DO WE NEED TO CONSIDER FLOODS RARER THAN 1% AEP?

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Abstract

Everyone is aware that floods rarer than the 1% AEP event occur. Australia-wide, over the last twenty years, floods between the 1% AEP and the probable maximum flood (PMF) have occurred on a number of occasions. One might almost say that they are 'common'. Whilst the probability of experiencing such a rare flood at a given location is clearly rarer than 1%, the probability of experiencing such a flood at any location in a large catchment, or at any location within the State, is much more likely.

Flood risk management requires consideration of both probability and consequence given that risk is defined as the product of probability and consequence under *AS/NZS 4360: 1999 Risk Management*. Whilst the probability of these events may be rare, the consequences in some cases may be so significant that the flood risk cannot be ignored.

The authors have been personally involved in carrying out a large number of floodplain management studies in eastern Australia, the majority of which have been in NSW. It has been the authors' experience that in a number of these studies, risks rarer than the 1% event, whilst previously having been ignored, did after further consideration turn out to be significant risks that required serious management by the local and state government authorities involved.

A proper assessment of the risks of using and occupying floodplains requires that the consequences of floods of all probabilities, not only the 1% AEP, be identified and evaluated.

Key Words: PMF, rare floods, floodplain management, flood planning level

Risk Management

Floodplain management is principally a risk management process. Australian Standard AS/NZS 4360: Risk Management, defines the generic risk management process as comprising the identification, analysis, evaluation and treatment of risks.

Unfortunately the term 'risk' is often used in common language to mean 'chance' or 'probability'. Within the Australian Standard for risk management, however, risk is defined as:

risk = probability x consequences

This definition can lead to changes in the way we have traditionally thought of flood risks. For example, consider 'Property A' that is inundated to depths of 1m and 2m respectively in the 5% and 0.5% floods. 'Property B' is not inundated in a 5% event and is inundated by 1m in a 0.5% flood. Which property has the worst flood risk? Property A?

Without knowledge of the consequences of such flooding, a risk assessment cannot be undertaken. If 'Property A' is a farm and 'Property B' is an aged persons home, it is likely that the flood risk at 'Property B' is significantly greater than 'Property A'.

Thus when considering flood risks, both the probability and consequences must be considered.

Use of the 1% AEP Flood

The 1% AEP flood has been adopted by many authorities throughout Australia as an almost uniform standard for flood-related planning controls. This flood has also been used to define the 'floodplain' or the 'limit of flooding' in many cases. The consequences of flooding above this level have, in the past, been largely overlooked.

But floods larger than the 1% AEP flood do occur, and in many instances such events do need to be considered.

In NSW the Department of Infrastructure, Planning and Natural Resources (formerly DLWC) has responsibility for providing funding and technical advice to local authorities to carry out flood and floodplain management studies. The Department now requires that these studies consider the full range of flooding, up to the probable maximum flood (PMF). The Department also released a revised Floodplain Management Manual [NSW Government, 2001], which now defines terms such as 'flood liable land', 'floodprone land' and 'floodplain' as being all land susceptible to flooding up to the PMF.

Should we all consider floods rarer than the 1% AEP event? This paper looks at some of the issues associated with rarer floods and attempts to provide an answer to this question.

Rare Floods are Common

There have been many instances, particularly in recent years, of floods larger than the 1% AEP flood occurring throughout Australia. Some examples include:

(i) Fortescue River, WA, 1975

Major flooding occurred in parts of WA as a result of Tropical Cyclone Joan in 1975. Rainfall totals that were recorded exceeded those estimated for the probable maximum rainfall.

(ii) Saltwater Creek, Bateau Bay, NSW, 1981

A severe storm of several hours duration was experienced on the NSW central coast in 1981, with rainfall totals exceeding those estimated for the 1% AEP event. One of the worst affected areas was at Bateau Bay, where several detention basins were overtopped and a number of downstream retirement villages were flooded.

(iii) Wollongong, NSW, 1984

Severe flooding was experienced throughout much of the Wollongong area in 1984. The total rainfall recorded over a 12 hour period was 720mm, nearly twice the 1% AEP rainfall and in excess of the probable maximum precipitation.

(iv) Nyngan, NSW, 1990

The 1990 flood at Nyngan is remembered both for its severity and problems associated with flood warning predictions. Peak flow rates down the Bogan River were more than 4 times higher than the highest recorded in 100 years. The levee that 'protects' Nyngan was overtopped and much of the town was devastated.

(v) Coffs Harbour, NSW, 1996

Up to 500mm of rainfall was recorded over a 6 hour period in the Coffs Harbour catchment area. Rainfall totals were nearly twice that of the 1% AEP event, and flood levels rose to more than 1m above the estimated 1% level. Some 260 homes and 200 commercial buildings were flooded, with an estimated damage bill of $30M. Many new homes that had been built above the 1% flood level were inundated.

(vi) Katherine, NT, 1998

The 1998 flood in Katherine was a major event, which peaked up to 1m higher than most people thought was possible. Problems were compounded by the fact that most bridges and evacuation routes were cut-off at an early stage of the flood. Some 2,500 homes were damaged during this event.

(vii) Wollongong, NSW, 1998

A second major flood was experienced in the Wollongong area in 1998. About 250mm of rain was recorded over a 4 hour period. Flood levels on many of the creeks were up to 1m higher than the estimated 1% AEP flood at that time.

When one considers the number of floods above the 1% AEP that have occurred

throughout Australia, it might be concluded that “rare floods are common”

Some Case Studies to Consider

The significance of floods larger than the 1% AEP event may not be fully appreciated until the event has been experienced first hand, as in the examples above. However, we have a much better chance of being able to respond to such disasters if we know the magnitude of the potential problem in advance, as flood and floodplain management studies are formulated for specific areas.

In many catchments, the difference between the 1% AEP flood and the PMF will be relatively small (eg less than 1m) and the significance of these larger floods may not be so important. In other catchments the difference may be much larger, due to the characteristics of the river and the floodplain. A good example is the Hawkesbury-Nepean River to the west of Sydney, where the PMF can be about 10m higher than the 1% AEP flood. In such cases, consideration of floods larger than the 1% AEP event is more critical.

The results from three floodplain management studies recently completed by Bewsher Consulting can be compared to demonstrate the impacts of floods greater than the 1% AEP event. These studies were undertaken on:

< The Georges River (Sydney);

< Camden Haven (mid NSW Coast); and

< Coffs Harbour (North NSW Coast).

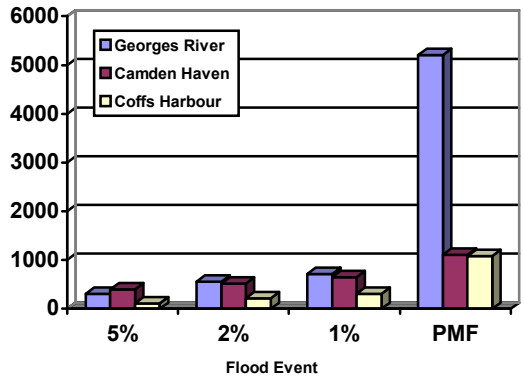
These studies investigated, amongst other things, the magnitude of the flood problem for various floods up to the PMF. Information on the extent of flood inundation, numbers of properties affected, and estimated flood damages were assessed.

The Georges River exhibits similar characteristics to the Hawkesbury-Nepean River, where a deeply incised river valley has a pronounced affect on large floods. Subsequently, the estimated PMF level on the Georges River can be up to 4m higher than the estimated 1% flood level. The Camden Haven and Coffs Harbour Catchments are more typical of average catchments, where the range between the two flood events is generally of the order of 1.5m.

A comparison of the number of residential homes that are affected by different floods in the three catchments is shown on Figure 1. In all cases there is a significant increase in the number of homes that will be affected in the PMF compared with the 1% AEP flood. The number of flood affected homes increases from:

< 721 to 5,204 on the Georges River;

< 653 to 1,106 on the Camden Haven; and



< 308 to 1,087 in Coffs Harbour.

Figure 1 – Numbers of Homes Flooded

The dramatic increase on the Georges River is due to the large difference in flood levels between the 1% AEP flood and the PMF, and due to the normal planning controls that have allowed development to occur just above the 1% AEP flood. Even the other two catchments, where variations in flood levels are more typical, the number of flood affected homes increases by between 2 to 3 times.

A similar comparison for flood damage estimates is provided in Table 1. Whilst significant flood damage is predicted for the 1% flood in all three catchments, the increase in flood damage in the PMF is even more significant.

Table 1
Estimated flood damage in Different Floods

Study	Estimated Damage in Flood Event			
	5%	2%	1%	PMF
Georges River	$29M	$71M	$100M	$830M
Camden Haven	$18M	$26M	$34M	$73M
Coffs Harbour	$11M	$19M	$28M	$179M

The average annual flood damage (AAD) is often calculated to get an appreciation of the flood damage, on an annual basis, which will accrue over a long period of time. This is usually used to rank the flooding problems of different catchments and to assess the economic benefits of various floodplain management measures. If the flood damage estimate for the PMF is not included in this assessment, the estimated AAD can be grossly underestimated, as shown in Table 2.

Table 2
Average Annual Flood Damage Calculations

Study	Average Annual Flood Damage		
	Only floods up to 1%AEP	All floods including PMF	Difference
Georges River	$3.6M	$8.2M	+128%
Camden Haven	$2.3M	$2.8M	+22%
Coffs Harbour	$1.2M	$2.2M	+83%

In situations like the Georges River, the magnitude of the flood problem in large floods is immense, and it is futile to expect that we are capable of solving these problems through flood mitigation works alone. It would also be unreasonable to impose controls to restrict future residential development to a level substantially higher than the 1% AEP flood.

But the flood risk remains and can not be overlooked. Thus there needs to be increased emphasis on flood preparedness and emergency management measures should such a rare event occur. These measures will include non-structural works, such as:

< flood warning schemes;

< evacuation strategies;

< community education and awareness programs; and

< planning controls for critical utilities and other sensitive development.

Setting Planning Levels

Examples of how a risk management approach can be used to set flood planning levels are provided below.

If we were to design a major water supply dam for Sydney or Melbourne, we would want to ensure that it was designed to withstand a very rare flood. We would probably want to ensure that the dam does not fail due to overtopping in events up to the probable maximum flood (PMF). We take these precautions because the consequence of dam failure is high. Many homes downstream of the dam could be swept away and many people could lose their lives should the dam fail. The city might also be without water for many years whilst a new dam is built.

A similar scenario might be where a nuclear power station is proposed near a river. If the station is inundated by floodwater, then nuclear waste might be washed downstream, or there may be potential for some form of nuclear disaster. Again, the consequence of flooding on this proposal is high, and a very rare flood, above the 1% flood, should be considered for planning purposes.

A final example is where the local sporting club wants to build some change rooms adjacent to the oval (which incidentally floods). The consequence of inundation of the proposal is low and a frequent flood, below the 1% event, could be considered for planning purposes.

In relation to normal floodplain management planning, different land uses should have different planning levels, based on the consequence should flooding occur. Some uses, such as sporting fields or recreational facilities, can be afforded a relatively low flood planning level. The majority of residential and commercial development might have a higher flood planning level, such as the 1% event. Other uses that have a greater consequence should flooding occur, such as critical utilities, hospitals and evacuation centres, should be based on a flood planning level that is higher still.

'Shrinking Islands'

Anyone assessing flood risks needs to consider the possibility of 'shrinking islands' forming within a floodplain as flood waters rise.

Communities on such islands may not be able to safely evacuate and may become isolated. If floodwaters continue to rise, the islands may themselves become overtopped, with potentially disastrous consequences.

Not all floodplains have topography that can lead to the formation of 'shrinking islands' during floods, but many do. A paper presented to the 2001 Traralgon Conference [Gillespie, Grech & Bewsher] describes a very serious

occurrence in the Hawkesbury-Nepean Valley in NSW. This valley was one of the first settled in Australia and its flood problems were officially recorded as early as 1817. Nevertheless, without a consideration of the consequences associated with large floods, the presence of 'shrinking islands' and their potentially serious risk to human life would not have been recognised.

Emergency Management

Emergency Management agencies within Australia have been much less 'fixated' on the 1% AEP flood event than have floodplain management professionals.

Emergency managers normally deal with a range of natural hazards, not only flooding, and are more adapt at considering a range of risks. However, these managers need data on the probabilities and consequences of a range of flood events, if they are to do their job properly.

Floodplain Management agencies and professionals therefore have a responsibility to consider a full range of flood probabilities (up to the PMF) and to identify the depths, velocities and inundation extents, and to provide this information to emergency managers to ensure proper emergency planning can be prepared.

Other Reasons to Consider Floods Rarer than 1% AEP

Apart from the considerations listed above, there are a number of other reasons why floods rarer than the 1% AEP event should be considered. These include:

(i) It provides relevant authorities with a better appreciation of the magnitude of potential problems that could occur;

(ii) Economic appraisals that do not include damage estimates from larger floods will underestimate the true costs when compared with catchments where larger floods have been included;

(iii) It allows emergency personnel to better respond to such an event, should it occur;

(iv) Maps that define the 'limit of inundation' at the 1% flood, or other advice based solely on the 1% flood level, is likely to give residents a false impression that they have no flood risk, when this may not always be the case;

(v) There are clearly some types of land uses that should be located above the 1% AEP flood level;

(vi) Care should be taken to avoid development that is above the 1% AEP flood, but still subject to flooding in larger events, becoming isolated at early stages of flooding;

(vii) The increased flood risk that occurs when levees and dams are overtopped in floods rarer than the 1% event needs to be carefully considered and appropriate response actions planned;

Conclusions

The authors believe that floods rarer than the 1% AEP event need to be carefully considered when undertaking flood and floodplain management studies, or other flood-related investigations. Such consideration is required if a risk management approach to floodplain management is to be followed.

Furthermore, relevant authorities and the community will not have a full appreciation of the potential flood risk unless rarer floods are considered and the implications of flooding properly assessed and communicated.

This is not to say that floods rarer than 1% AEP should be universally adopted as the main residential flood planning level. There may be certain types of development where a higher (or lower) flood planning level may be more appropriate. We need to be aware of the risks of rarer floods and have appropriate emergency management response plans in place, should such an event occur.

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