shown by ◇ symbols) identified in the peaks over threshold analysis.

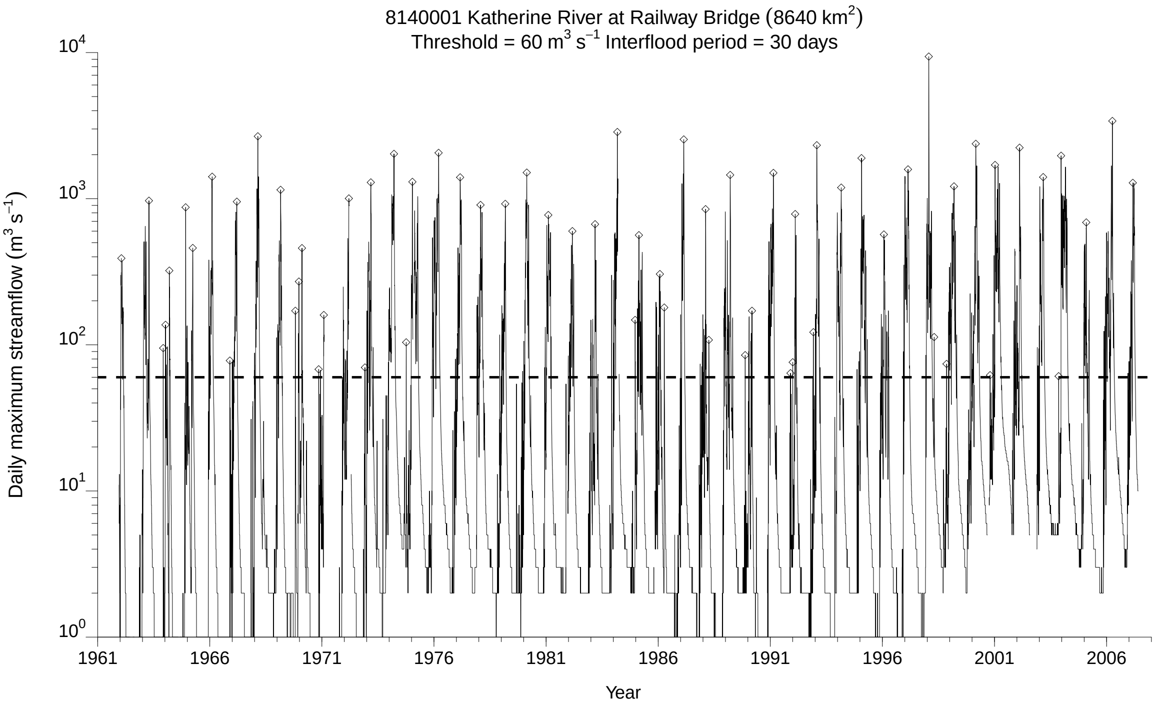

Figure 8: Log-scaled hydrograph showing peaks (shown by ♢ symbols) identified in the peaks over threshold analysis.

Figure 9: Fitted flood frequency curve for station 8140001. Dashed lines indicate a 95% confidence interval for the prediction. Note curve is only fitted to events with an average recurrence interval $\geq$ 1 year.

B 814008 Fergusson River at Old Railway Bridge

Return Period (years)	Q (m^3s^{-1})	Year	Water Year
0.66	33.76	1975	1975/1976
0.67	34.26	1965	1964/1965
0.68	34.40	1984	1984/1985
0.69	36.81	1986	1986/1987
0.70	38.30	1982	1982/1983
0.71	38.39	1987	1987/1988
0.72	40.36	1994	1994/1995
0.73	44.62	1960	1960/1961
0.74	50.43	1964	1963/1964
0.75	53.58	1962	1962/1963
0.76	55.30	1996	1995/1996
0.77	63.16	1969	1969/1970
0.79	63.52	2000	2000/2001
0.80	72.24	1970	1970/1971
0.81	74.95	1981	1981/1982
0.83	80.14	1988	1987/1988
0.84	81.65	1983	1982/1983
0.85	90.73	1990	1989/1990
0.87	112.02	1986	1985/1986
0.88	120.36	1959	1958/1959
0.90	125.84	1965	1964/1965
0.92	126.32	1992	1992/1993
0.94	126.66	1963	1963/1964
0.95	133.79	1969	1969/1970
0.97	162.53	1996	1995/1996
0.99	167.58	1970	1969/1970
1.01	168.61	1966	1966/1967
1.03	173.59	1964	1963/1964
1.06	193.39	1985	1984/1985
1.08	198.14	2002	2001/2002
1.10	207.12	1961	1960/1961
1.13	227.35	1983	1982/1983
1.15	267.33	1982	1981/1982
1.18	316.58	1985	1984/1985
1.21	330.54	1989	1988/1989
1.24	332.22	1991	1990/1991
1.27	346.27	1958	1957/1958
1.31	356.69	1964	1964/1965
1.34	399.07	1993	1992/1993
1.38	399.76	1963	1962/1963
1.42	409.57	1959	1958/1959
1.46	423.94	1962	1961/1962
1.51	466.59	1960	1959/1960
1.56	491.21	1957	1957/1958
1.61	498.23	1972	1971/1972
1.66	523.78	1977	1977/1978
1.72	532.26	1993	1993/1994
1.78	564.26	1973	1972/1973
1.85	576.53	1979	1978/1979
1.92	588.94	1997	1996/1997
2.00	609.46	1969	1968/1969
2.08	621.43	1971	1970/1971
2.18	634.25	1992	1991/1992
2.28	652.00	1975	1974/1975
2.39	653.10	1999	1998/1999
2.51	689.61	1989	1988/1989
2.65	690.52	1987	1986/1987
2.80	693.99	1966	1965/1966
2.96	697.14	1980	1979/1980
3.15	805.44	2001	2000/2001
3.37	835.09	1981	1980/1981
3.62	894.18	2003	2002/2003
3.90	907.45	2004	2003/2004
4.24	948.79	1997	1996/1997
4.64	953.39	1967	1966/1967
5.12	997.33	1968	1967/1968
5.72	1039.15	1984	1983/1984
6.47	1128.56	2006	2005/2006
7.45	1132.83	2007	2006/2007
8.79	1160.73	1974	1973/1974
10.70	1189.41	1976	1975/1976
13.67	1240.07	1977	1976/1977
18.92	1687.67	2000	1999/2000
30.75	2743.04	1995	1994/1995
82.00	3127.34	1998	1997/1998

Table 5: Flood peaks identified by the peaks over threshold analysis for station 8140008.

Return Period (years)	Lower C.I. (m^3s^{-1})	Estimated Quantile (m^3s^{-1})	Upper C.I. (m^3s^{-1})
2	500	578	663
5	838	1000	1141
10	1089	1338	1585
20	1309	1741	2131
25	1389	1885	2355
50	1584	2386	3167
100	1677	2982	4301

Table 6: Fitted flood quantiles for station 8140008. Values have been reported to four significant digits.

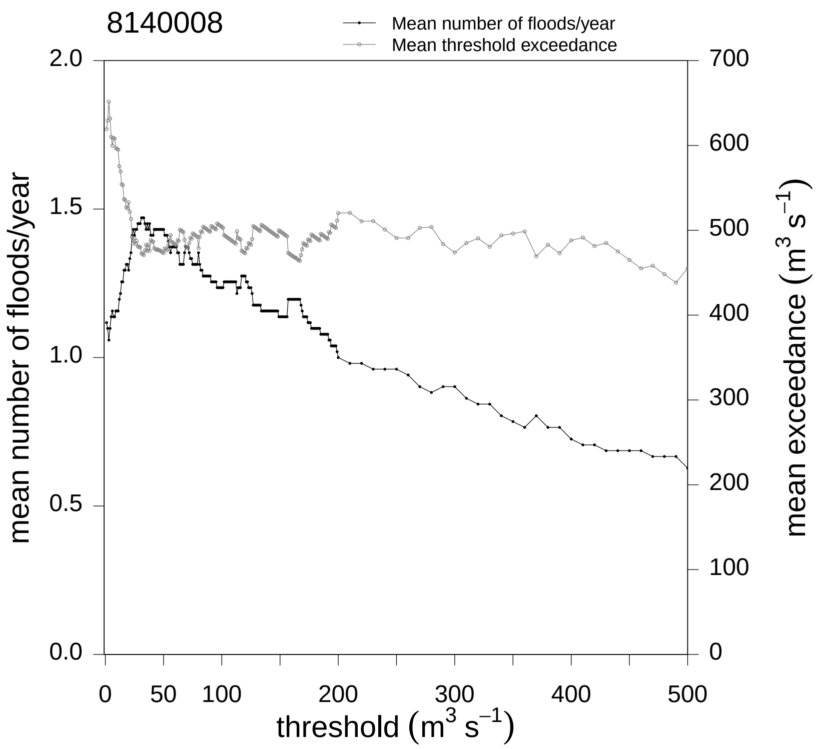

Figure 10: Threshold selection steps.

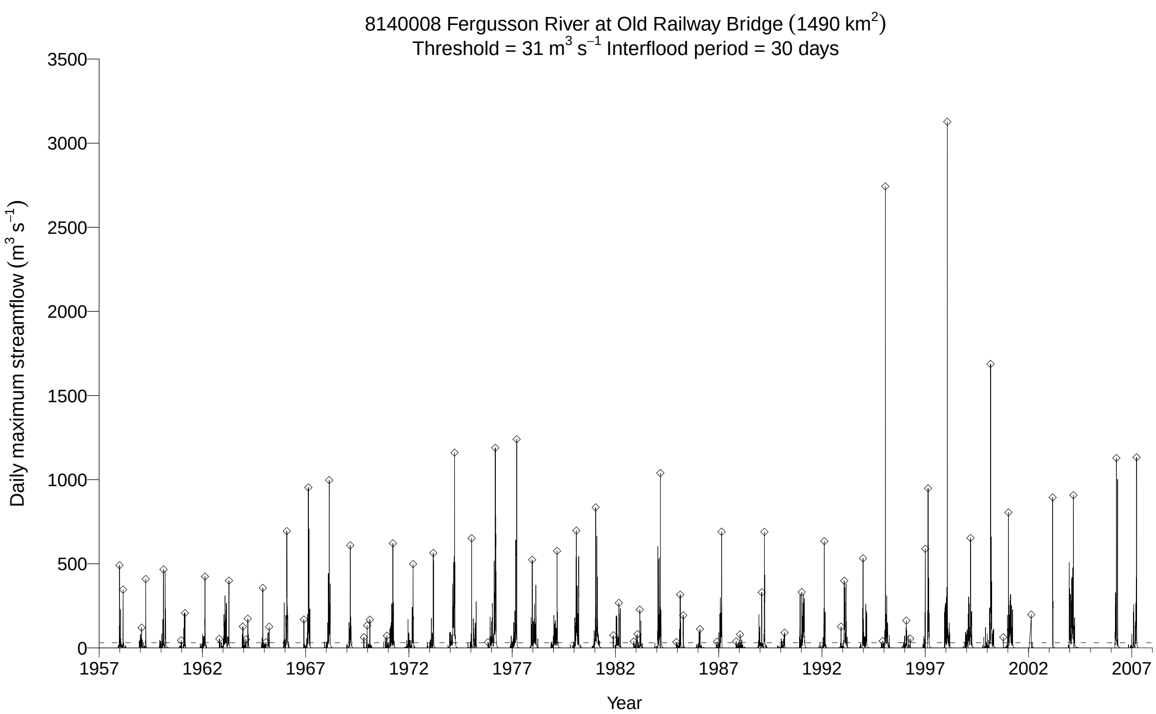

Figure 11: Linear-scale hydrograph showing peaks (shown by ◇ symbols) identified in the peaks over threshold analysis.

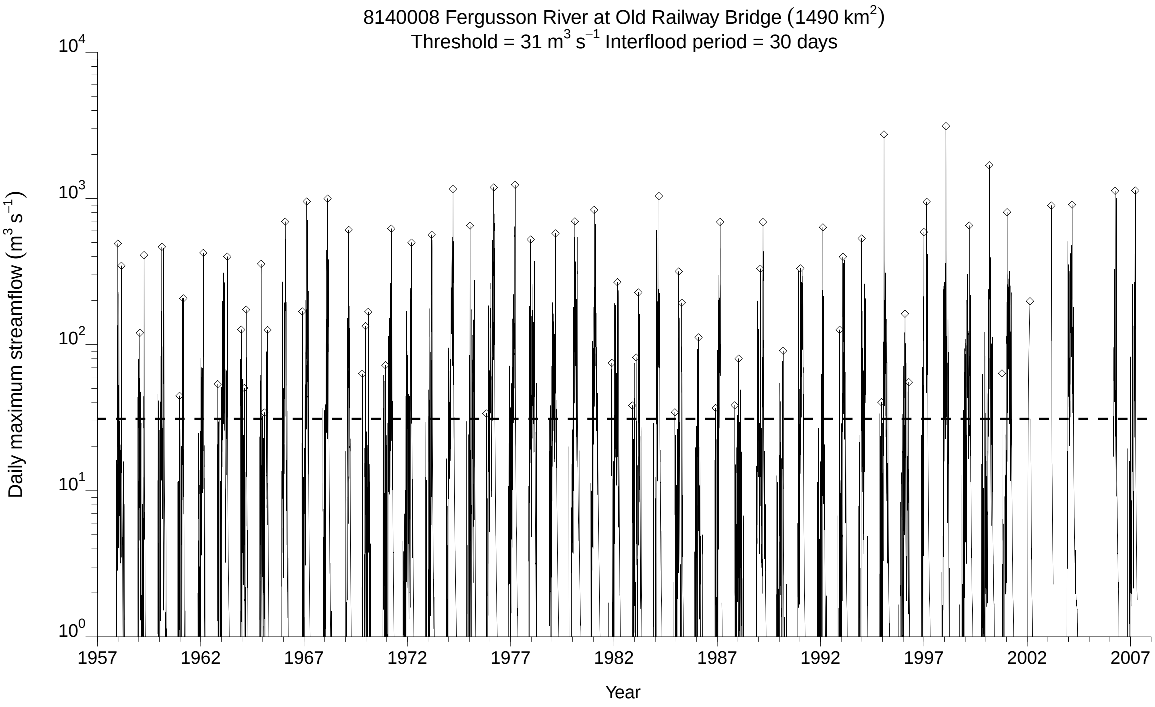

Figure 12: Log-scaled hydrograph showing peaks (shown by ◇ symbols) identified in the peaks over threshold analysis.

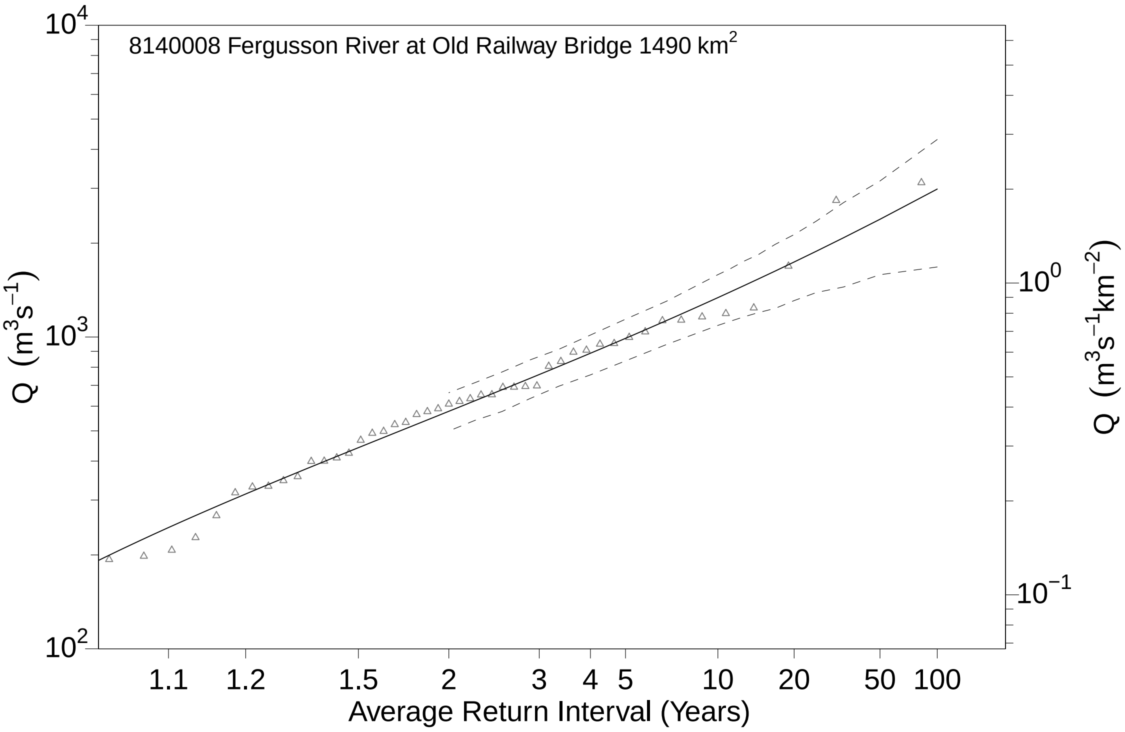

Figure 13: Fitted flood frequency curve for station 8140008. Dashed lines indicate a 95% confidence interval for the prediction. Note curve is only fitted to events with an average recurrence interval $\geq$ 1 year.

C 814011 Dry River at Manbulloo Boundary

Return Period (years)	Q (m^3s^{-1})	Year	Water Year
0.82	7.85	1977	1977/1978
0.84	8.56	1968	1968/1969
0.86	8.85	1981	1981/1982
0.88	9.31	1988	1987/1988
0.90	9.33	1985	1984/1985
0.92	9.37	1978	1978/1979
0.94	9.76	1990	1989/1990
0.96	10.38	1969	1968/1969
0.99	10.68	1993	1992/1993
1.02	12.15	1988	1988/1989
1.04	13.00	1995	1994/1995
1.07	13.02	1973	1972/1973
1.10	13.09	1971	1971/1972
1.14	14.40	1973	1972/1973
1.17	19.14	1974	1973/1974
1.21	20.23	1994	1993/1994
1.25	22.60	1989	1988/1989
1.29	23.06	1992	1991/1992
1.34	37.39	1969	1968/1969
1.38	50.93	1979	1978/1979
1.44	55.20	1996	1995/1996
1.49	60.40	1994	1994/1995
1.55	62.44	1985	1984/1985
1.62	78.60	1995	1994/1995
1.69	83.62	1982	1981/1982
1.77	94.23	1999	1998/1999
1.85	99.88	1981	1980/1981
1.95	128.29	1998	1997/1998
2.05	154.93	2002	2001/2002
2.17	169.37	1984	1983/1984
2.30	179.04	1977	1976/1977
2.45	182.63	1987	1986/1987
2.62	182.92	2001	2000/2001
2.81	213.33	1978	1977/1978
3.03	215.74	1994	1993/1994
3.29	215.74	1997	1996/1997
3.60	219.83	1975	1974/1975
3.98	254.50	2006	2005/2006
4.44	295.71	1974	1973/1974
5.03	297.96	1972	1971/1972
5.79	299.20	1980	1979/1980
6.82	350.80	2000	1999/2000
8.30	379.87	1968	1967/1968
10.61	381.58	2006	2005/2006
14.69	472.00	2004	2003/2004
23.88	1336.86	1991	1990/1991
63.67	2671.01	1976	1975/1976

Table 7: Flood peaks identified by the peaks over threshold analysis for station 8140011.

Return Period (years)	Lower C.I. (m^3s^{-1})	Estimated Quantile (m^3s^{-1})	Upper C.I. (m^3s^{-1})
2	86	114	149
5	214	294	366
10	330	495	633
20	436	789	1092
25	496	910	1213
50	562	1400	2049
100	528	2124	3456

Table 8: Fitted flood quantiles for station 8140011. Values have been reported to four significant digits.

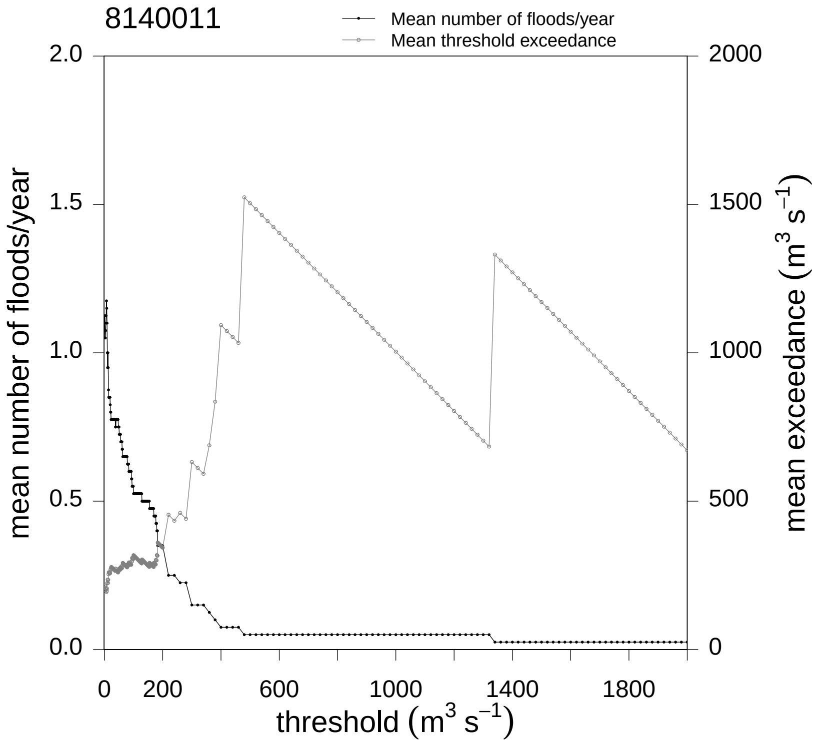

Figure 14: Threshold selection steps.

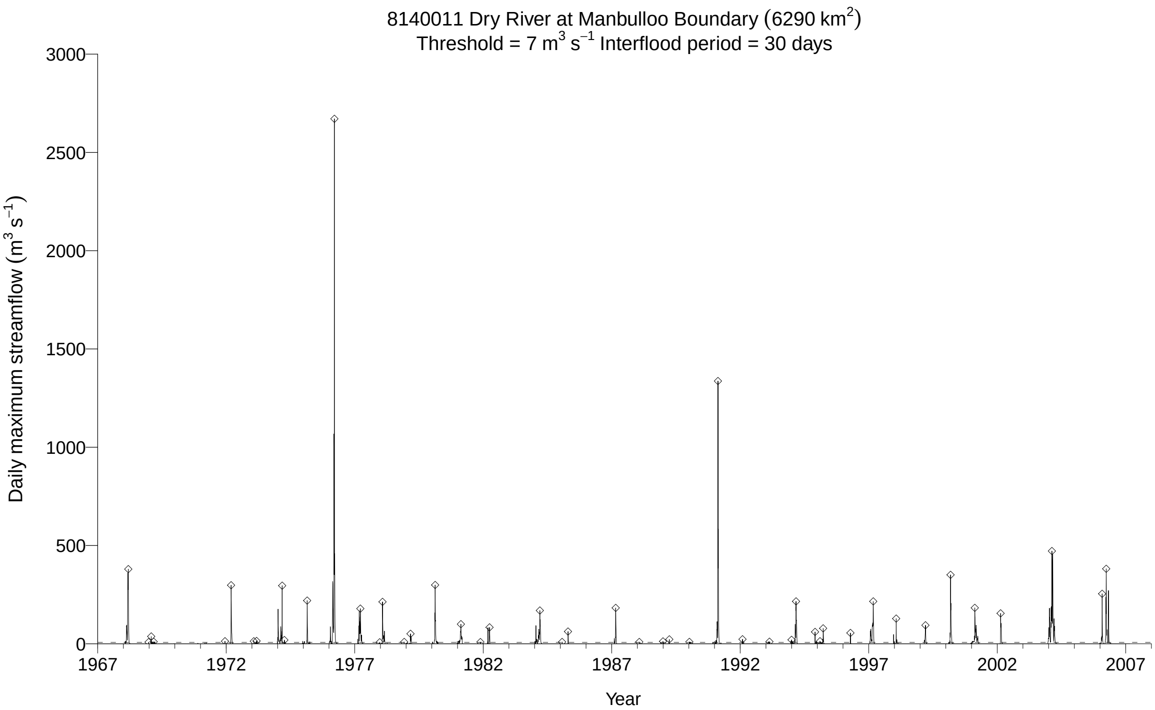

Figure 15: Linear-scale hydrograph showing peaks (shown by ◇ symbols) identified in the peaks over threshold analysis.

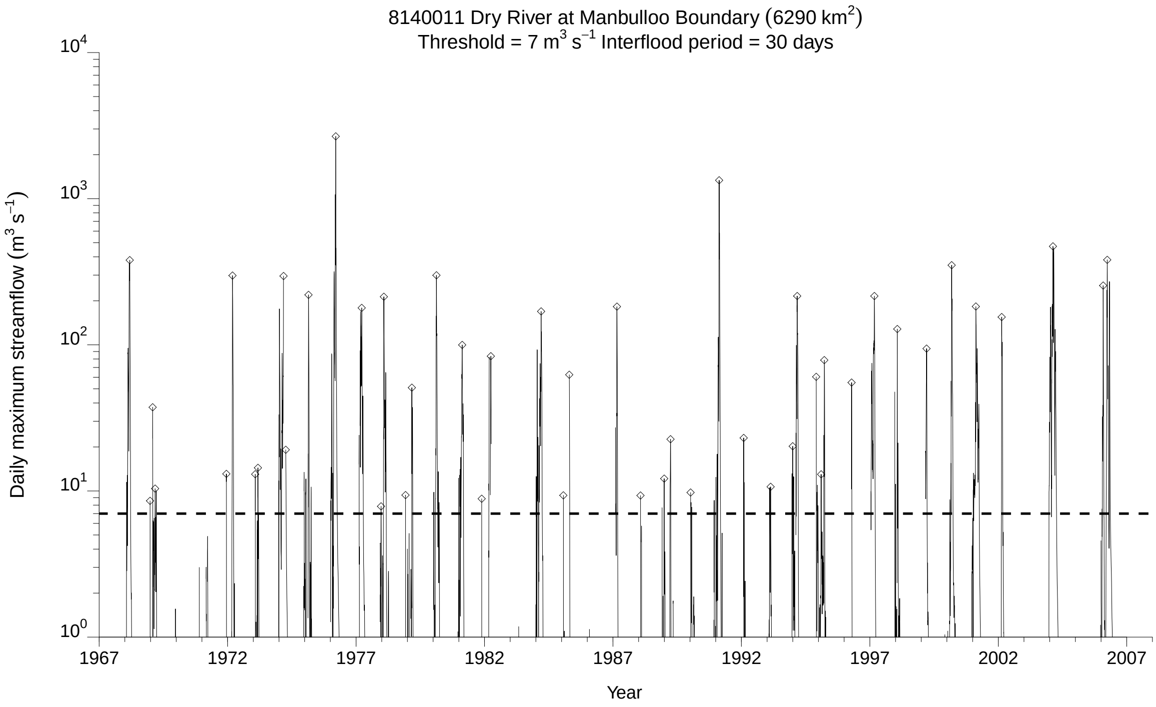

Figure 16: Log-scaled hydrograph showing peaks (shown by ◇ symbols) identified in the peaks over threshold analysis.

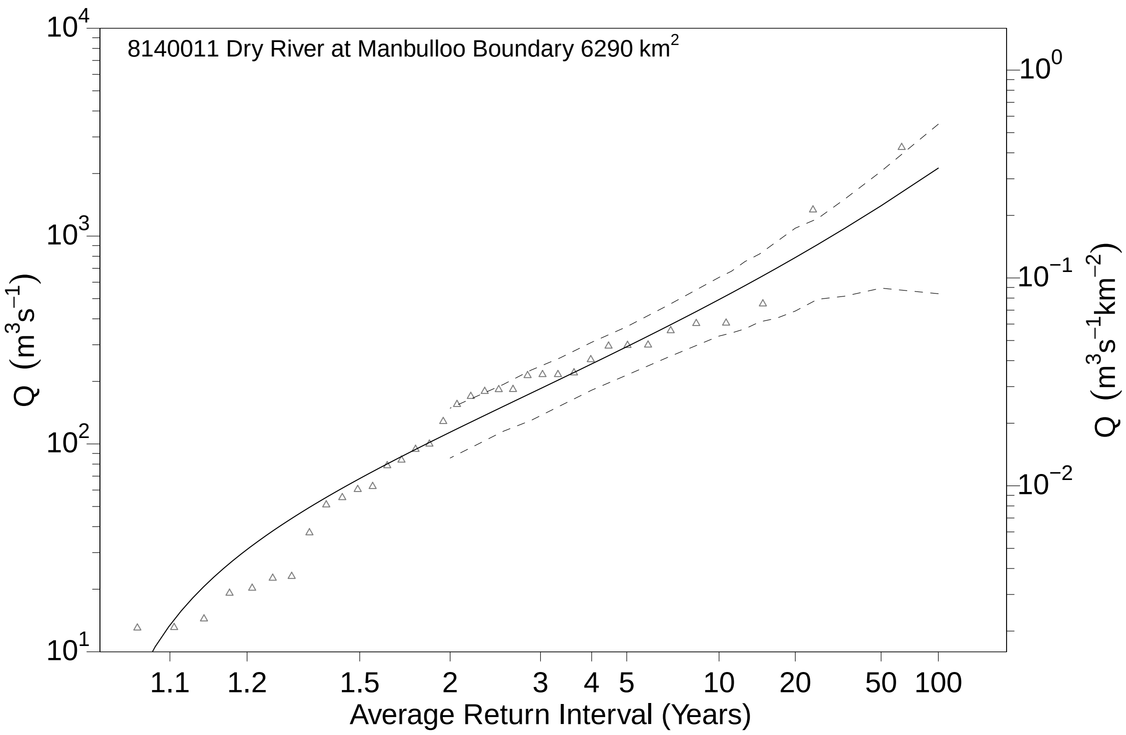

Figure 17: Fitted flood frequency curve for station 8140011. Dashed lines indicate a 95% confidence interval for the prediction. Note curve is only fitted to events with an average recurrence interval $\geq$ 1 year.

D 8140040 Daly River at Mount Nancar

Return Period (years)	Q (m^3s^{-1})	Year	Water Year
0.74	55.20	1976	1976/1977
0.75	58.45	1994	1994/1995
0.77	59.19	1983	1983/1984
0.79	61.50	1984	1984/1985
0.80	63.19	1979	1979/1980
0.82	70.82	1991	1991/1992
0.84	75.47	1974	1974/1975
0.86	81.52	1977	1976/1977
0.88	86.45	1973	1972/1973
0.90	115.51	1974	1974/1975
0.92	126.02	1976	1976/1977
0.94	127.81	1986	1985/1986
0.96	287.49	1969	1969/1970
0.99	317.78	1990	1989/1990
1.02	369.26	1986	1985/1986
1.04	548.52	1985	1984/1985
1.07	585.80	1988	1987/1988
1.10	612.48	1970	1969/1970
1.14	754.10	1996	1995/1996
1.17	1144.01	1982	1981/1982
1.21	1251.26	1971	1970/1971
1.25	1291.45	1983	1982/1983
1.29	1294.67	1992	1991/1992
1.34	1599.53	1978	1977/1978
1.38	1639.37	1985	1984/1985
1.44	1645.27	1979	1978/1979
1.49	1698.17	1975	1974/1975
1.55	1778.18	2005	2004/2005
1.62	2169.28	1989	1988/1989
1.69	2395.81	1973	1972/1973
1.77	2476.97	2007	2006/2007
1.85	2513.90	1981	1980/1981
1.95	2551.56	1999	1998/1999
2.05	2558.42	1980	1979/1980
2.17	2587.36	1994	1993/1994
2.30	2708.81	1972	1971/1972
2.45	2725.73	1987	1986/1987
2.62	2799.66	2003	2002/2003
2.81	2940.48	1993	1992/1993
3.03	3035.23	1991	1990/1991
3.29	3337.43	2001	2000/2001
3.60	3385.34	1995	1994/1995
3.98	3448.29	1984	1983/1984
4.44	3477.54	2006	2005/2006
5.03	3785.31	2002	2001/2002
5.79	4321.66	2004	2003/2004
6.82	4334.86	1997	1996/1997
8.30	4603.18	1977	1976/1977
10.61	5474.77	2000	1999/2000
14.69	5839.00	1974	1973/1974
23.88	5873.29	1976	1975/1976
63.67	8292.58	1998	1997/1998

Table 9: Flood peaks identified by the peaks over threshold analysis for station 8140040.

Return Period (years)	Lower C.I. (m^3s^{-1})	Estimated Quantile (m^3s^{-1})	Upper C.I. (m^3s^{-1})
2	2091	2299	2746
5	3440	3826	4433
10	4287	4873	5661
20	5052	5905	6980
25	5217	6238	7459
50	5790	7283	8889
100	6236	8348	10602

Table 10: Fitted flood quantiles for station 8140040. Values have been reported to four significant digits.

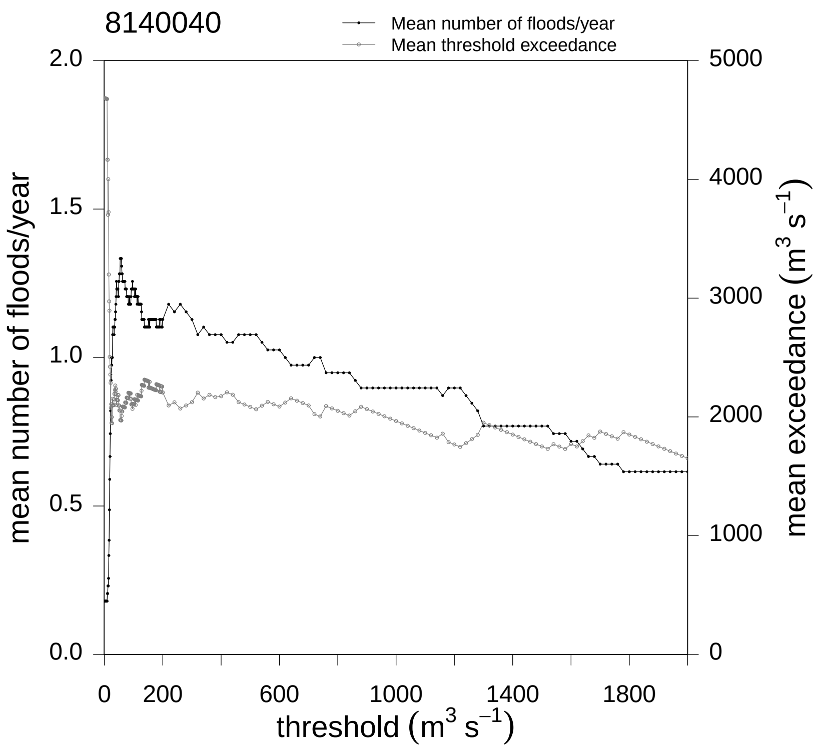

Figure 18: Threshold selection steps.

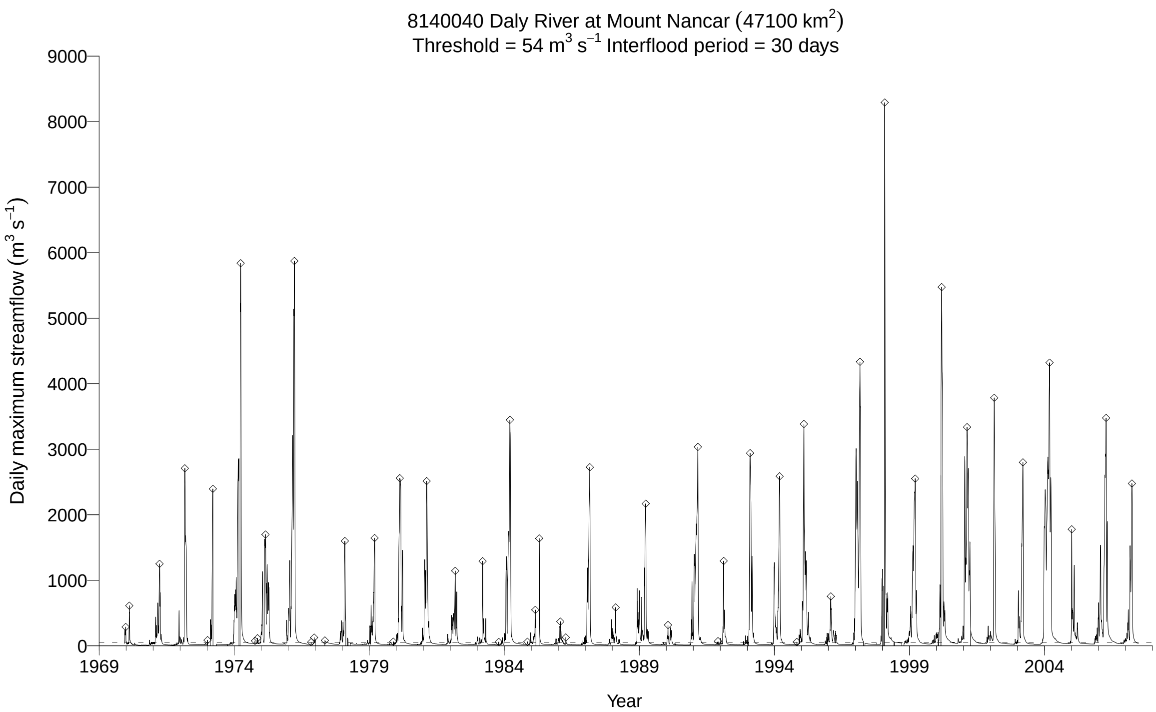

Figure 19: Linear-scale hydrograph showing peaks (shown by ◇ symbols) identified in the peaks over threshold analysis.

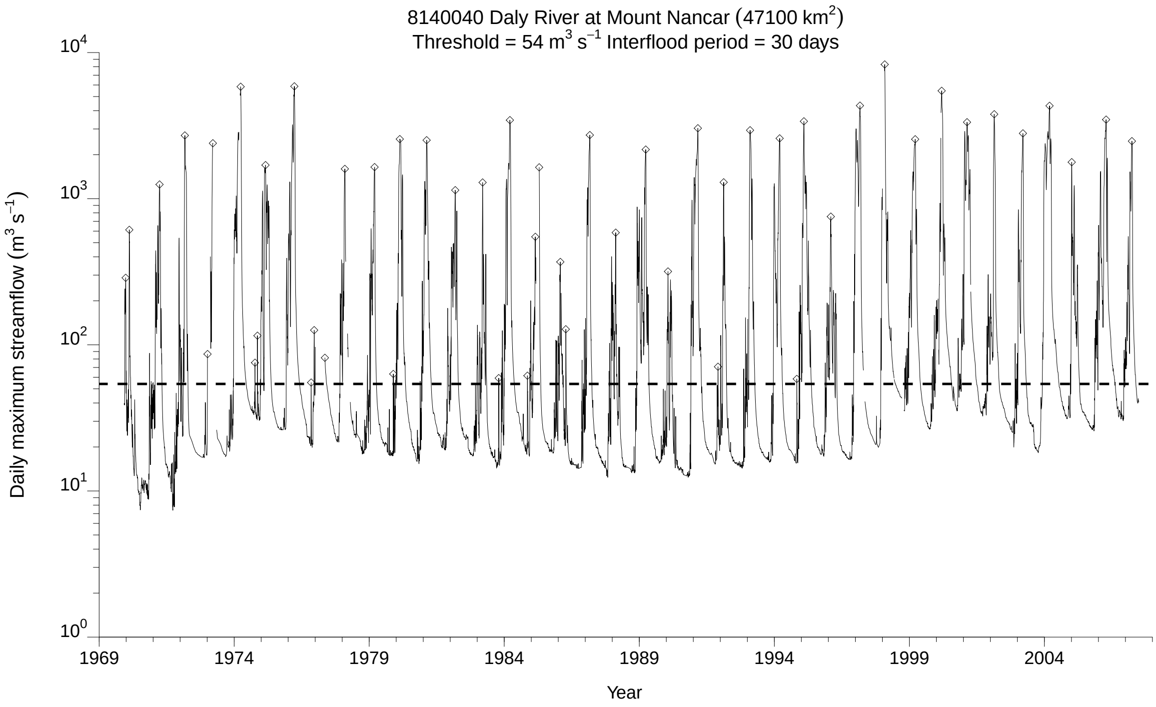

Figure 20: Log-scaled hydrograph showing peaks (shown by ◇ symbols) identified in the peaks over threshold analysis.

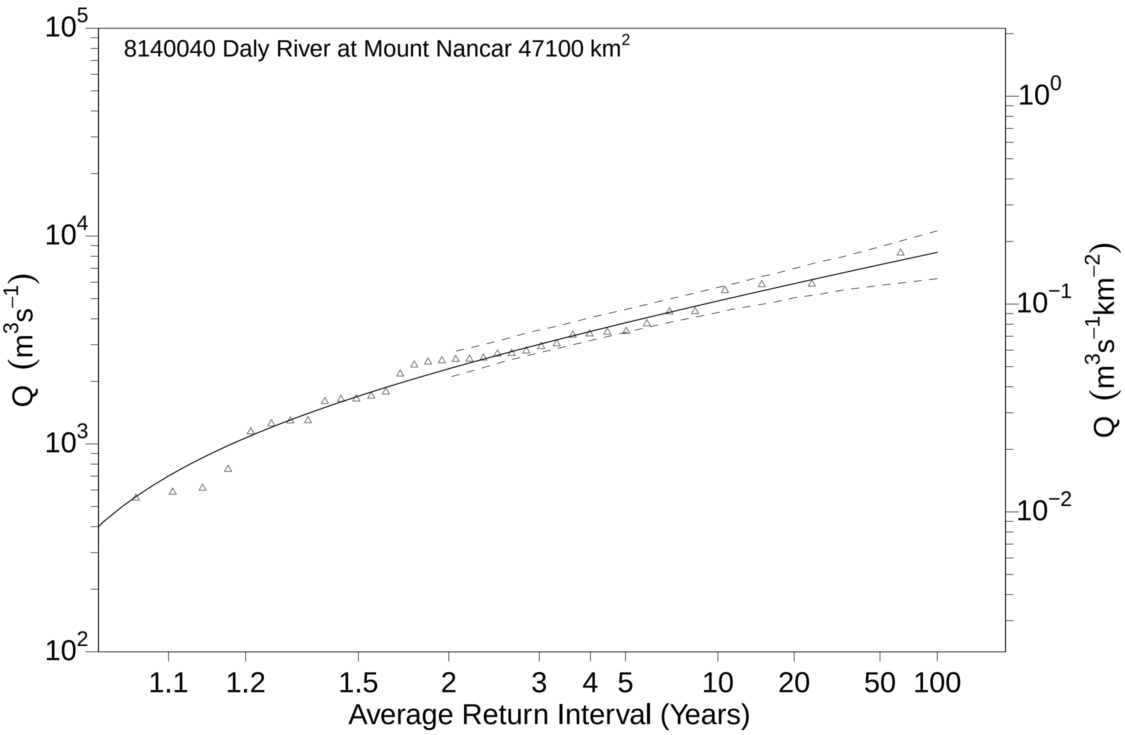

Figure 21: Fitted flood frequency curve for station 8140040. Dashed lines indicate a 95% confidence interval for the prediction. Note curve is only fitted to events with an average recurrence interval $\geq$ 1 year.

E 8140042 Daly River 2 km downstream of Beeboom Crossing

Return Period (years)	Q (m^3s^{-1})	Year	Water Year
0.78	50.42	1997	1997/1998
0.80	55.60	1983	1983/1984
0.83	57.62	1991	1991/1992
0.86	58.34	1984	1984/1985
0.89	60.15	1989	1989/1990
0.92	97.39	1988	1987/1988
0.95	199.10	1986	1985/1986
0.98	295.17	1990	1989/1990
1.02	525.82	1986	1985/1986
1.07	577.40	1988	1987/1988
1.11	622.44	1996	1995/1996
1.16	778.47	1983	1982/1983
1.21	1130.36	1999	1998/1999
1.27	1251.82	2005	2004/2005
1.34	1358.90	1985	1984/1985
1.41	1383.93	1992	1991/1992
1.49	1392.33	1982	1981/1982
1.58	2023.73	1989	1988/1989
1.68	2243.58	1994	1993/1994
1.79	2298.78	1993	1992/1993
1.93	2329.85	2007	2006/2007
2.08	2378.60	1995	1994/1995
2.26	2425.09	1999	1998/1999
2.47	2502.08	2003	2002/2003
2.73	2551.25	1987	1986/1987
3.05	2579.14	1991	1990/1991
3.45	2652.50	2001	2000/2001
3.97	2674.48	1984	1983/1984
4.68	3083.03	2002	2001/2002
5.70	3146.80	2006	2005/2006
7.28	3353.04	1997	1996/1997
10.08	3811.86	2004	2003/2004
16.38	4387.86	2000	1999/2000
43.67	7486.42	1998	1997/1998

Table 11: Flood peaks identified by the peaks over threshold analysis for station 8140042.

Return Period (years)	Lower C.I. (m^3s^{-1})	Estimated Quantile (m^3s^{-1})	Upper C.I. (m^3s^{-1})
2	1850	2095	2350
5	2909	3319	3717
10	3579	4150	4712
20	4179	4963	5739
25	4344	5225	6095
50	4827	6040	7221
100	5151	6866	8644

Table 12: Fitted flood quantiles for station 8140042. Values have been reported to four significant digits.

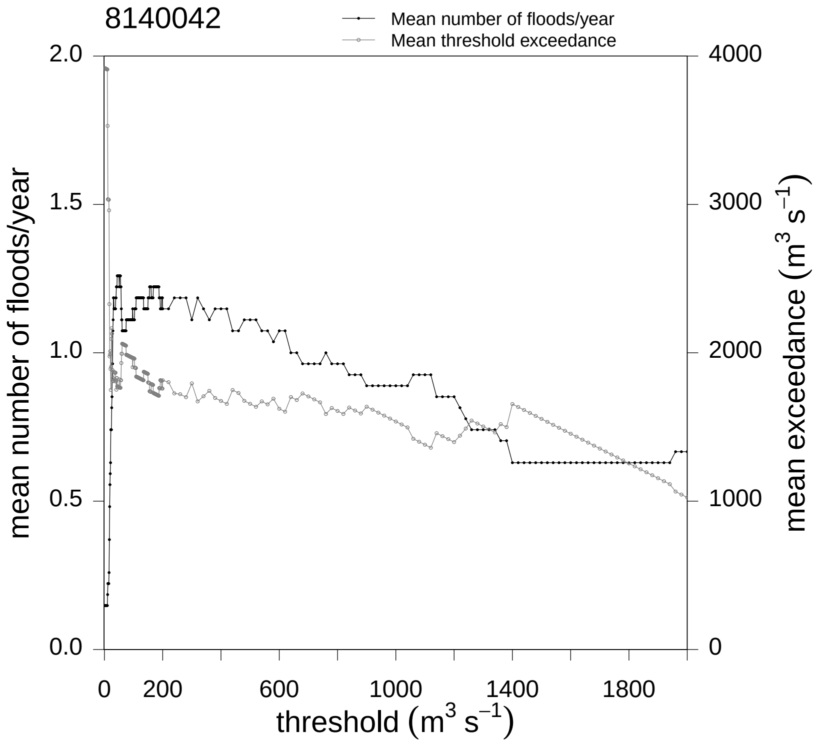

Figure 22: Threshold selection steps.

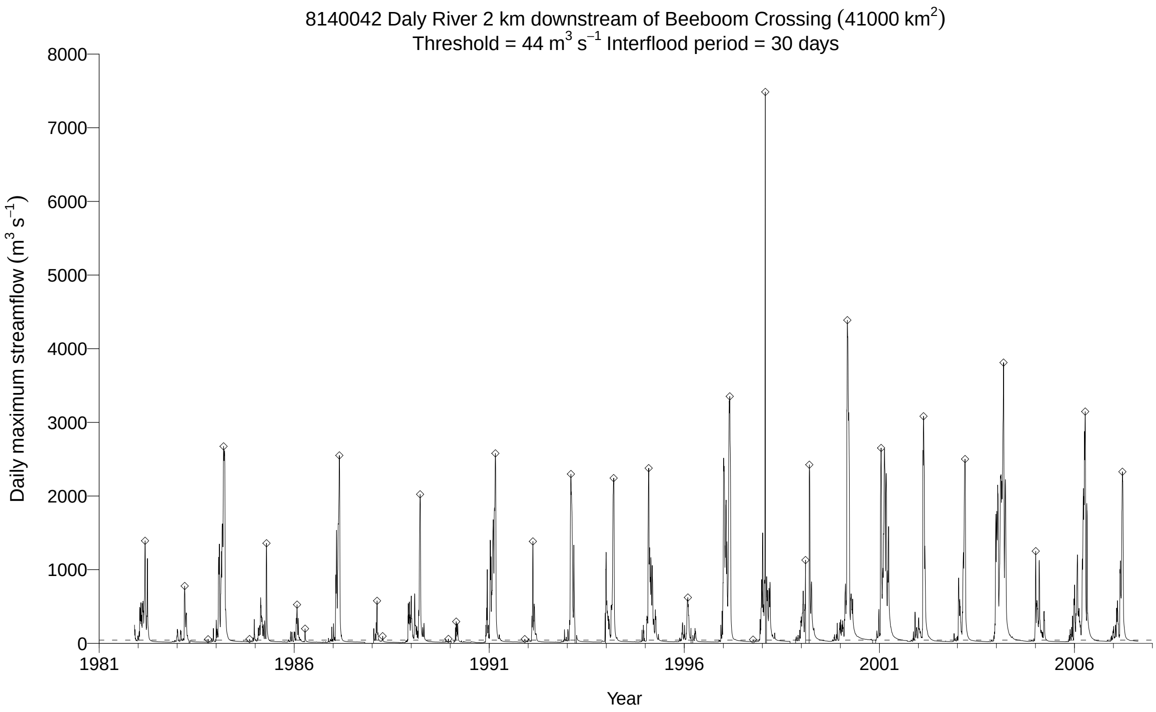

Figure 23: Linear-scale hydrograph showing peaks (shown by ◇ symbols) identified in the peaks over threshold analysis.

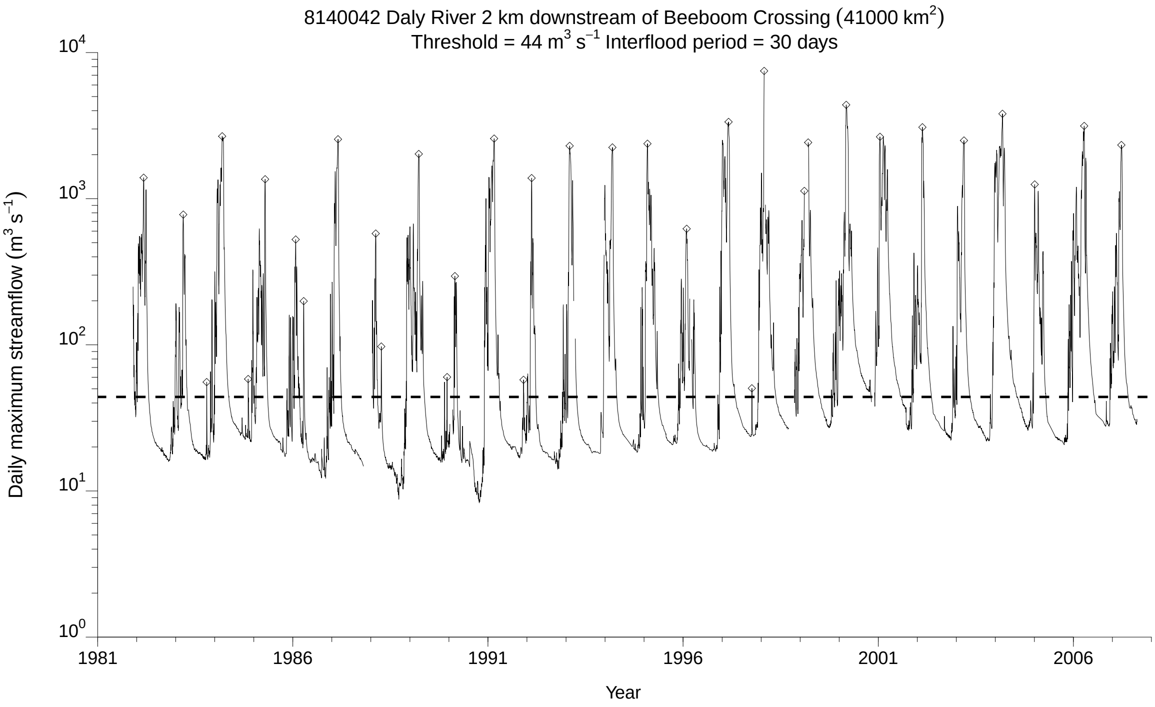

Figure 24: Log-scaled hydrograph showing peaks (shown by ◇ symbols) identified in the peaks over threshold analysis.

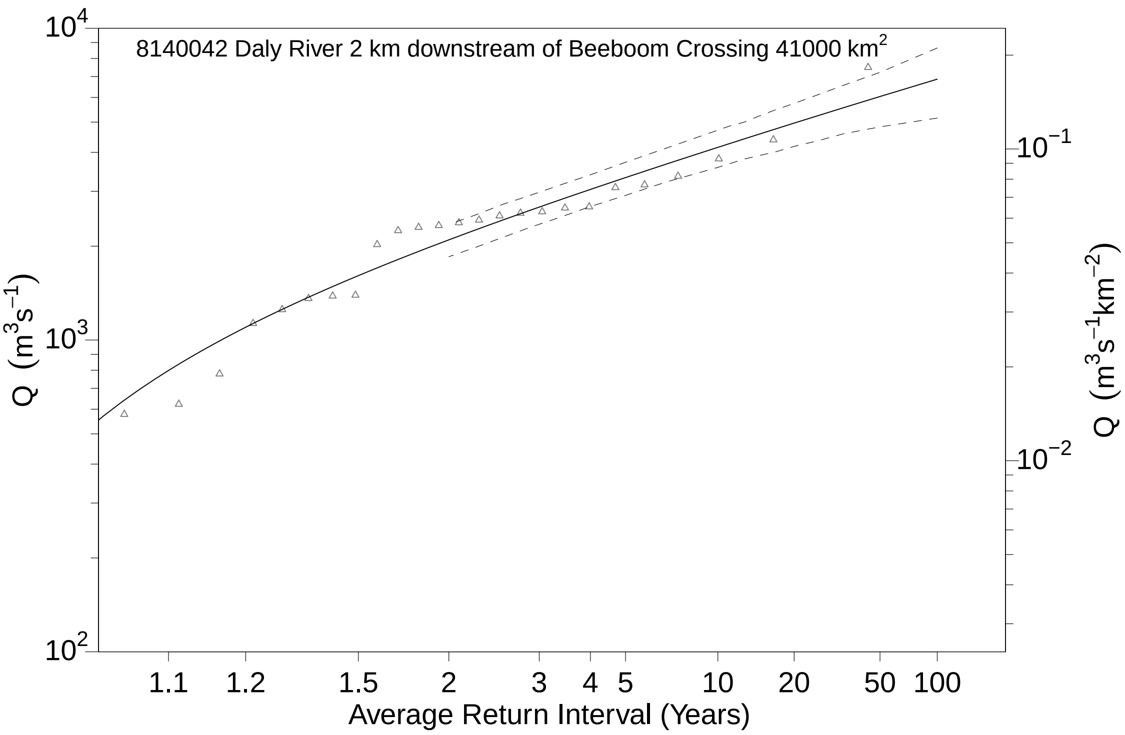

Figure 25: Fitted flood frequency curve for station 8140042. Dashed lines indicate a 95% confidence interval for the prediction. Note curve is only fitted to events with an average recurrence interval $\geq$ 1 year.

F 8140063 Douglas River downstream of Old Douglas Homestead

Return Period (years)	Q (m^3s^{-1})	Year	Water Year
0.78	5.08	1990	1989/1990
0.79	5.72	1968	1967/1968
0.80	6.40	1981	1981/1982
0.81	6.69	1990	1989/1990
0.83	6.79	1993	1992/1993
0.84	9.00	1965	1964/1965
0.86	9.08	2004	2003/2004
0.87	10.68	1986	1985/1986
0.89	10.94	1970	1969/1970
0.90	13.48	1998	1998/1999
0.92	13.76	1971	1971/1972
0.94	14.00	1990	1989/1990
0.95	14.69	1988	1987/1988
0.97	15.32	1972	1971/1972
0.99	19.87	1987	1987/1988
1.01	27.05	1961	1960/1961
1.03	27.10	1996	1995/1996
1.05	28.80	1976	1975/1976
1.08	28.90	1983	1982/1983
1.10	36.85	1976	1975/1976
1.13	37.47	1990	1990/1991
1.15	44.13	1968	1967/1968
1.18	50.44	1959	1958/1959
1.21	50.98	1978	1977/1978
1.24	52.69	1990	1989/1990
1.27	54.26	1964	1963/1964
1.30	55.14	1964	1964/1965
1.34	56.14	1977	1976/1977
1.37	64.58	1985	1984/1985
1.41	77.17	1965	1964/1965
1.45	80.25	1977	1976/1977
1.49	97.14	1960	1959/1960
1.54	109.24	1979	1978/1979
1.59	118.75	2005	2004/2005
1.64	128.16	1987	1986/1987
1.70	144.55	1994	1993/1994
1.76	145.65	1963	1962/1963
1.82	153.54	2003	2002/2003
1.89	166.72	1984	1983/1984
1.96	170.41	1985	1984/1985
2.04	172.75	1989	1988/1989
2.13	182.36	1992	1991/1992
2.22	183.09	1982	1981/1982
2.32	189.97	1999	1998/1999
2.44	190.68	1971	1970/1971
2.56	195.70	1973	1972/1973
2.70	201.45	1975	1974/1975
2.85	203.42	1957	1957/1958
3.02	213.87	1991	1990/1991
3.22	219.63	1981	1980/1981
3.44	223.84	2007	2006/2007
3.69	223.96	1959	1958/1959
3.98	259.38	2004	2003/2004
4.33	279.36	1966	1965/1966
4.74	312.48	1980	1979/1980
5.23	319.45	1967	1966/1967
5.84	427.69	1972	1971/1972
6.61	593.65	1997	1996/1997
7.61	811.35	2006	2005/2006
8.96	870.27	2001	2000/2001
10.91	1036.58	1995	1994/1995
13.94	1418.95	2002	2001/2002
19.31	1430.48	1974	1973/1974
31.38	1783.09	2000	1999/2000
83.67	1941.65	1998	1997/1998

Table 13: Flood peaks identified by the peaks over threshold analysis for station 8140063.

Return Period (years)	Lower C.I. (m^3s^{-1})	Estimated Quantile (m^3s^{-1})	Upper C.I. (m^3s^{-1})
2	125	162	206
5	290	391	484
10	437	640	813
20	580	1000	1326
25	613	1140	1581
50	698	1715	2524
100	744	2546	3981

Table 14: Fitted flood quantiles for station 8140063. Values have been reported to four significant digits.

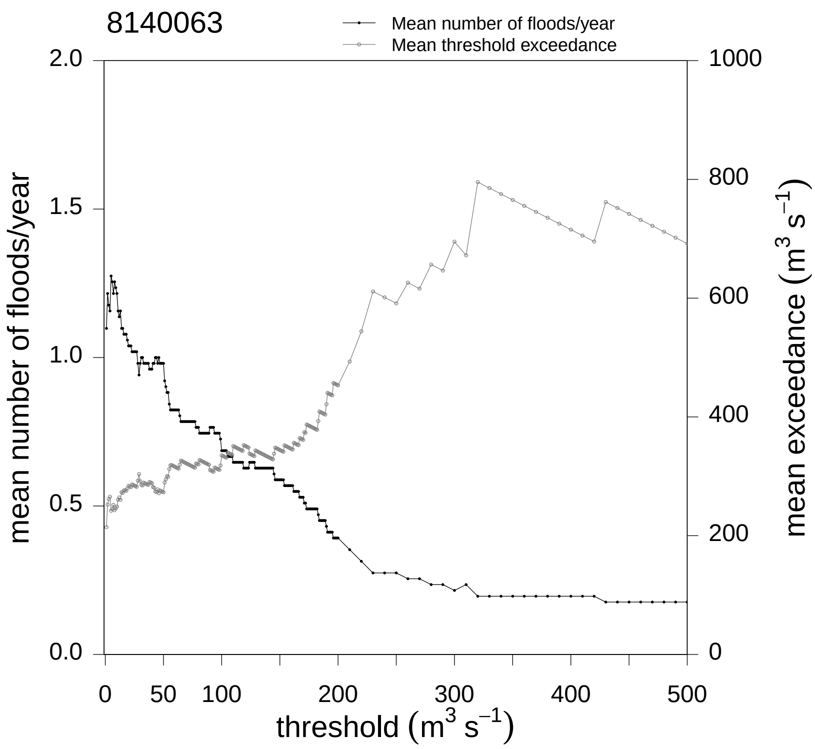

Figure 26: Threshold selection steps.

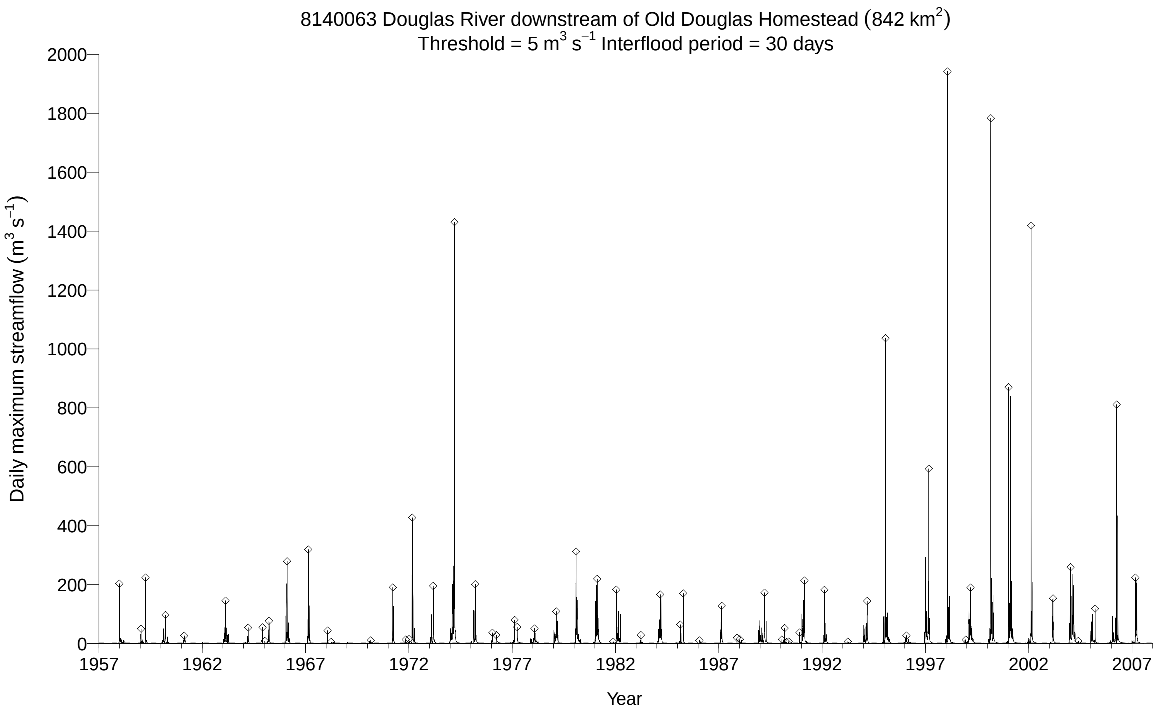

Figure 27: Linear-scale hydrograph showing peaks (shown by ◇ symbols) identified in the peaks over threshold analysis.

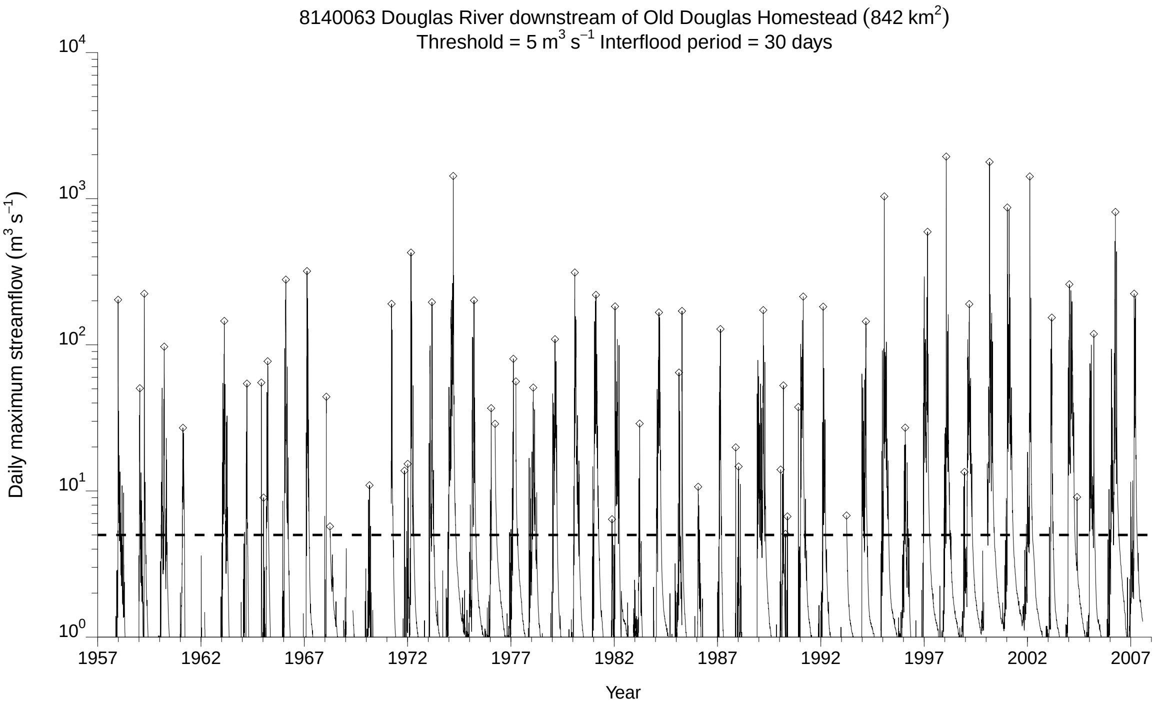

Figure 28: Log-scaled hydrograph showing peaks (shown by ◊ symbols) identified in the peaks over threshold analysis.

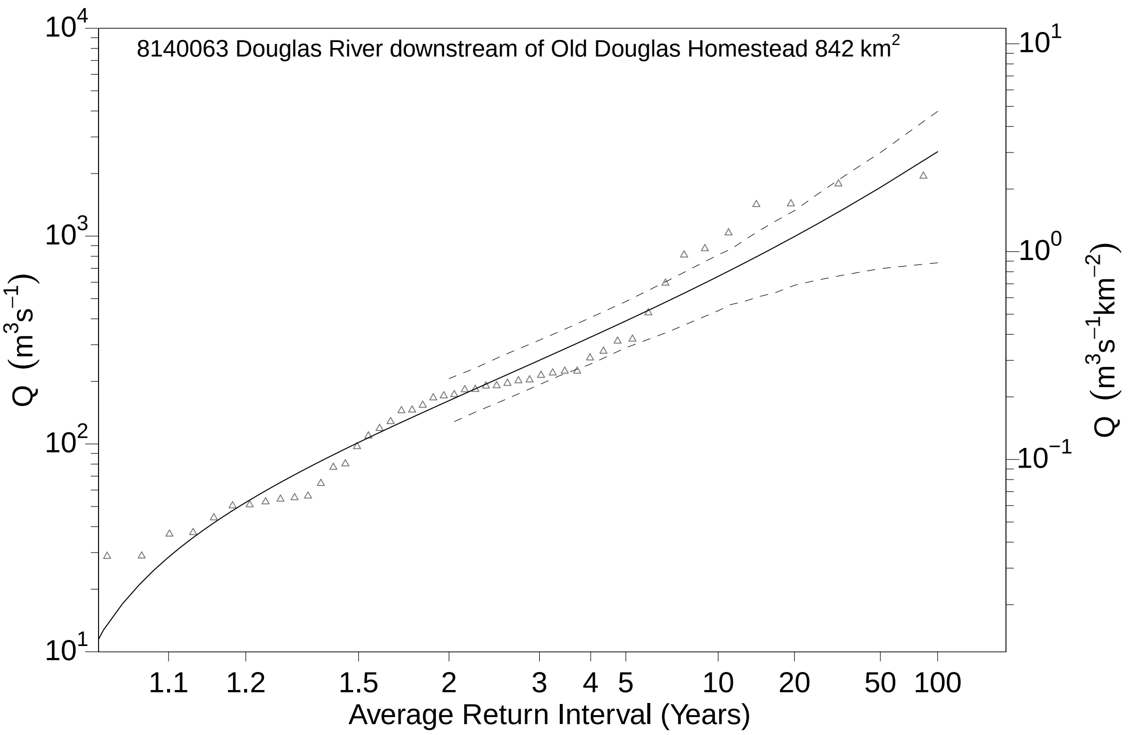

Figure 29: Fitted flood frequency curve for station 8140063. Dashed lines indicate a 95% confidence interval for the prediction. Note curve is only fitted to events with an average recurrence interval $\geq$ 1 year.

G 8140067 Daly River upstream of Dorisvale Crossing

Return Period (years)	Q (m^3s^{-1})	Year	Water Year
0.70	96.48	1998	1998/1999
0.71	98.83	1968	1967/1968
0.72	102.87	1988	1987/1988
0.74	104.38	1974	1974/1975
0.75	107.67	1976	1976/1977
0.76	119.23	1989	1988/1989
0.78	127.56	1989	1988/1989
0.79	140.73	1965	1964/1965
0.81	145.34	1975	1974/1975
0.82	154.18	2002	2002/2003
0.84	158.89	1966	1966/1967
0.85	159.35	1985	1985/1986
0.87	165.10	1970	1970/1971
0.89	175.89	1986	1985/1986
0.91	187.15	1969	1969/1970
0.93	259.93	1981	1981/1982
0.95	269.88	1974	1974/1975
0.97	331.22	1984	1984/1985
0.99	381.72	1969	1969/1970
1.01	465.32	1990	1989/1990
1.04	514.05	1965	1964/1965
1.06	553.83	1986	1985/1986
1.09	656.34	1996	1995/1996
1.12	671.75	1970	1969/1970
1.15	690.37	1988	1987/1988
1.18	731.21	1989	1988/1989
1.21	943.17	1983	1982/1983
1.25	1167.97	1975	1974/1975
1.29	1300.15	1985	1984/1985
1.33	1302.43	2005	2004/2005
1.37	1522.87	1982	1981/1982
1.41	1567.28	1992	1991/1992
1.46	1712.15	1971	1970/1971
1.51	1752.78	1979	1978/1979
1.57	1826.39	1978	1977/1978
1.62	1876.93	1981	1980/1981
1.69	1998.92	1968	1967/1968
1.76	2007.92	2007	2006/2007
1.83	2287.95	1994	1993/1994
1.91	2335.67	1972	1971/1972
2.00	2335.79	1999	1998/1999
2.10	2429.17	1993	1992/1993
2.20	2480.89	1967	1966/1967
2.32	2806.92	1973	1972/1973
2.45	2916.79	1980	1979/1980
2.60	3113.20	1966	1965/1966
2.77	3161.17	2003	2002/2003
2.96	3192.10	1969	1968/1969
3.18	3207.05	2001	2000/2001
3.43	3532.62	1997	1996/1997
3.72	3788.53	2006	2005/2006
4.08	3936.50	2002	2001/2002
4.50	4035.11	1995	1994/1995
5.02	4162.47	2004	2003/2004
5.68	4188.44	1987	1986/1987
6.55	4236.45	1991	1990/1991
7.71	4261.51	1984	1983/1984
9.39	4765.74	2000	1999/2000
12.00	5006.93	1976	1975/1976
16.62	5483.80	1977	1976/1977
27.00	6498.66	1974	1973/1974
72.00	8354.69	1998	1997/1998

Table 15: Flood peaks identified by the peaks over threshold analysis for station 8140067.

Return Period (years)	Lower C.I. (m^3s^{-1})	Estimated Quantile (m^3s^{-1})	Upper C.I. (m^3s^{-1})
2	2039	2390	2745
5	3485	3958	4421
10	4330	5007	5663
20	5046	6022	6974
25	5250	6345	7437
50	5790	7347	8894
100	6280	8350	10387

Table 16: Fitted flood quantiles for station 8140067. Values have been reported to four significant digits.

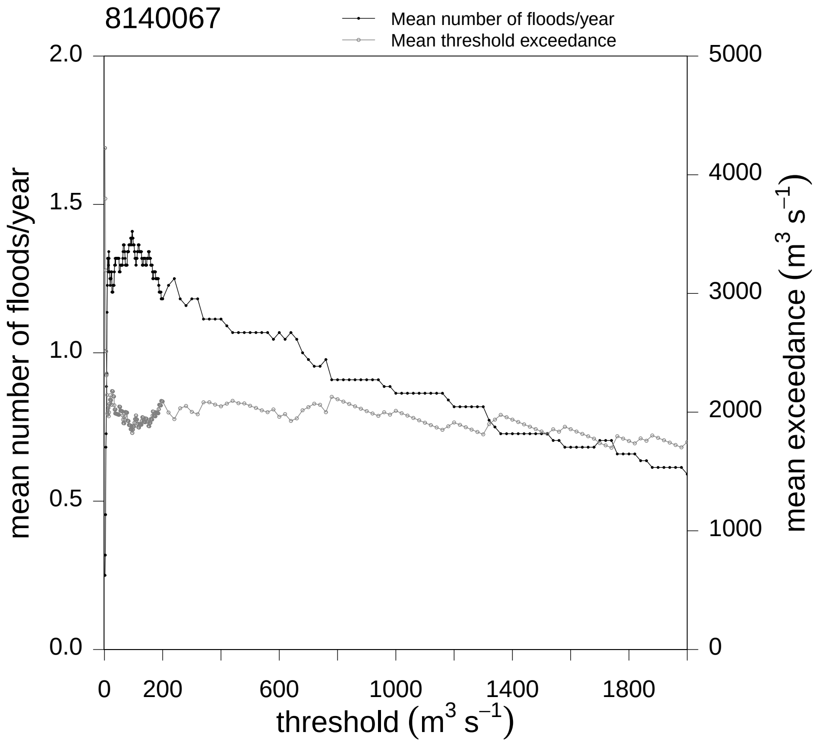

Figure 30: Threshold selection steps.

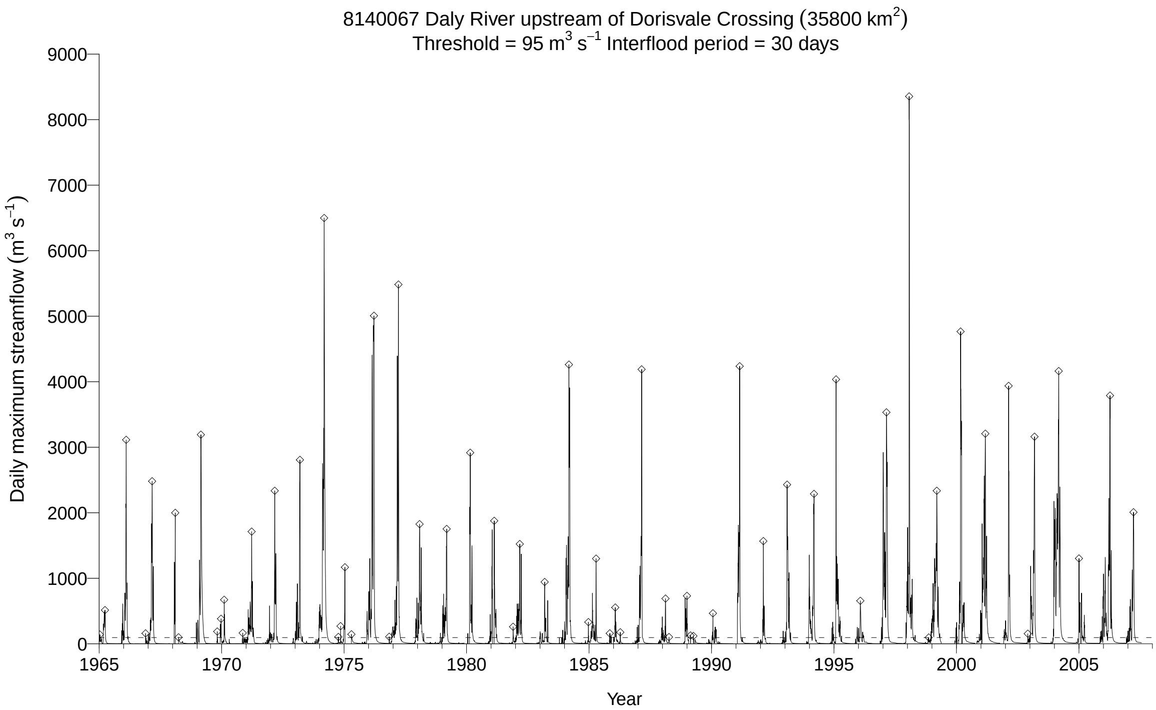

Figure 31: Linear-scale hydrograph showing peaks (shown by ◇ symbols) identified in the peaks over threshold analysis.

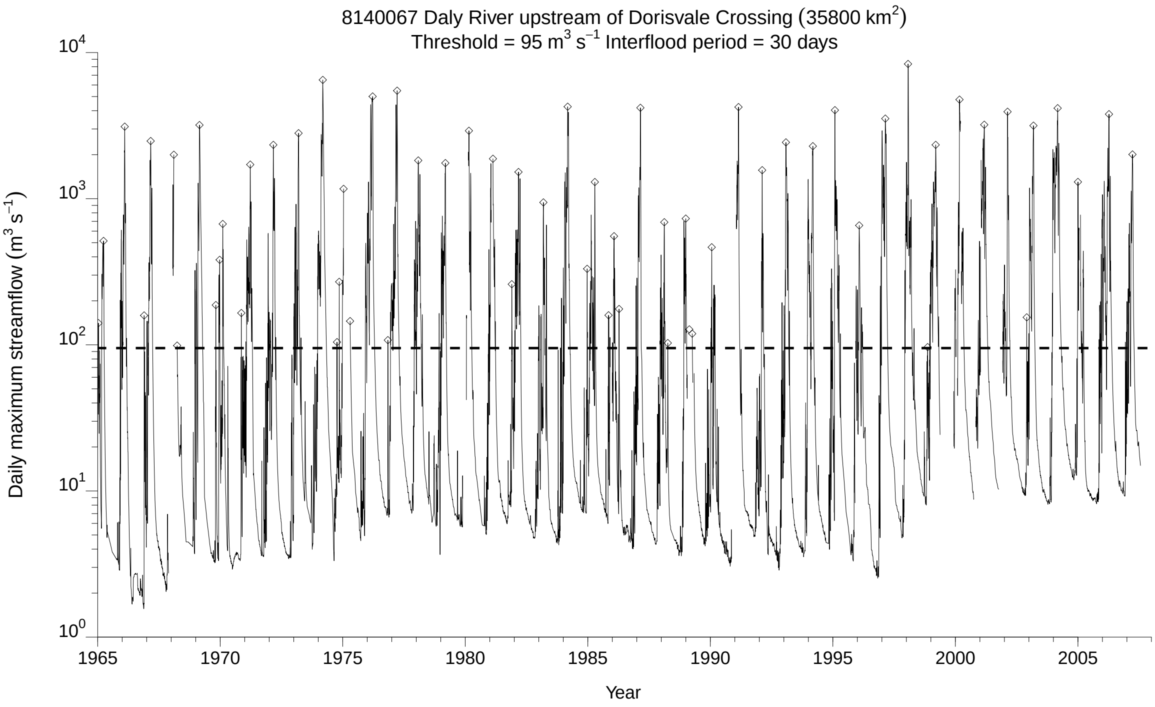

Figure 32: Log-scaled hydrograph showing peaks (shown by ◇ symbols) identified in the peaks over threshold analysis.

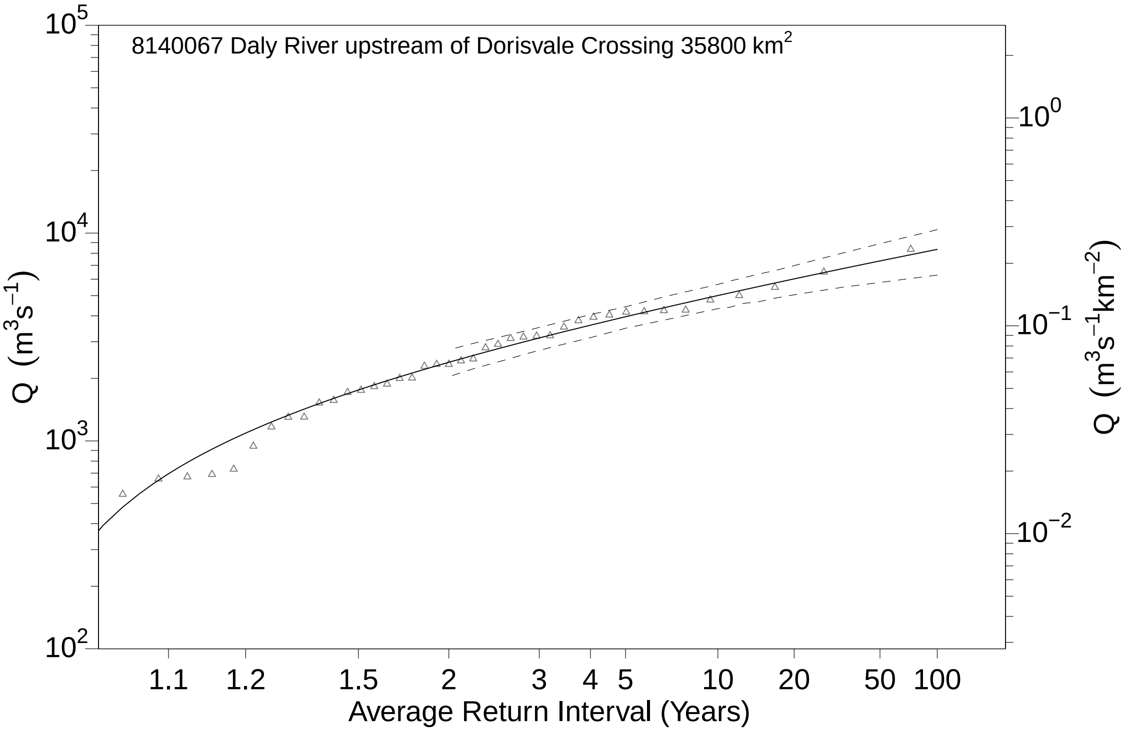

Figure 33: Fitted flood frequency curve for station 8140067. Dashed lines indicate a 95% confidence interval for the prediction. Note curve is only fitted to events with an average recurrence interval $\geq$ 1 year.

H 8140158 McAdden Creek at Dam Site

Return Period (years)	Q (m^3s^{-1})	Year	Water Year
0.73	9.17	1965	1964/1965
0.75	9.40	1970	1970/1971
0.76	9.74	1994	1994/1995
0.77	9.89	1996	1995/1996
0.79	10.67	2006	2006/2007
0.80	12.01	1966	1966/1967
0.82	13.88	1979	1978/1979
0.83	14.67	1996	1995/1996
0.85	14.98	1975	1974/1975
0.87	15.28	1964	1963/1964
0.89	15.78	1964	1964/1965
0.91	18.49	1976	1976/1977
0.93	18.61	1985	1985/1986
0.95	21.91	2000	1999/2000
0.97	22.52	1985	1984/1985
0.99	25.59	1993	1993/1994
1.01	27.43	1973	1973/1974
1.04	31.36	1976	1976/1977
1.07	38.29	1984	1984/1985
1.09	40.80	2007	2006/2007
1.12	41.93	1964	1963/1964
1.15	50.00	1979	1978/1979
1.19	50.76	1963	1962/1963
1.22	53.80	1972	1971/1972
1.26	58.32	1978	1977/1978
1.29	58.43	1998	1998/1999
1.34	65.69	1993	1992/1993
1.38	79.11	1983	1983/1984
1.43	80.71	1964	1964/1965
1.48	84.30	1982	1981/1982
1.53	92.24	1994	1993/1994
1.59	102.00	1983	1982/1983
1.65	117.07	1981	1980/1981
1.72	119.50	1963	1962/1963
1.79	124.58	1987	1986/1987
1.87	146.97	2005	2005/2006
1.95	159.97	2003	2002/2003
2.05	161.23	1976	1975/1976
2.15	162.08	1971	1970/1971
2.27	170.50	1967	1966/1967
2.40	181.04	1966	1965/1966
2.54	185.22	1969	1968/1969
2.71	196.86	1980	1979/1980
2.89	207.60	2004	2003/2004
3.10	209.79	1991	1990/1991
3.35	218.92	1973	1972/1973
3.64	225.24	2001	2000/2001
3.98	227.41	1999	1998/1999
4.40	235.35	1975	1974/1975
4.91	293.10	1968	1967/1968
5.55	318.75	1997	1996/1997
6.39	339.18	1984	1983/1984
7.54	362.69	1977	1976/1977
9.17	420.70	2000	1999/2000
11.72	447.81	2002	2001/2002
16.23	618.54	2006	2005/2006
26.38	784.42	1998	1997/1998
70.33	981.82	1995	1994/1995

Table 17: Flood peaks identified by the peaks over threshold analysis for station 8140158.

Return Period (years)	Lower C.I. (m^3s^{-1})	Estimated Quantile (m^3s^{-1})	Upper C.I. (m^3s^{-1})
2	116	142	170
5	229	284	336
10	312	412	498
20	390	571	730
25	416	629	827
50	485	842	1175
100	526	1109	1688

Table 18: Fitted flood quantiles for station 8140158. Values have been reported to four significant digits.

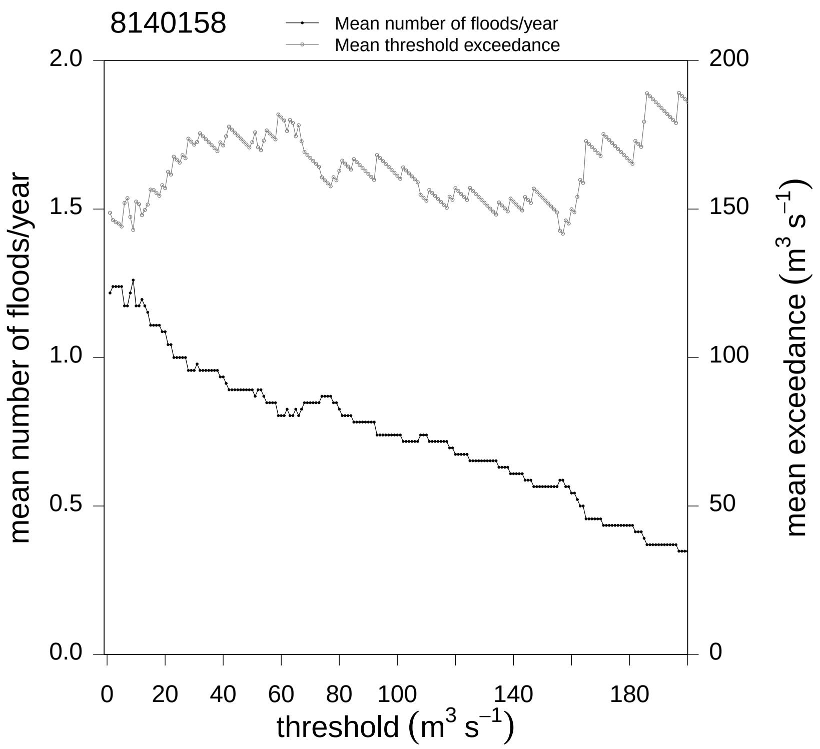

Figure 34: Threshold selection steps.

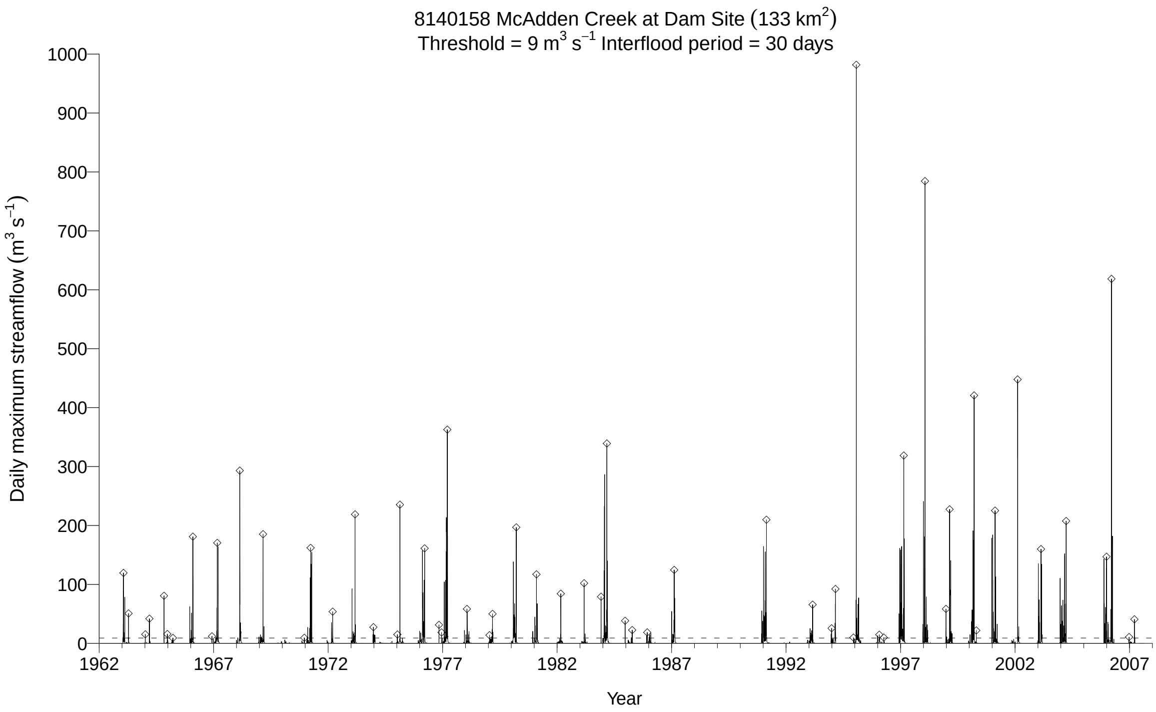

Figure 35: Linear-scale hydrograph showing peaks (shown by ◇ symbols) identified in the peaks over threshold analysis.

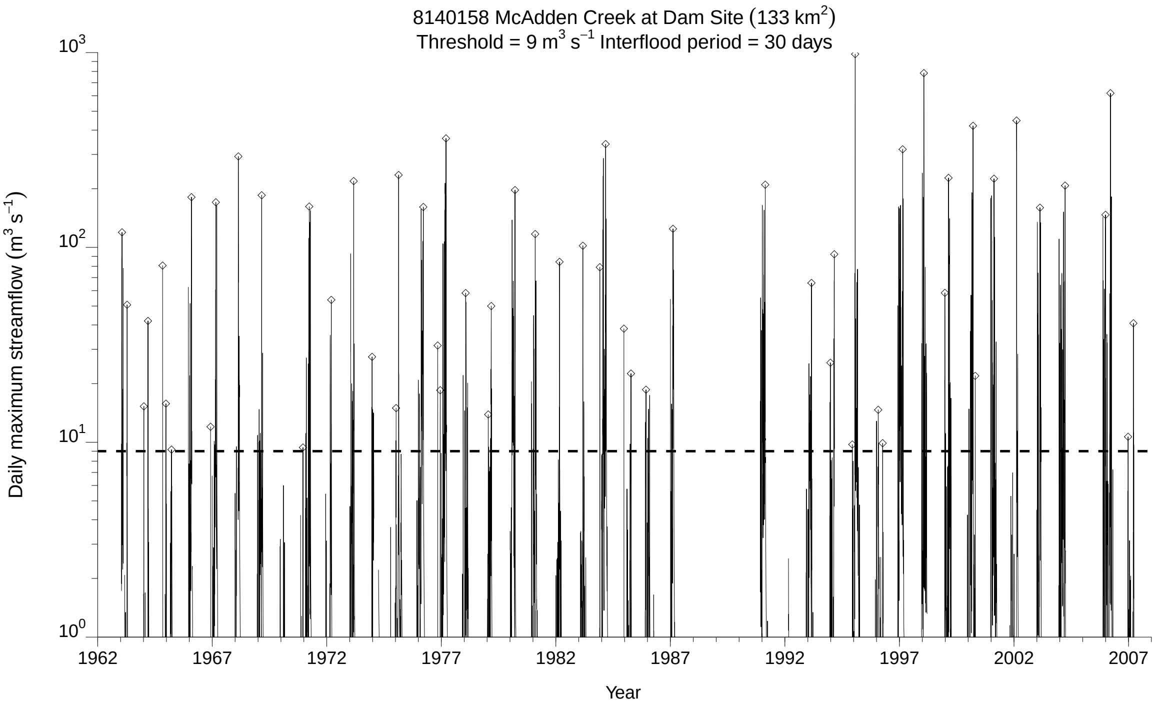

Figure 36: Log-scaled hydrograph showing peaks (shown by ◇ symbols) identified in the peaks over threshold analysis.

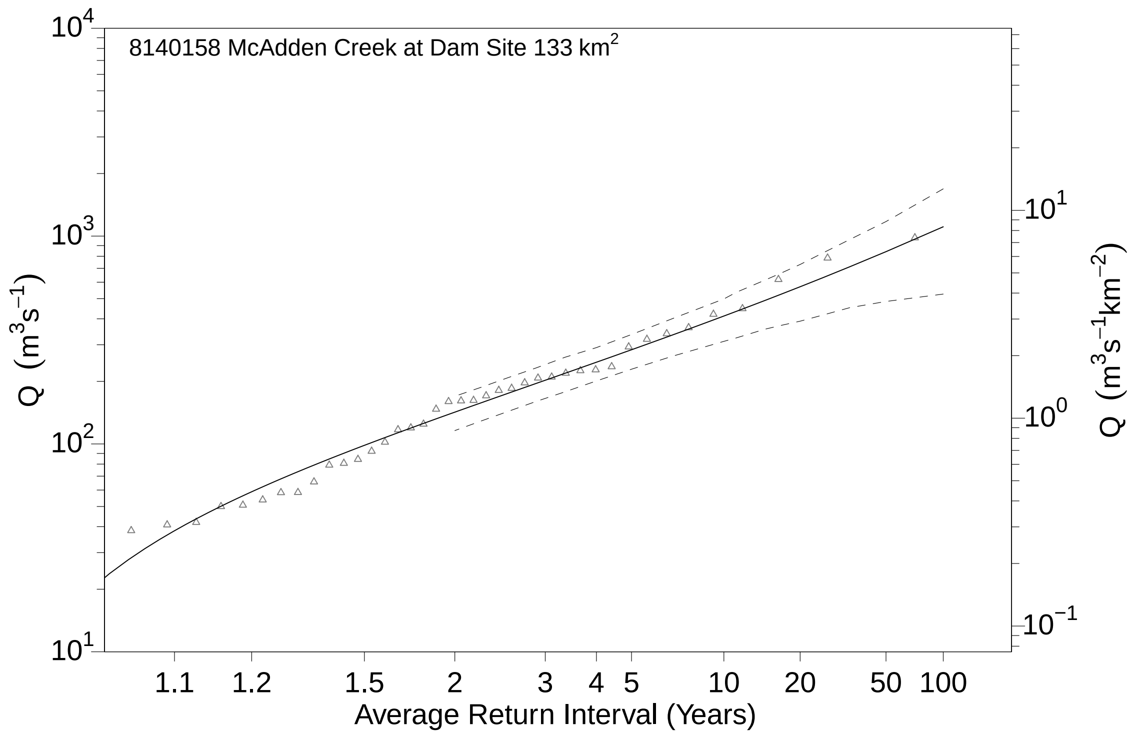

Figure 37: Fitted flood frequency curve for station 8140158. Dashed lines indicate a 95% confidence interval for the prediction. Note curve is only fitted to events with an average recurrence interval $\geq$ 1 year.

I 81400159 Seventeen Mile Creek at Waterfall View

Return Period (years)	Q (m^3s^{-1})	Year	Water Year
0.65	10.32	1970	1970/1971
0.66	10.65	1996	1995/1996
0.67	11.47	1997	1997/1998
0.68	11.72	2004	2004/2005
0.69	11.83	1978	1977/1978
0.70	12.28	1986	1986/1987
0.71	14.00	1965	1964/1965
0.72	15.80	1986	1985/1986
0.73	17.17	1986	1985/1986
0.75	20.17	1979	1978/1979
0.76	21.18	1987	1987/1988
0.77	21.92	1964	1963/1964
0.78	24.97	1973	1973/1974
0.80	25.42	1985	1985/1986
0.81	25.68	1965	1964/1965
0.83	26.86	1999	1999/2000
0.84	28.93	1985	1984/1985
0.86	30.14	1970	1969/1970
0.88	32.67	2007	2006/2007
0.89	35.61	1964	1963/1964
0.91	44.01	1990	1989/1990
0.93	47.00	1996	1995/1996
0.95	47.51	1971	1971/1972
0.97	49.28	1985	1984/1985
0.99	50.38	1991	1991/1992
1.01	50.86	1989	1988/1989
1.04	51.77	1970	1970/1971
1.06	60.69	1992	1992/1993
1.09	63.32	1969	1969/1970
1.11	63.40	1977	1977/1978
1.14	74.23	2005	2004/2005
1.17	76.15	1983	1982/1983
1.20	84.23	1988	1987/1988
1.23	94.34	1969	1969/1970
1.27	102.72	1972	1971/1972
1.31	115.67	1983	1982/1983
1.35	120.38	1978	1977/1978
1.39	124.17	1989	1988/1989
1.43	133.32	1982	1981/1982
1.48	135.74	1971	1970/1971
1.53	153.48	1969	1968/1969
1.58	156.57	1999	1998/1999
1.64	173.05	1968	1967/1968
1.70	174.98	1983	1983/1984
1.77	181.68	1988	1988/1989
1.84	187.51	1993	1992/1993
1.92	195.91	2007	2006/2007
2.00	196.20	1992	1991/1992
2.09	201.28	1987	1986/1987
2.19	217.14	1967	1966/1967
2.31	221.30	1966	1965/1966
2.43	227.27	1981	1980/1981
2.57	241.43	1963	1962/1963
2.72	247.73	1975	1974/1975
2.90	260.69	1980	1979/1980
3.10	282.50	1991	1990/1991
3.32	295.06	1976	1975/1976
3.59	327.58	1973	1972/1973
3.90	350.38	2003	2002/2003
4.26	355.84	1993	1993/1994
4.71	357.11	1974	1973/1974
5.26	429.47	1977	1976/1977
5.95	432.67	2004	2003/2004
6.85	459.94	2001	2000/2001
8.07	461.37	1984	1983/1984
9.83	492.99	2006	2005/2006
12.56	518.93	1997	1996/1997
17.38	586.81	2002	2001/2002
28.25	612.96	2000	1999/2000
75.33	1179.08	1995	1994/1995

Table 19: Flood peaks identified by the peaks over threshold analysis for station 8140159.

Return Period (years)	Lower C.I. (m^3s^{-1})	Estimated Quantile (m^3s^{-1})	Upper C.I. (m^3s^{-1})
2	171	201	233
5	304	362	417
10	396	493	582
20	478	642	796
25	509	694	877
50	578	874	1156
100	641	1083	1519

Table 20: Fitted flood quantiles for station 8140159. Values have been reported to four significant digits.

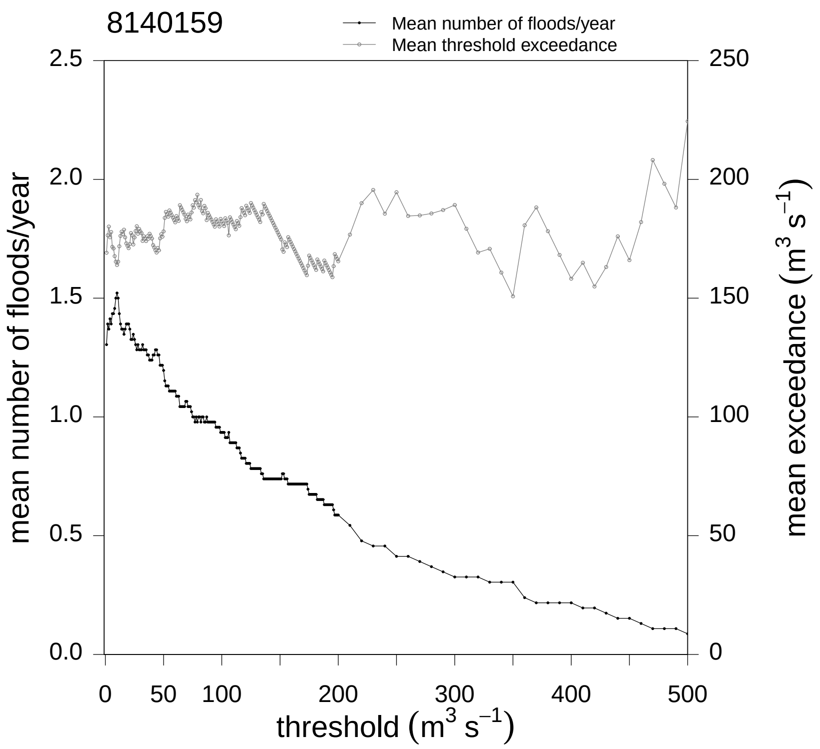

Figure 38: Threshold selection steps.

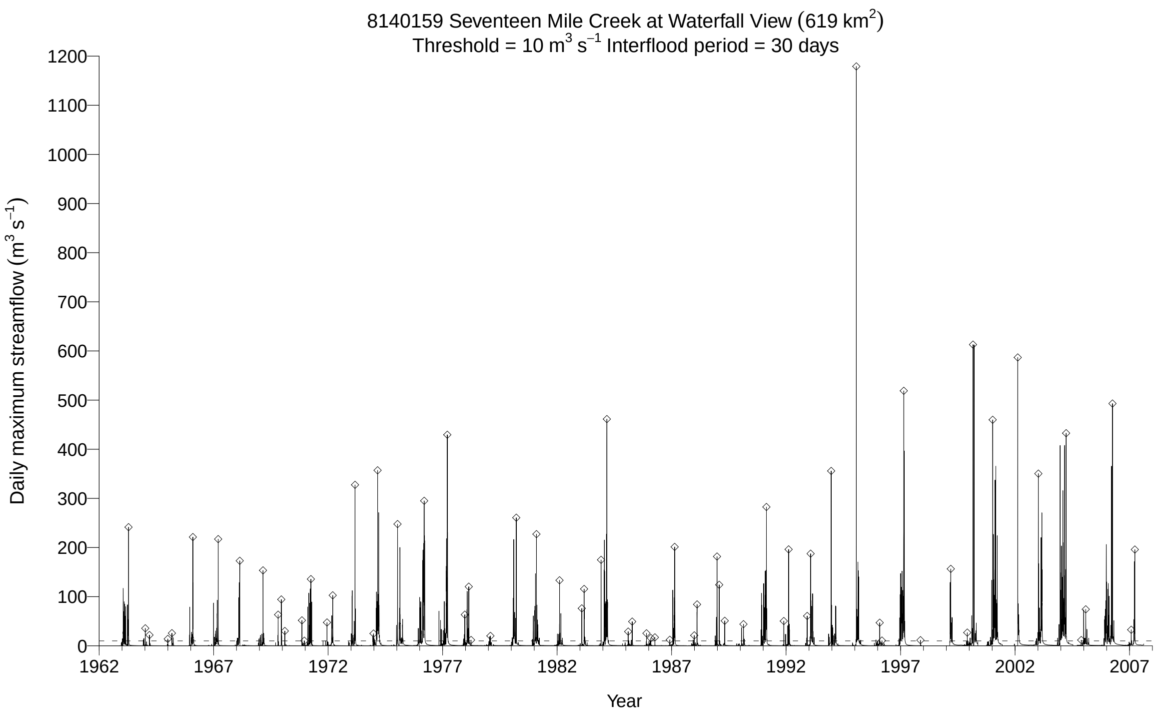

Figure 39: Linear-scale hydrograph showing peaks (shown by ◇ symbols) identified in the peaks over threshold analysis.

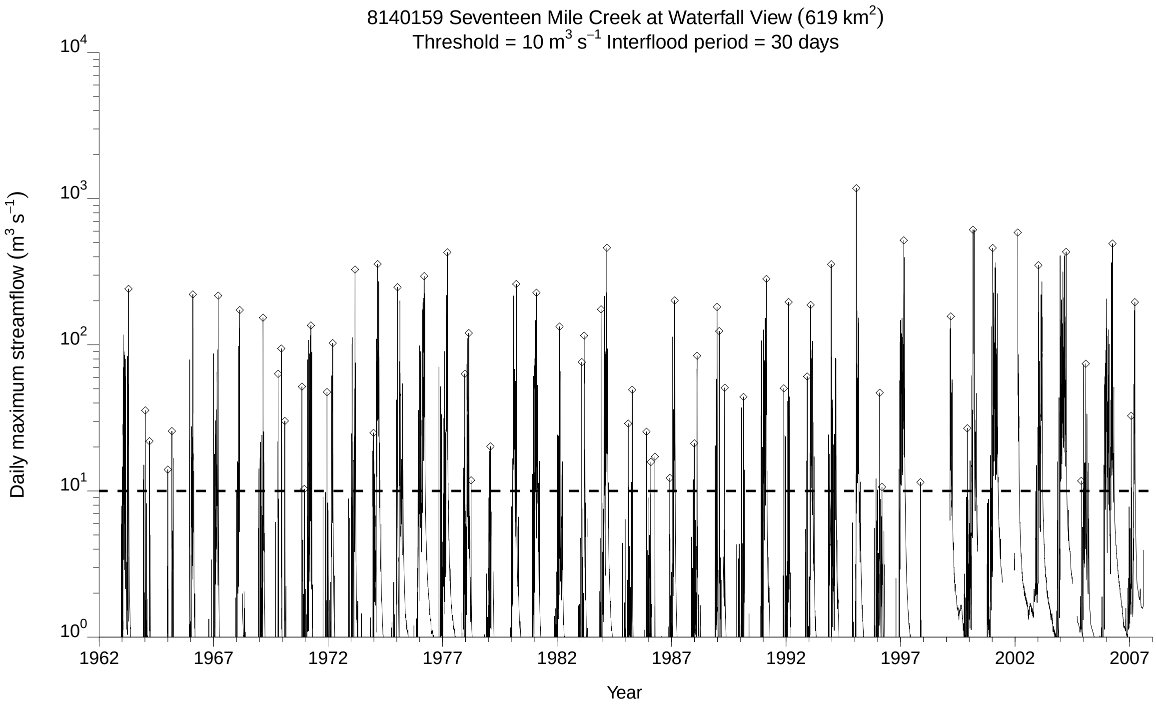

Figure 40: Log-scaled hydrograph showing peaks (shown by ◇ symbols) identified in the peaks over threshold analysis.

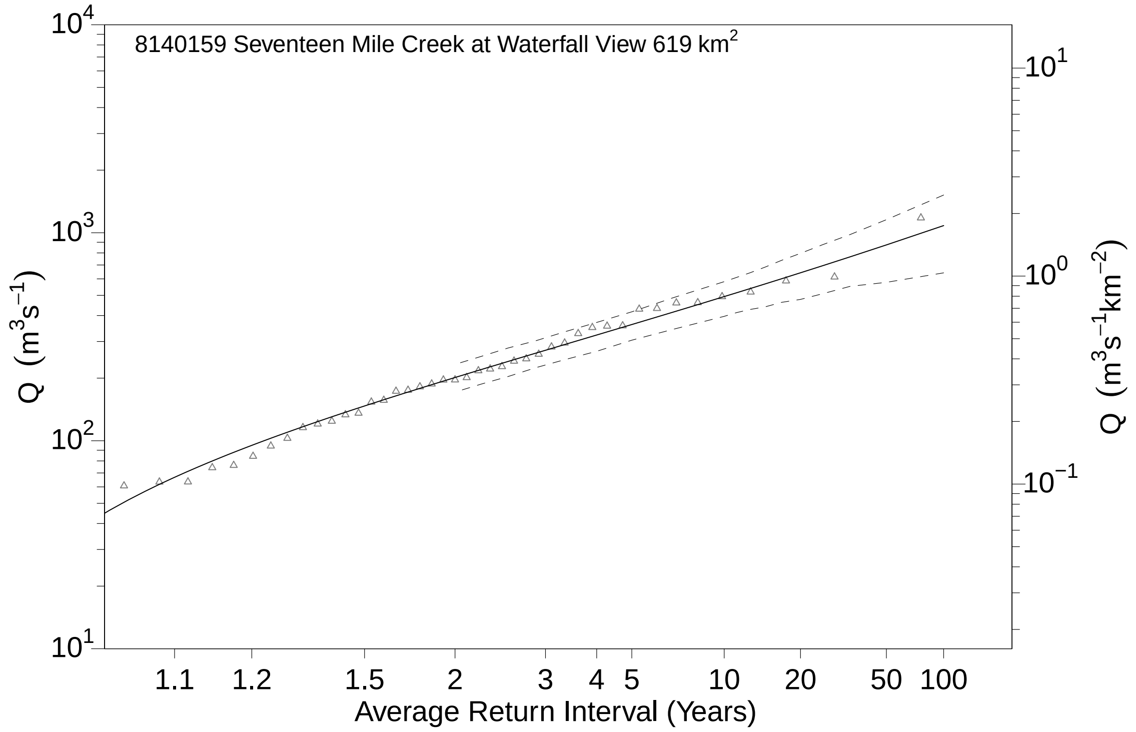

Figure 41: Fitted flood frequency curve for station 8140159. Dashed lines indicate a 95% confidence interval for the prediction. Note curve is only fitted to events with an average recurrence interval $\geq$ 1 year.

J 8140161 Green Ant Creek at Tipperary

Return Period (years)	Q (m^3s^{-1})	Year	Water Year
0.66	3.13	1989	1989/1990
0.67	3.19	1974	1974/1975
0.69	3.29	1993	1993/1994
0.70	3.60	1983	1983/1984
0.71	3.87	1971	1971/1972
0.72	4.25	1988	1987/1988
0.74	4.38	1989	1989/1990
0.75	4.44	1984	1984/1985
0.76	4.97	1969	1969/1970
0.78	5.45	1991	1991/1992
0.79	6.01	1995	1995/1996
0.81	6.34	1999	1999/2000
0.83	6.48	1984	1984/1985
0.84	7.29	1990	1989/1990
0.86	7.34	1986	1985/1986
0.88	9.39	1999	1999/2000
0.90	10.55	1970	1969/1970
0.92	10.74	1970	1969/1970
0.94	10.88	2000	1999/2000
0.97	14.20	2006	2006/2007
0.99	14.63	2006	2006/2007
1.02	16.05	1971	1971/1972
1.04	17.18	1986	1985/1986
1.07	18.47	1982	1982/1983
1.10	19.50	1987	1987/1988
1.13	21.82	1992	1992/1993
1.16	22.10	1995	1995/1996
1.20	24.09	1990	1989/1990
1.23	25.12	1979	1978/1979
1.27	27.05	1971	1970/1971
1.31	33.85	1977	1977/1978
1.36	55.61	1982	1981/1982
1.41	55.65	1987	1986/1987
1.46	59.75	1992	1991/1992
1.51	60.43	1983	1982/1983
1.57	61.68	2003	2002/2003
1.63	61.84	1994	1993/1994
1.70	65.46	2004	2003/2004
1.78	66.04	1993	1992/1993
1.86	73.58	1989	1988/1989
1.95	87.80	1980	1979/1980
2.05	90.86	2001	2000/2001
2.16	91.09	1984	1983/1984
2.28	91.88	2005	2004/2005
2.42	96.63	1991	1990/1991
2.58	98.17	1973	1972/1973
2.75	102.20	1976	1975/1976
2.96	107.57	1981	1980/1981
3.19	108.11	1995	1994/1995
3.47	111.53	1968	1967/1968
3.79	112.11	1999	1998/1999
4.19	117.52	1985	1984/1985
4.67	125.75	2002	2001/2002
5.29	131.11	1997	1996/1997
6.09	132.66	1969	1968/1969
7.18	158.68	1975	1974/1975
8.74	212.85	2006	2005/2006
11.17	224.55	1998	1997/1998
15.46	279.42	1974	1973/1974
25.12	367.62	1977	1976/1977
67.00	434.91	1972	1971/1972

Table 21: Flood peaks identified by the peaks over threshold analysis for station 8140161.

Return Period (years)	Lower C.I. (m^3s^{-1})	Estimated Quantile (m^3s^{-1})	Upper C.I. (m^3s^{-1})
2	63	76	89
5	118	144	168
10	157	202	245
20	196	270	341
25	205	295	381
50	237	381	518
100	267	486	682

Table 22: Fitted flood quantiles for station 8140161. Values have been reported to four significant digits.

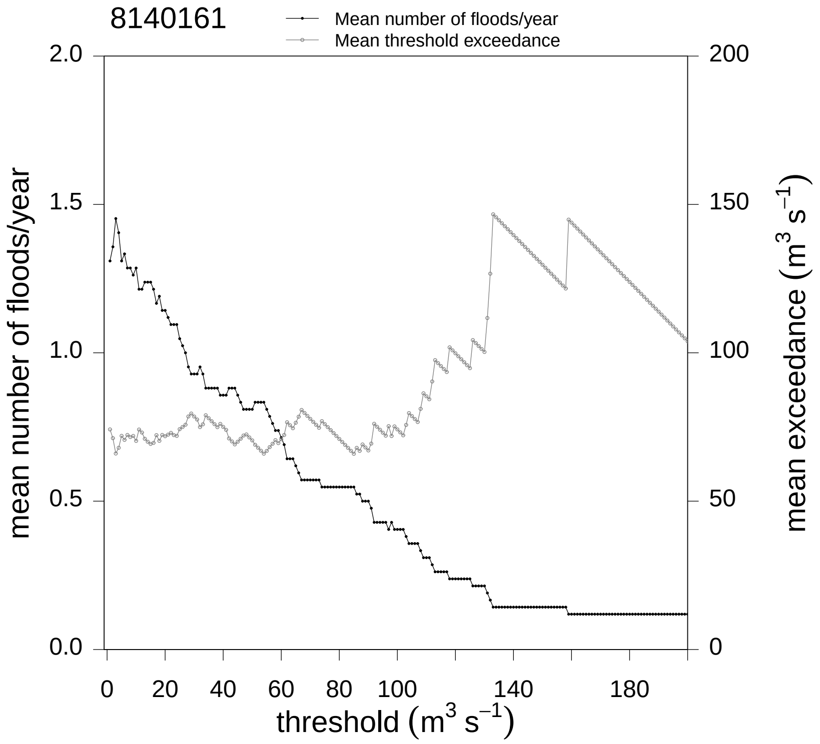

Figure 42: Threshold selection steps.

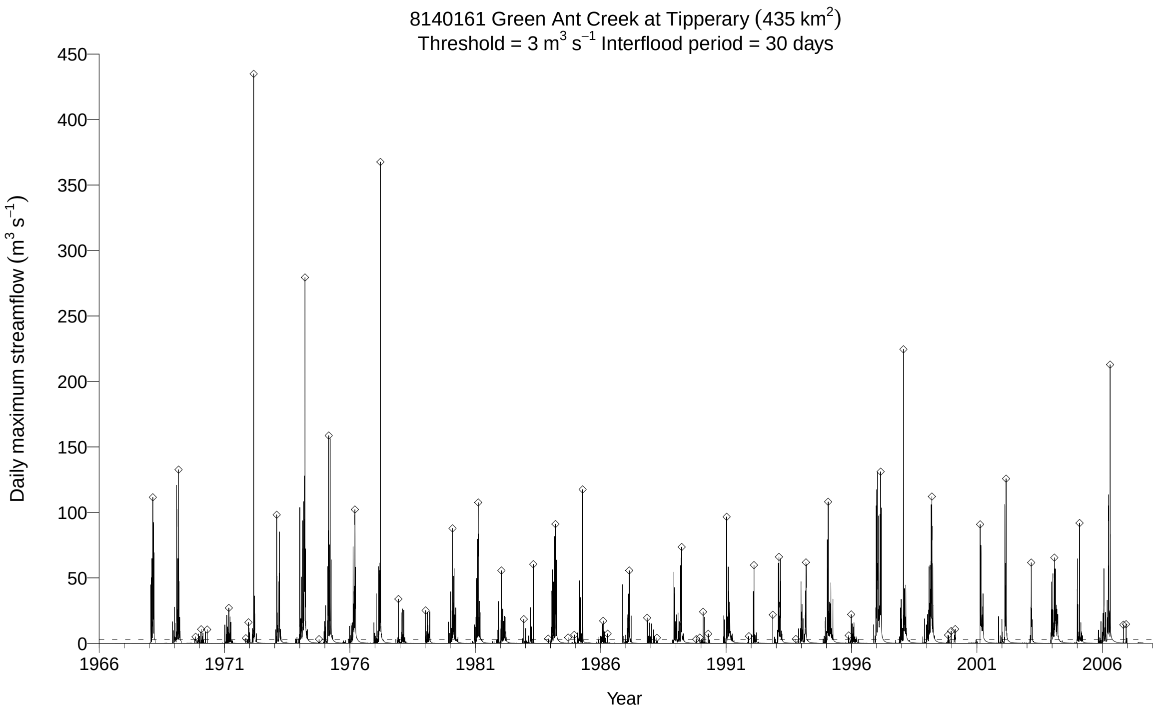

Figure 43: Linear-scale hydrograph showing peaks (shown by ◇ symbols) identified in the peaks over threshold analysis.

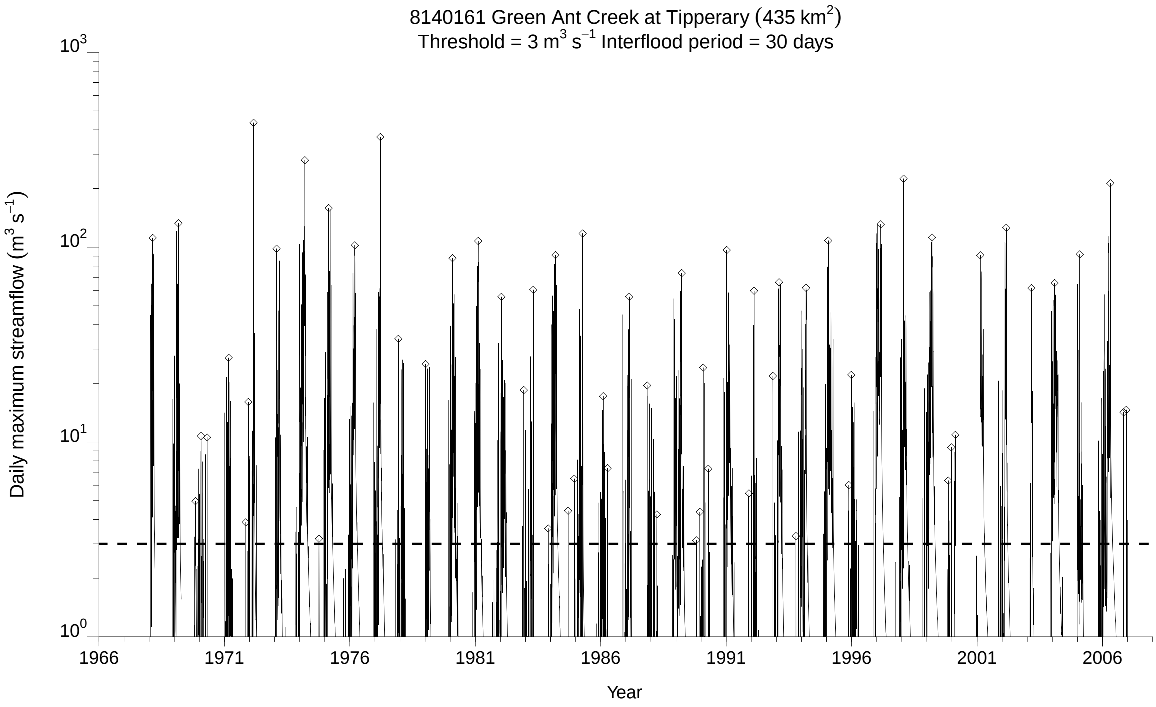

Figure 44: Log-scaled hydrograph showing peaks (shown by ◇ symbols) identified in the peaks over threshold analysis.

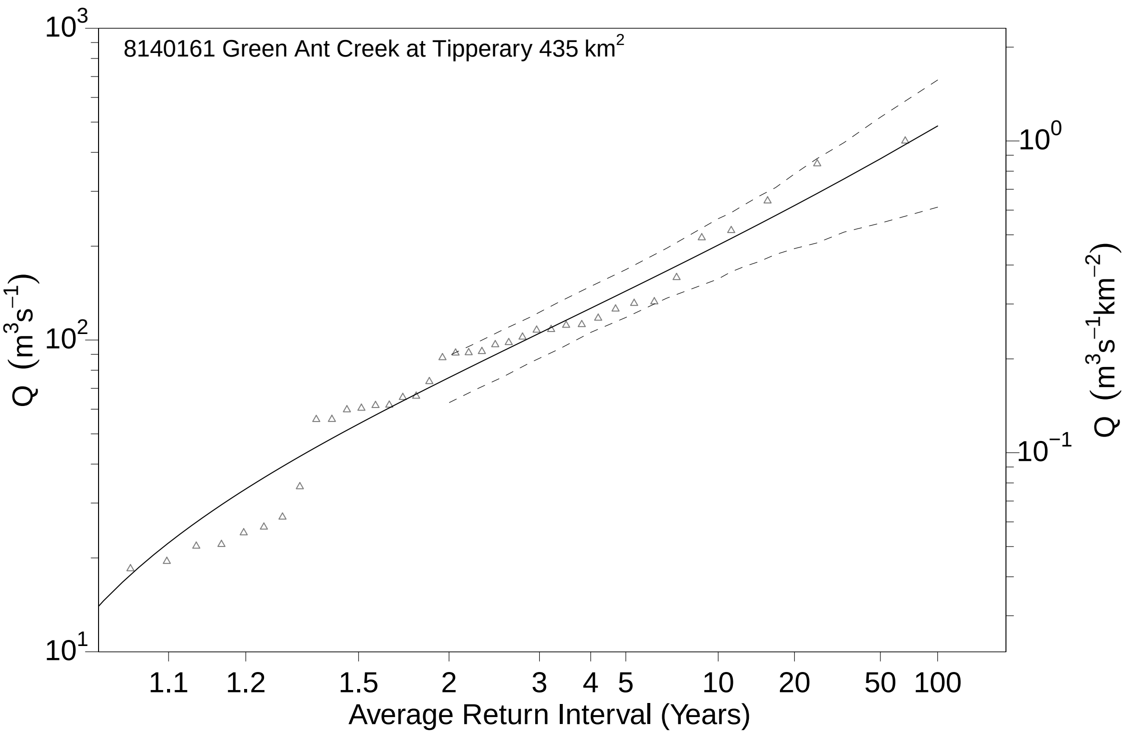

Figure 45: Fitted flood frequency curve for station 8140161. Dashed lines indicate a 95% confidence interval for the prediction. Note curve is only fitted to events with an average recurrence interval $\geq$ 1 year.