Flooding

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THE 2053 SOUTH QUEENSLAND FLOOD

Only Young Water Professionals Need Attend

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ABSTRACT

A 'roadshow' of flood engineers in the early 1980s 'prophesised' the flooding that occurred in South East Queensland (SE QLD) during 2011 to 2015. The events of 2011 to 2015 may have given increased credibility to a long-held notion that SE QLD may be subject to a 40-year flood cycle. This paper examines the data on flooding within the ten major SE QLD catchments, bounded by three mountain ranges and comprising more than 63,000 km^2. The purpose was to test the existence and the strength of any regularity to flooding in this well-populated region of Australia. The approach identifies the flooding that occurred during predetermined five-year periods that were 35 years apart – the 40-year cycle – and the flooding that occurred outside of these nominated 5 year periods. The basic statistics were weighted for the length of flood record, catchment area, ranking of flood, and a combination of these factors. The results indicate that 69-87% of major floods in SE QLD have occurred within a set of five year periods exactly 35 years apart. No explanation is offered at this stage of the research. The implications for traditional hydrologic methods are outlined.

Keywords: Flooding, flood cycles, regularity, flood frequency

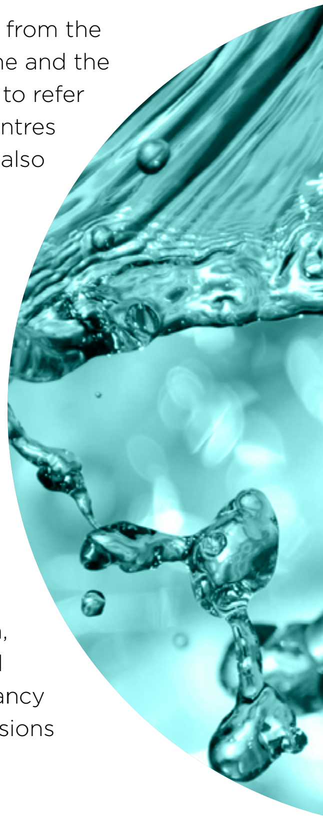
INTRODUCTION

The early years of the 1970s in South East Queensland was a period of multiple flooding events, remembered mostly for the January 1974 flooding of Brisbane. The following decade was one that experienced widespread estuarine development, where State and Local Government concerns that the development be above the 1in100AEP flood on top of a cyclonic surge, with allowance for future water level rises due to global climatic change, engaged a community of engineers who specialised in relevant fields.

While the engagement of Local Government engineering specialists and most consultants may have been within particular catchments, a group of State Government engineers and specialists from a few consultants undertook flood studies across the region and the State. The State Government engineers, under the processes advocated by the Coordinator General for approving coastal developments, and under processes used to secure immunity from liability for Local Governments under the Flood Mitigation Works Approval Act, met frequently at Committees set up for principal estuarine development proposals (and other purposes) at different centres within South East Queensland.

The State Government engineers, mainly from the Coordinator General, Harbours and Marine and the Department of Local Government, came to refer to their frequent meetings in different centres as 'the Roadshow'. Harbours and Marine also brought the physical hydraulic modelling specialists to the Roadshow, and the Department of Local Government included the Town Planning function during those years.

The experience of that concentrated work in hectic times on flood matters, across a geographic spread of estuaries, was supported by other experience in other types of flood-related problems, including flood investigations, flood escape routes, flood warning systems, flood proofing, dam operations, dam upgrades and such, gained by specialist teams and individual specialists in government and in consultancy firms. All that experience came to discussions held at the Roadshow.



That experience accumulated a number of lessons about floods – double (and triple) peaks in major floods occur often, late peaking temporal patterns can be worse than 'design' patterns, intense local storms can occur as the river flood passes by, floods can rise and fall overnight, cyclones cause rainfall and surges, 1in50AEP events are unlikely to occur three times in two years, physical models speak to people and stakeholders more effectively than computer diagrams, major floods are usually 'major' because two or more contributing events coincide, large floods usually come in pairs. Some of these lessons may have been lost to government engineering in recent decades

One such lesson was the likelihood that South East Queensland may have been subject to a 40-year flood cycle. Exchanges in the early 1980s amongst government and consulting engineers within and with the Roadshow about developments that were being allowed to occur on floodplains that had recently been subject to flood studies led to discussion of the risks of a future disaster. A piece of humour about which of the Roadshow members would be retired when the disaster was likely to occur, and when a Royal Commission was likely to be held, led to a calculation as to when 'the next 1974 flood' would occur. The period 2013±2.5 was suggested.

The author's career from the late 1980s moved into drought management and the disaster caused by drought, including the management of the natural resources scientific research unit within the State Government. During this time, with the assistance of super computers, scientists leapt from the study of paddocks to the modelling of ocean weather systems and their impact on rainfalls in Queensland and Australia's region. While the scientists were focussed on agricultural production, and the prediction of 90-day and 180-day rainfalls, the *el nino / la nina* mechanisms that were explored opened up the possibilities for identifying an explanation as to why the largest floods in South East Queensland might be occurring irregularly rather than randomly.

Hypotheses existed for physical forces that could impact on rainfall volumes – the eruptions of volcanoes in Indonesia, Tambora 1815 and Krakatoa 1883, for example, may have affected weather systems for 5 to 10 years, some (Robock, 2000; Self, 2006; Czopak, 2012) have proposed – but no hypotheses had proposed an explanation for bringing regularity to major flooding events.

The major flood events in South East Queensland during January 2011 and January 2013 fell within the prediction made approximately 30 years earlier of 2013±2.5, and thus gave more creditability to the notion of a 40-year flood cycle.

This paper sets out to demonstrate just how regular or irregular and / or non-random the largest flooding events in South East Queensland have been since records have been taken.

MATERIAL AND METHODS

The study herein reported is best served by the description of 'preliminary'. This is because the records of flood flow relied on by the study were accepted rather than interrogated. There are mixtures in quality and / or continuity of flow records in the South East Queensland region, and interrogation of the data used might be necessary to achieve a consistency in the processes adopted towards the flow records that have a mixture of quality.

The study area is bounded by the MacPherson Ranges in the South, the Great Dividing Range in the West, and the Dawes / Burnett Ranges in the North. The region has a total area of 63,000 sqkm

The following information is offered about the ten catchments that make up the bulk of the target region:

Burnett River – with a catchment area of 33,000km2, this is the largest catchment in the region. There are 140 years of flood height records at Bundaberg at the downstream end of the River. The construction of dams during that period would have some impact on the records taken at Bundaberg in the last half of that period. The four largest floods were used for this study, namely Jan 2013, Jan 1890, Feb 1893 and Feb 1942. A second flood also occurred in Feb 1893 (as also occurred in the Brisbane River) but only one of the floods from Feb 1893 was included in the four largest floods taken from this River (BoM, 2014).

Mary River – this catchment is over 7000km2, with the downstream records of flood heights at Maryborough since 1910, and records of major floods from before that time. Again, the construction of dams would have some effect in recent decades. The study used the four largest floods for which records are held, namely, Feb 1893, Mar 1955, Jan 1974 and Jan 2013 (BoM, 2014).

Noosa River – this catchment is 1900km2 in area. There are 25 years of records at Tewantin, plus a historical record of the 1968 flood. The study counted only one flood event from this catchment, the Jan 1968 flood (BoM, 2014).

Maroochy River – there are 630km2 in this catchment. There is also a 90-year gap from 1893 in the flood height record at Picnic Point, so this study worked off the historical records quoted by BoM. There may be minor impact from dams on the record. The four major floods taken from this catchment were the Feb 1893, Jan 1974, Jan 1951 and Feb 1992 floods (BoM, 2014).

Mooloolah River – this catchment is only 196km2, for which there are flood height records at Mooloolah since 1972. The two highest floods were taken for this study, the Apr 1989 and the Feb 1972 floods (BoM, 2014).

Caboolture River – this catchment has a total catchment area of 370km2. There are records of flood heights at Caboolture since 1970. The two highest floods were used in this study, namely Jan 2011 and Feb 1972 (BoM, 2014).

Pine River – there are 800km2 in this catchment, where the impacts of dam construction on the flood records at Youngs Crossing would be significant, since 1976. This study took the three largest floods from before 1976 and the largest from after 1976, namely, Feb 1931, Feb 1893 and Jan 1974 (Middlemann et al, 2000), and Jan 2011 (BoM, 2014).

Brisbane River – the total Brisbane River catchment has an area of 15,000km2. Quality records for flood heights at Brisbane City go back to 1887 (Cossins, 1975). There would have been some impact from dam construction on the records, principally from 1942 (Somerset Dam) and then from 1985 (Wivenhoe Dam). The study took the two largest floods from the records before 1942, one more from the period 1942 to 1985, and the largest from post-1987. Those floods were Feb 1893 and Mar 1890, Jan 1974, and Jan 2011. Special mention is necessary with respect to three aspects of this selection of floods.

BoM (2014) published the existence of an 1841 record of a flood larger than the Feb 1893 flood. Cossins (1975) reports that the origin of this 1841 event was a report written in 1895 by a government officer to the Parliament in the aftermath of the 1893 flood. In 1841, Queensland was still a penal colony, free settlers had only been allowed access a year earlier, and there were no daily newspapers. The 1841 flood, strangely for its size, is not described in the historical record for Queensland for 1841 (Coote, 1882). A lesson learned is to verify statements made by government about flooding in the period after a major flood. Verification of an 1841 flood has not been found.

The Jan 2011 flood too has a history. While Brisbane floods may be expected to be mitigated by the Somerset and Wivenhoe Dams, in 2011 an operational rationale used in controlling the flood, that did not comply with the operations manual for the Dam (QFCI, 2011) took the Wivenhoe Dam out of the flood mitigation operational regime and into the Save-the-Dam operational regime. This change in regimes caused the operations to release a flood peak estimated at 7500 cumecs (Seqwater, 2011) or at 11,561 cumecs (Rodriguez, 2014). This peak release was superimposed upon the peak of the downstream flood waters in the Bremer River (QFCI, 2011). A study as to what the flood levels would have been if the Dam had been operated according to the Manual, and had the Dam been able to remain in the flood mitigation role, has yet to be reported.

There were three flood peaks within the month of February 1893. The third was slightly larger than the first peak, the second peak slightly lower than the first. The first peak is the one used in this study. The decision was taken not to include two peaks from Feb 1893 in this study.

Logan River – this catchment is 3850km2 in total area. Records of flood heights are broken before 1967. There are records of events in Jan 1947 (lower than Jan 1974 levels at Waterford), in Jan 1887 (slightly higher than Jan 1974 levels at Waterford), and in Feb 1893 (much higher than Jan 1974 levels at Dulbolla) (Middelmann et al, 2000). This study has taken the three highest events from this broken record set, and determined these to be Feb 1893, Feb 1974 and Jan 1947 (Jan 1887 was ruled out).

Nerang River – this catchment is 400km2 in size. The records of flood heights go back to 1920, but have been significantly affected by dam construction in 1976 and 1989. The three highest floods at Evandale, prior to 1976, have been used in this study, being Jan 1974, Feb 1954 and Feb 1931 (Middelmann et al, 2000), and the largest flood post-1976 was Jan 2013 (BoM, 2014).

The Preference for Downstream Records

In making the above selections of floods for this study, the focus has been on the most downstream set of records that were viable for the purpose of this study. The focus has not included upstream records. Upstream records mean records for smaller catchment areas, and the records for smaller catchment areas are more vulnerable to a bias for large rainfall systems that are relatively smaller than other systems, but register higher on flood records because the system aligns closely to the boundaries of the smaller upstream catchment. Smaller catchments are well represented in the list of catchments for which records have been included in the study.

Weighting the Results

The above methodology has weighted the results to those catchments that have the longer rainfall records (or observations of peak flood heights). A greater number of flood events were taken from each catchment if that catchment had a longer record of flood events.

The other weightings imposed on the results, already weighted for their length of flood records, were based on:

- the area of each catchment, and
- the ranking of each flood event within that catchment.

The weighting for area simply gives more weight to catchments and the floods recorded within catchments with the greater catchment areas. The reasoning here is that an event that is significant in a big catchment has demonstrated greater size than a flood that was significant in a smaller catchment. The proportion of floods in a catchment that occurred in the five-year target periods, 1891-95, 1931-35, 1971-75 and 2011-2015, is multiplied by the proportion of the total study area (63,000km2) occupied by that catchment. Those weighted results for each catchment are then added to derive an area-weighted result for the total region.

The weighting for ranking of each flood in a catchment is best described by an example. The reasoning here is that the occurrence of the largest flood event is a better demonstration of the behaviour of large events than is a smaller large event. Take a catchment from which four events have been identified. The largest of the four events has been given a weighting of '4', the second highest has been given a weighting of '3', the third has been given '2', and the fourth '1'. If the highest and third highest floods in that catchment occurred within the five-year target periods, mentioned above, the unweighted score would have been 2 floods out of 4 floods, or 0.5. The rank-weighted score for that catchment, however, would now be 4+2 points out of (4+3+2+1=) 10, or 0.6.

The weightings can be combined by applying the area-weighting process to the rank-weighted catchment outcomes.

RESULTS AND DISCUSSION

A first outcome was the realisation that there was a better five-year target period than the one taken from the original forecast of 2013±2.5 years made by those 'Roadshow' engineers three decades earlier. The results showed that shifting by one year to the set of five-year target periods 1890-94, 1930-34, 1970-74 and 2010-04 captured two more events (Jan 1890 in the Burnett, and Mar 1890 in the Brisbane River) and lost no events.

The original 'Roadshow' forecast was based only on the largest floods in the Brisbane River (Feb 1893), the Pine River (Feb 1931) and the Nerang River (Jan 1974).

The '3' in '2013' was the median from those three events, the range from '3' was 2 years to capture both other years from this three-event base, and a half-year was added to capture the full wet season which, in Queensland, starts in December.

When this study widened the focus to more than just the largest flood, and to all catchments in the South East Queensland region, the five-year target period achieves a slightly improved result if it is based on five-year target periods 1890-94, 1930-34, 1970-74 and 2010-04 in lieu of 1891-95, 1931-35, 1971-75 and 2011-15.

Abbreviating 'five-year target periods' to FYTP, the following results were recorded:

- The largest flood occurred during the FYTP in 8 out of 10 catchments (80%). If the segmentation of certain records for dam construction impacts is considered, the FYTP captured the largest flood in 86% of cases.
- If the two largest floods are considered for catchments for which two or more floods have been identified, FYTP captures 76% of the largest floods on record.

The results from the weighting exercises are set out in Table 1.

Some observations can be made about these results in the broad sense and in the detail. Recall that the effort here is not to identify anything about the occurrence of flooding in general, but to identify any regularity in the occurrence of the largest floods.

A first observation is that 5 years in a 40-year period accounts for 69% to 87% of the ranked floods taken from the ten catchments in South East Queensland, depending on the aspect taken of these ranked floods. The figure, 80%, appears to be a fair figure for representing this phenomenon.

If consideration is made of those flood events of sufficient size that they are ranked in more than one of the subject catchments, the FYTP captures 100% of these largest of floods – Feb 1893 (1st), Feb 1893 (3rd), Feb 1931, Feb 1972, Jan 1974, Jan 2011 and Jan 2013.

Table 1. Results from Weightings for ranking of flood events and for catchment area

Catchment	Area '000 sqkm	No. of Ranked Events	FYTP Score	Score Rank weighted	Score Area weighted	Score Combined weighting
Burnett	33	4	75%	90%	40.0%	47.9%
Mary	7	4	75%	70%	8.3%	7.8%
Noosa	1.9	1	0%	0%	0%	0%
Maroochy	0.6	4	50%	70%	0.5%	0.7%
Mooloolah	0.2	2	50%	33%	0.2%	0.1%
Caboolture	0.4	2	100%	100%	0.6%	0.6%
Pine	0.8	4	100%	100%	1.3%	1.3%
Brisbane	15	4	100%	100%	23.7%	23.7%
Logan	3.9	3	67%	83%	4.1%	5.1%
Nerang	0.4	4	75%	75%	0.5%	0.5%
Totals	63.2		69.2%	72.1%	79.2%	87.7%

Note: The results for Pine, Brisbane and Nerang have included an allowance for impacts from dams

In three out of the four FYTPs, two years of the five years in the FYTP featured at least one ranked flood – 1890 (2 floods) and 1893 (3 floods) in FYTP 1890-94; 1972 and 1974 for FYTP 1970-74, and 2011 and 2013 for FYTP 2010-14.

Of the sixteen events given ranking by this study, seven occurred in January, seven in February, and two in March. The six largest of floods came three in January and three in February. This may be a lead to some physical explanation for the results provided by this study.

If consideration is made of ranked floods that did not occur within the FYTPs, nil occurred in the 35-year period leading up to the 1931 event, two - occurred in the 35-year period leading up to the 2013 flood, but six occurred in the period leading up to the 1974 flood. There may be a correlation or a relationship between the flooding intensity in the 35-year period leading up to the FYTP and the size of the event(s) that occur in the next FYTP.

Additionally, any explanation that emerges as to why the FYTPs are capturing the largest floods could be confirmed by an associated explanation as to why so many major floods occurred during 1942 to 1968 (6 ranked events) or during the eight years 1947 to 1955 (4 events).

The capture, by 12.5% of the record, of 80% of ranked floods, and of 100% of the largest of floods, merits a rethink as to how flood frequency analyses are conducted for catchments in South East Queensland.

The conduct of a flood frequency analysis just for the twenty years of a combined FYTP may assist the engineering profession and its clients in appreciating the true flood risk faced in South East Queensland.

THE AUTHOR

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CONCLUSIONS

The forecast made by the 'Roadshow' appears to have been supported by this study. Confirmation of the basis for that forecast may require an explanation for the results obtained, a physical explanation about which the statistics can then inform.

There appears to be an 80% probability that the next very large flood event in South East Queensland will occur during 2050-54, and a 60% probability that two or more significant events may occur in that five-year period.

Flooding in SE QLD might better be described as irregular rather than regular, but not as random.

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