Second Submission to
Queensland Floods Commission of Inquiry

by
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Qualifications and background

To avoid the need to peruse my first submission, the first two paragraphs are repeated here.

Since I will be making some personal comments and referring to various technical issues is is appropriate that the Commission be aware of my background.
I graduated with a Master of Science from the University of Sydney in 1955.
I then worked from 1956 to 1965 as a Scientific Officer and later Senior Scientific Officer at the Royal Aircraft Establishment in Britain on various problems involving turbulent flow of air, including low speed flows, which are, in many cases, little different to flows of liquids.
I joined the staff of the Department of Mathematics at the University of Queensland in 1965 as a Lecturer, and was promoted to Senior Lecturer in 1975. I retired from that position in 1997.

I have personal experience of both the 1974 and 2011 floods. In 1974 our house at Graceville was inundated to a depth of about 1.6 metres in the upper level. In 2011 we were living at The Village at Yeronga in retirement. This was inundated to a level of about a metre on the ground floor, and the basement, including electrical switchboard and various essential services was put out of action. We returned, with access from ground level via the fire escape stairs, on 14 March 2011.

This submission covers forecasting and some other matters.

Probability, Forecasting, and the Q-100 Flood Line

This section may, in places, involve a small amount of technical detail about random events, and thus not always use terminology with which members of the Commission are familiar. And some of the language which has been used by the media in connection with flood events is, to say the least, misleading to many members of the general public. An attempt has been made to express concepts in everyday language, but since I may not have succeeded in all places, I would be happy to provide supplementary information, or appear in person to answer questions.

The meaning of "one-in-100-year flood level
The article "Flood recovery build plan" on page 13 of The Courier-Mail for March 23, 2011 the second paragraph read:

> The Government admits more than half the 14 fast-tracked projects are on plots below the one-in-100-year flood level, some of which were hit by flooding this summer.

This article, and a number of others which have appeared, and comments in the media, show that most people do not understand the correct technical meaning when experts refer to some disaster as a "once in a century" event. Judging by the complaints about buildings constructed above the Q-100 flood line, people expected that it would be about a century after the 1974 flood before they needed to be concerned, and that this line indicated the extent of any such flood.

Putting it in blunt terms, the reaction seems to have been “We had a big flood in the 19th century (1893), another one in the 20th century (1974), about 80 years later, so why are we now suffering only 37 years after the last one?” A more thoughtful response would be to include the 1930 flood and say “1893, 1930, 1974 and now 2011 looks more like about every 40 years than once in a century.” In either of these, the unspecified interpretation of “once in 100 years” is that these floods will occur fairly regularly, and not at unpredictable, random intervals.
The other major misconception is that the Q-100 line marks the maximum extent of the flood, whereas it was intended (this may be a charitable interpretation on my part) to indicate a line above which floods may reach once a century, on average.
Correcting these widespread misunderstandings will involve a massive educational program for politicians, insurance companies, business interests and, most importantly, the general public. And this should not be just a one-off event, but should be repeated, preferably annually, especially for people engaged in town planning, granting building permission and others concerned with infrastructure.
I was not aware of the existence of the Q-100 Flood Line map until partway through the 2011 flood. I have not been able to obtain a copy of it, though small parts of it can be found in several places:: a map on Web site of The University of Queensland at St Lucia shows the Q-100 line, the line of the 1974 flood, and facilities there which were damaged/destroyed in the 2011 flood. Given that the 1974 flood was above the claimed Q-100 “once-in-a-100-year-flood” line, I find it surprising that this line is still being used for planning purposes.

It is the very idea that it is possible to produce a map which will provide information about the frequency of floods of a specific size which has very little scientific justification.

The meaning of “random” and “average”
I used the words “random events” in the introductory paragraph of this section. The meaning of the phrase is, in its simplest terms, that any particular event cannot be predicted with confidence, and a collection of such events has no discernible pattern. This may be illustrated by some examples.
(a) Consider the incidence of road fatalities in Queensland. It is impossible to predict when or where the next fatality will occur, though some places (and times) may be more likely than others to have a fatality. And although it may be possible to discern some pattern in the variation of number of fatalities on different days of the week, and different weekends during the year, fluctuations in the road toll over, say, the Christmas period, show no pattern.
(b) A readily available tool I have used to show students of mathematics something of the nature of “random” is the Brisbane White Pages. Open this (at some random page) and make a note of the last digit of successive phone numbers. These show no pattern, though they are all perfectly definite and errors in the printed numbers are very rare. And if part of a column is covered, by looking at the exposed digits predictions can be made about the covered digits. But the chance of guessing the next digit correctly is 1 in 10, of guessing the next two digits correctly is 1 in 100, and 1 in 1,000 for the next three digits, and so on.
(c) More easily observed collections of random events can be seen at your nearest hotel which displays games of Keno on screens in the bar, or in the dining room (as at the Salisbury Hotel Motel where we stayed from mid-January to mid-March). If the average person was asked to select 20 numbers at random from the numbers 1 to 80, they would be unlikely to include two consecutive numbers. And the idea that three or four pairs of consecutive numbers, and one string of three, could be random, would strike them as incredible. Yet this is just the sort of things which appear on the Keno screen. And from one “game” it is impossible to predict which numbers will show up in the next game.
(d) From time to time there are reports that some workplace has a “cluster” of cases of breast cancer among female employees. The number of cases is significantly above the

average number expected for the number of employees. One consequence of this, rarely mentioned, is that there must be workplaces, of comparable size, where the incidence is below average. These get no mention in the media, nor do we read advertisements "Come and work for us! Our office has been free of breast cancer for over 10 years now!"

Keno, and other gambling machines, are very carefully programmed, and even more carefully checked, to ensure that the results are actually random, and do not show any pattern which clever gamblers can use (which is why mathematicians rarely gamble). And part of the checks include ensuring that, over long runs, each number is selected with approximately equal frequency, so it's no good appealing to "the law of averages".

Probability and "the law of averages"

A very common fallacy among gamblers is to appeal to "the law of averages". The same faulty reasoning lies behind the many complaints about buildings which were constructed above the Q-100 level being inundated only 37 years after the last major flood.

Ask a gambler, or a member of the non-gambling public, what the odds are of a toss of a coin yielding heads or tails, and the answer will almost certainly be 50:50, or evens. But tell them that the last six tosses of the coin were all heads, and ask them what the next toss will be and the very common answer is "tails, because of the law of averages". Bookmakers and casinos make much of their profit from this idea.

The truth, which people usually recognise as soon as it is mentioned, is that a coin has no memory, and is equally likely to land heads or tails on any particular toss.

The same argument applies to the very concept of a "once in 100 years" flood, and even more strongly to the phrase "once in 5,000 years flood" that I heard on TV recently. The true meaning to be placed on random events which, for purposes of argument, occur, on average, once in 100 years, is that there is a 1 in 100 chance of it happening this year, 1 chance in 100 of it happening next year, 1 chance in 100 of it happening the following year, and so on. Applying this to major flood events, even if it were possible to draw a line in a map which indicated the extent of a flood which would occur, on average, once a century, the fact that such a flood happened in the summer of 2010/2011 would not reduce the probability of another flood occurring in 2011/2012: the chance would still be 1 in 100. And this chance would be the same for the following summer, and the one after that, and the next one, and so on, indefinitely. But the word "indefinitely" also has a hidden assumption which needs further explanation.

For the phone book, if a long list of the last digits is made it will emerge that about a tenth of these is 0, about a tenth is 1, about a tenth is 2, about a tenth is 3, and so on. But the list needs to be quite long for this average behaviour to show up.

And this is where the first major problem with determining the magnitude of a flood which might occur "once-in-a-hundred-years" can be found. We simply do not have accurate records of major floods in the Brisbane area, extending back far enough in time, to make any deductions. The area inundated in 1974 is accurately known, and that for 2011 will be known fairly shortly. The area covered in 1930 is less accurately known, and for the 1893 and earlier floods much of the information is anecdotal. This topic is discussed in more detail in the next part of this submission.

Predicting the magnitude of a flood

By "magnitude" I mean the parts of Brisbane which will be covered by flood waters. If these are known, it is not too difficult to make reasonable estimates of the depth of water (above ground level) in those parts which are affected.

In order to do this, the major sources of the water involved need to be known. And this immediately shows the difficulties. In 1974, the major source of water was the (approximately) 600 millimetres of rain received in the Brisbane/Ipswich area on the Friday and Saturday before the flood peak on Monday. But for 2011 the major rainfall occurred

outside the immediate Brisbane/Ipswich area, and a major contribution to the height of the flood was the release of water from the Wivenhoe dam, starting on the Tuesday before the flood peaked on Thursday. For the Lockyer Valley area, on the other hand, the disaster was caused almost entirely by a large amount of rain over a relatively short period of time, where the runoff was confined to a fairly narrow portion of the region.
Another major item which affects the height of a flood is the amount of water already absorbed by the ground, and the amount of open space where rain can be absorbed. It would clearly be inappropriate to use information from the sparsely built up area in 1887 to predict what a downpour of 465 millimetres in one day (21 January 1887) would do to Brisbane in the summer of 2011/2012. And even the changes in the topography of Brisbane between 1974 and 2011 were sufficient for some places which escaped inundation in 1974 being affected in 2011, and some places affected in 1974 escaping in 2011. One matter which seems to have been given insufficient attention is the growing tendency for what are best described as mansions being built on standard residential blocks, at least in Brisbane. Instead of a large proportion of the block being open space for children or garden, the mansion occupies almost all the block. Thus any rainfall tends to run off, instead of being absorbed, and there have already been a number of cases of local flooding from the run-off arising from heavy, but not excessively so, rainfall.

Summary
Given all the problems mentioned here, which are some of the major ones but far from a complete list, it should be clear that even attempting to produce a map showing which parts of Brisbane would be likely to be affected, on average, once in a century by flooding, would be a generally futile exercise. It would give many people an unwarranted sense of security, and lead to even more social problems when (not if) the next major flood occurs. And this is so, even if any further development in Brisbane were to be completely banned. Further clearing of land for roads or residential purposes would only exacerbate the problem. And developments outside Brisbane, as mentioned in the article quoted above from *The Courier-Mail*, would have a completely unpredictable effect on the Brisbane/Ipswich area.
I suggest that the Commission considers strongly recommending that any references to the Q-100 flood line be discontinued, and that no attempt be made to replace it with some comparable map. It would, however, be of some limited advantage if maps could be produced showing the areas affected by both the 1974 and 2011 floods, with lines showing which additional areas would have been affected by floods reaching a height 1 and 2 metres higher.

Wivenhoe Dam

There is much confusion over some of the terminology quoted in the media about the various activities associated with the dam during January 2011. It would be helpful if clarification could be provided on these, and the excuse of “national security” should not used as a smokescreen to hide behaviour which was less than adequate.

Capacity of the dam
On any meaningful interpretation of “capacity”, this should be the amount of water which the dam is capable of holding. When the water is lapping at the top of the dam wall, but not overflowing, the dam should be described as 100% full.
This is not how things were described in various statements, where the dam was described as running at up to 190% capacity well before water started flowing over the dam wall. It should be strongly recommended that in any public statements or media releases the language should be such that it can easily be understood by both the media and the general public.

Safety measures for the dam
In the panic surrounding the release of a large amount of water two days before the peak of the flood there were a number of rather mystifying statements from managerial levels about ensuring the safety of the dam. The words “fuse plugs” were used, without any clear description of what these were, or the purpose for which they were put in place. There were several statements that these were needed to protect the safety of the dam. My immediate reaction was that these must be some sort of device to relieve the pressure on the dam wall. If this is indeed the case, and the safety of the dam relies on the water level not being permitted to be high enough to lap over the top of the wall, there must be some fairly serious fault in the design of the dam. No doubt this will all be covered in detail in the report, but so many people were misled into believing that the dam was provided primarily for flood mitigation, and not as part of the water supply for Brisbane, that urgent attention should be paid to quelling peoples' fears.
In addition, the use of Wivenhoe Lake as a recreational body of water is to be deprecated. If the water is for drinking purposes, recreational pursuits, which can very easily lead to pollution, should be avoided.

Future planning.

The ideal solution to avoid future flood damage would be to move all buildings affected by the flood to higher ground, leaving the banks of the Brisbane River clear of all types of infrastructure other than parks and some recreational facilities. This, however, is clearly not practical, so solutions to limit the damage during future floods should be sought.

Much of the damage during the flood was caused to various utilities, especially electrical works which were located at ground level or in basements for ease of construction and access. This affected particularly the large number of high-rise buildings built after the 1974 flood. Lifts are an essential part of these buildings, and even if the lifts themselves were not damaged, they could not be operated until the main electrical switchboards were repaired (or replaced) and the whole building inspected and certified as safe for reconnection of mains power.
It should not be beyond the powers of the various planning authorities to insist that all major electrical equipment was at least one or two metres above the level reached by the 1974 flood. This should apply to all new development, to any redevelopment of existing premises, and should be gradually introduced to all other premises any part of which is on land inundated in 1974. There is a precedent here in the requirement for the gradual introduction of earth leakage circuit breakers.
A rather more controversial measure would be to restrict the proportion of any site which could be covered so that rainfall could not be absorbed. The immediate impact of this would be on the redevelopment of residential properties, either for high-rise residential buildings, for the replacement of former residential areas by commercial areas, and similar changes. There would doubtless be strong objections to this from developers, but the reduced run-off which ensued would do much to lessen the damage caused by any future flood of the magnitude experienced in 1974 and 2011.

Conclusion
The main point I have been trying to make in this submission is that any attempt to produce any sort of guide to likely “once in 100 year” flood levels for planning purposes would not only be futile, but also extremely misleading, and give many people an unwarranted sense of security. Should further explanation of some points be required I would be happy to supply this, or appear in person to answer questions.

Dr Ken Smith: 30 March 2011