This feature includes articles on lessons from the Queensland floods, flood modelling, stormwater harvesting, dam upgrades and sewer leaks.

Compiled by Kirill Reztsov

Brisbane: Lessons from large floods

by Rory Nathan

There are many lessons to be learnt from the 2010/2011 Queensland floods, and there are some lessons for the engineering profession that need particular attention. The casual observer over the past 18 months could be forgiven for thinking that the sole cause of the disaster was the manner in which Wivenhoe Dam was operated. The fact that the dam has a finite capacity that is designed to handle some tolerable limit of loading at an acceptable cost has largely been ignored. The true features of this natural disaster have received little attention in contrast to the supposed failings of an engineering system designed to mitigate the problem.

Big rains cause big floods

So let's be clear: this was a big flood, caused by big rainfalls. The conversion of rainfall to runoff was particularly severe as the catchment was primed to overflow by the sequence of heavy rainfalls over the preceding month. The period from late November 2010 to mid January 2011 was extremely wet through much of eastern Australia and parts of Western Australia. The rainfalls in December 2010 represent the wettest December on record over most of south-eastern Queensland; by the second week of January the catchments were fully primed, which greatly enhanced the proportion of further rainfall that appeared as flood runoff.

The rainfalls that occurred in January 2011 in the Brisbane catchment were unusually extreme, and ranged in severity from 1-in-5 to 1-in-2000 (Figure 1). When compared with historical events, flood volumes indicate the volume of the January 2011 event was almost double that of the January 1974 flood, and rivals the February 1893 flood (the two largest floods in the historical record).

The highest concentration of deaths occurred in the Lockyer Valley, which lies on a tributary uninfluenced by Wivenhoe Dam. Nineteen people lost their lives in this valley, and the media described the flood as an "inland tsunami". This commentary was just about the only hydrological observation that the media got right.

Facts do not speak for themselves

While media reporting helped engender wider community understanding and support for the tragic consequences that unfolded, the media were quick to search for some anthropogenic agency to blame.

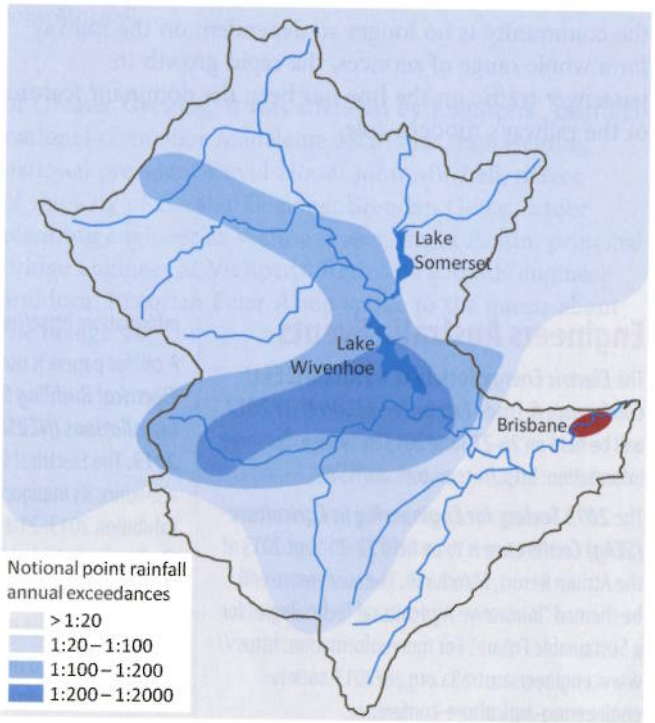

Figure 1: General arrangement of Brisbane River catchment and approximate distribution of annual exceedance probabilities of recorded point rainfalls.

Allegations were made against the individual flood operations engineers for "inventing" data and for making poor decisions; the managers of Seqwater were blamed for not drawing down the dam at the beginning of the wet season. The Bureau of Meteorology was criticised for not providing adequate warning and for their inaccurate forecasts. Planners were blamed for allowing development in flood prone areas. The insurers were universally damned for the tardiness and miserliness of their response. Local authorities and engineering consultants were harshly scrutinised for their modelling and analyses.

The general storyline underlying media coverage was that the Brisbane flood was largely the product of water released from the dam arising from poor decision-making. It should be recognised that the volume of the flood was almost twice the volume of the available flood storage, and while the first peak was almost fully absorbed, the maximum flood level was reached on the falling limb of

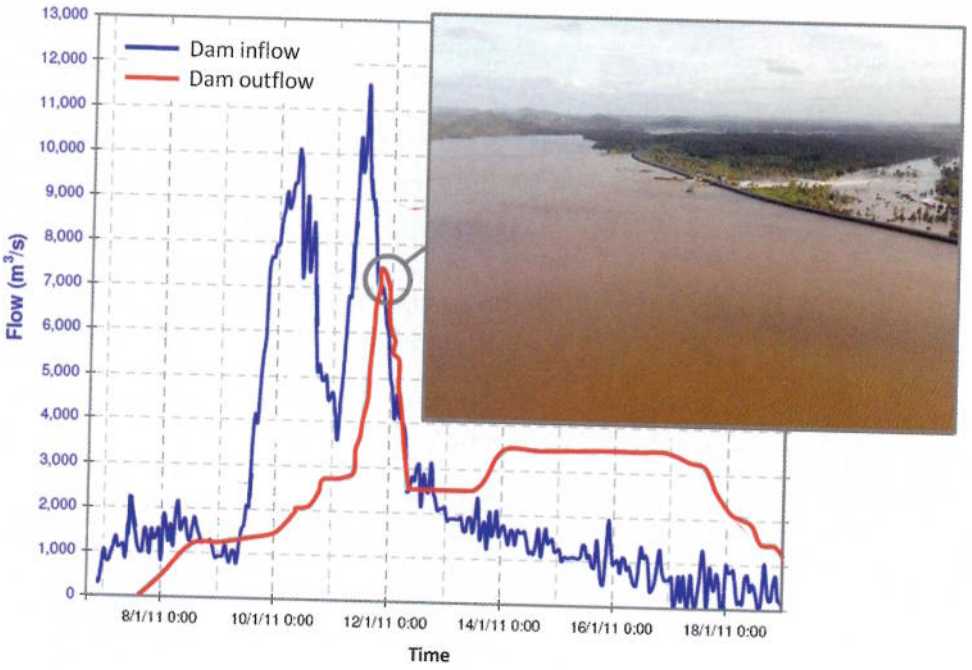

Figure 2: Inflow and outflow hydrographs for Wivenhoe Dam showing level of reservoir near peak of the outflow event.

the second inflow hydrograph (Figure 2).The reality is that the flood engineers achieved a level of flood mitigation that appreciably reduced flood damages to Brisbane. Independent review of the dam release strategies concluded that the flood mitigation effect was "close to the best possible flood mitigation result".

It is disappointing that the public coverage and debate around this issue has not given adequate recognition to the substantial mitigation effects of the dam, and the efforts of flood professionals acting to the best of their abilities in a tremendously challenging situation. The debate has been solely focused on allegations of wrong-doing, and not on the lessons for improvement that are the inevitable outcome of any disaster.

We may think fondly that Australia is a "land of droughts and flooding rains", but it appears we are easily surprised and outraged by natural disasters, and we are not satisfied until a human agent for our problems can be found and blamed.

Egotism undermines professionalism

It became clear as events unfolded that many of the professionals with requisite skills were contributing to the proceedings in some way or another and thus unable to provide public comment. The media were thus left with a pool of professionals with a variable depth of expertise, where the only ones available to provide comment were those who had little or no direct knowledge of the system in question. Perhaps not surprisingly, the media always referred to such people as "experts".

Another area where engineering professionals did not always take a constructive approach was with the reviews and opinion solicited by the Commission of Inquiry. It is difficult for non-specialists to assess the real implication of technical issues raised in a technical debate, and it is incumbent upon the specialists involved to always clarify the relative importance of concerns raised. However, there were a number of occasions where written submissions seemed more focused on cataloguing all possible flaws than actually attempting to assess the efficacy of the work being commented on. It is easy for someone with the right expertise to highlight the limitations and shortcomings of any work undertaken, but it is much more difficult – indeed it is the art of engineering – to identify a solution to a problem given imperfect knowledge and real-world constraints. This lack of constructive balance in some reviews provided rich material for the media to sensationalise, and was of no help to the process being conducted by the Commission of Inquiry.

It is difficult to understand the attitudes and behaviours of some engineering professionals during this process. Being positioned as an expert in the media can flatter the ego, but it is difficult to control the media message and any caveats that may have been imposed around the original opinion will be lost in translation. The lesson to be learned here is that opinion should be developed with the attitude that the work being commented on is adequate unless there is clear evidence to the contrary; judgment should be offered in a way that the media and non-specialists can understand the relative importance of any issues raised in a balanced fashion without the need for technical understanding.

Communicating risk is hard

The 2011 Brisbane flood has made it painfully evident that characterising flood risk in terms of average recurrence interval is a poor basis for representing or communicating risk. Most non-specialists would assume that the Q100 (the "100 year flood") refers to a flood that occurs once every 100 years. This is a misleading interpretation, and it is more useful to regard it as flood that has a 1-in-100 chance of being exceeded in any one year.

Hydrologists might quantify risks using statistics, but people respond to such information using their stomachs and feelings. One thing is for sure: engineers need help with this, and we should never cite risks in terms of average recurrence intervals.

Hydrologic complexity cannot always be ignored

A great deal of evidence was presented to the Commission of Inquiry on the nature of the flood risk along the lower reaches of the Brisbane River. Over the years a large

number of reports have been prepared on this topic, and the nature of the debate and discussions held during the hearings made it clear that traditional flood estimation techniques have failed us in this particular catchment.

The Commission of Inquiry convened a panel of experts to explore the nature of the investigations that would be required to estimate the flood risk downstream of the dams with more certainty. This panel agreed that the only defensible way of estimating flood risk for current conditions is to analyse the joint probabilities in an explicit manner using such techniques as Monte-Carlo simulation.

Conclusions

The floods that occurred in Australia over the summer of 2011 had shocking consequences for the community. They also yielded many lessons for professionals involved in dam operations, hydrology, floodplain planning, risk management, emergency preparedness, and meteorological forecasting. It is likely that the most painful lessons have been learned many times by our predecessors, and will probably need re-learning repeatedly in the future. ■

Dr Rory Nathan provided expert testimony to the Queensland Flood Commission of Inquiry, and is the practice leader for hydrology with engineering consultancy Sinclair Knight Merz. This article was largely drawn from a paper and keynote address he gave to the New Zealand Symposium on Large Dams in Wellington, New Zealand, in August 2012.

Dam upgrade in Tasmania

Hydro Tasmania has awarded Hazell Bros a contract for the first stage of a major upgrade of Rowallan Dam in Tasmania's north. Work started in November and is scheduled for completion by May 2013.

The project will upgrade the 44-year old dam to modern standards over the next three years at a cost of $13.4 million.

Rowallan Dam, a 43m high earth and rock-fill dam on the Mersey River, was commissioned in 1968.

In 2011, Hydro Tasmania's review found the dam's performance was consistent with expectations for its design, construction and age. However, improved understanding of the dam's risks meant Hydro Tasmania is now able to reduce risks that were unforeseen in 1968.

The $3.9 million Hazell Bros contract is to build new concrete walls inside the existing spillway walls, which will be retained. The new walls will be anchored into the bedrock using a series of post-tensioned steel anchors on both sides of the spillway.

The second stage of the project will improve the flood capacity of the dam and is scheduled to take place during the 2014/2015 summer.

Hydro Tasmania's chief technical and operations officer Evangelista Albertini said the planned work would ensure the dam continued to perform well into the future. ■

Investigation work on the Rowallan Dam spillway.