Submission

to the

Queensland Floods Commission of Inquiry

by

Risk Frontiers

Macquarie University

March 2011

Risk Frontiers welcomes the opportunity to make a submission to the *Queensland Floods Commission of Inquiry.* This submission is in line with Risk Frontiers' vision, which is *to build safer communities through a better understanding of natural perils and their consequences.*

SUBMISSION SUMMARY

- Reluctance on the part of some councils in Queensland to make available flood modelling information is contributing to a reluctance on the part of some insurers to offer riverine flood cover as they are unable to price this risk.
- The cost of natural disasters worldwide is increasing due to rapid growth in population and wealth in exposed locations. This is particularly true of south east Queensland.
- If we truly want to reduce our vulnerability to future natural disasters in the short and long term, then policies should be directed towards helping communities adapt to the more extreme expressions of climate, whatever their cause.
- The canonical 1-in-100 year event (i.e. the event with a 1% annual likelihood of being exceeded) that has become enshrined in land use planning policies should be viewed as only one manifestation of a spectrum of possible flood levels.
- Better risk-informed land use planning decisions can reduce the impacts (loss of life, property and economic capital) from natural disasters such as the 2011 Brisbane floods. Specifically, we must stop encouraging dangerous property development on the floodplain.
- Without explicitly commenting on the operation of the Wivenhoe Dam in respect to this disaster, Risk Frontiers has considerable expertise in stochastic modelling and we note that forecast uncertainty (that may result in significant overestimation or underestimation of rainfall in catchments) and thus uncertain inflows to the dam needs to be considered in operational decision-making. The current system of decision-making as we understand it appears inflexible and rules-based, a practice that can be dangerous in dynamically changing situations.

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About Risk Frontiers

Risk Frontiers is a world leader in quantitative natural hazards risk assessment and risk management. Based at Sydney's Macquarie University, Risk Frontiers is a not-for-profit research organisation whose research agenda is sponsored by the Australian insurance community. Insurance company sponsors of Risk Frontiers include: Swiss Re; Insurance Australia Group; QBE Insurance; Suncorp Group; Aon Benfield; Guy Carpenter and the Australian Reinsurance Pool Corporation (ARPC). ARPC is the statutory body created to administer the Australian government’s terrorism reinsurance scheme.

Risk Frontiers’ role is to help insurers, international reinsurers and their intermediaries better understand and price natural catastrophe risk in the Asia-Pacific region. Risk Frontiers’ suite of probabilistic catastrophe loss models, which includes *FloodAUS*, and databases are widely used by insurers and reinsurers in Australasia, Europe, North America and Asia.

Risk Frontiers provides a rapid response reconnaissance team for its sponsors for local and international disaster events of interest. In the last six months, it has sent teams to both Christchurch earthquakes, the Brisbane floods and Tropical Cyclone Yasi, the latter in association with the Cyclone Testing Station of James Cook University. It generally aims to have people on location within days of an event and before the sites become sanitised by clean-up operations.

Risk Frontiers regularly undertakes assignments for non-sponsor insurance and reinsurance companies and their reinsurance broking intermediaries, government and emergency management providers; it is the primary provider of research to the New South Wales State Emergency Service and has recently undertaken studies for the Queensland Department of Community Safety.

Risk Frontiers is the lead organisation responsible for developing the National Flood Information Database (NFID) for the Insurance Council of Australia. NFID is a five year project aiming to integrate flood information from all city councils in a consistent form to better enable insurers to price flood risk.

Introduction

This submission will contribute to the following aspects of the Commission of Inquiry's terms of reference:

- private insurers and their responsibilities
- land use planning

It will also make some additional comments pertinent to the:

- adequacy of forecasts and early warning systems

and decision-making in respect to the

- implementation of systems operation plans for dams

We begin with issues pertaining to the provision of flood insurance and in particular data constraints. The views expressed in this section arise from Risk Frontiers' experience in jointly developing the National Flood Information Database (NFID) for the Insurance Council of Australia with Willis Re[1]. NFID is a five year project aiming to integrate in a consistent form flood information from all city councils with significant risk to riverine flooding to better enable insurers to price this risk.

The views and opinions of the authors expressed herein do not necessarily state or reflect those of the companies listed above who sponsor Risk Frontiers.

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[1] Willis Re is an International reinsurance broking intermediary with expertise in flood risk modelling.

Data Constraints on the Provision of Flood Insurance

While damage arising from most other natural hazards – earthquake, tropical cyclone, thunder storm, etc. – is automatically covered by a home and contents insurance policy, riverine flood cover is often excluded. This disparity exists because there is often little available information that would allow an insurer to adequately price this flood risk.

Moreover, there is a certain proportion of dwellings that have been constructed in locations where the frequency of flooding is such that this risk is not insurable at an affordable price. Consider, for example, a home and contents policy covering a dwelling and contents valued at $400,000 and located in a situation vulnerable to significant over floor flooding on average once in 20 years and where total destruction is likely once in every 100 years. Based on the recent Brisbane experience, claims in the smaller floods are likely to be around $50,000, so the actuarially-fair annual *flood* insurance premium would be roughly $6,000[2], excluding costs of administering this policy and ignoring the likelihood of other floods.

We suspect few homeowners would be willing or able to pay such a premium, despite this sum reflecting the real price of this risk.

It would be irresponsible for insurers to cover riverine flood without quantifying and pricing this risk accordingly. The first step in establishing risk-adjusted premiums is to know the likelihood of the *depth of flooding* at each address. This information has to be address-specific because the severity of flooding can vary widely over small distances, e.g. from one side of a road to the other. The aim of NFID is to collate and process data from local councils to enable insurers to underwrite this risk at an address level.

An insurer can use the NFID database together with other building specific information to model the riverine flood losses to their portfolio of insured assets. In other words, to understand and quantify

[2] 6,000 = 50,000/20 + (400,000 – 50,000)/100

their risk. Unfortunately, obtaining the base data for NFID from some local councils is difficult and sometimes impossible despite the support of **all** state governments for the development of it.

Councils have an obligation to assess their flood risk and to establish rules for safe land development. However, many are antipathetic to the idea of insurance.

Some states and councils have generally been very supportive -- New South Wales (NSW) and Victoria, particularly. Some states have a central repository -- a library of all flood studies and digital terrain models (digital elevation data).

Council reluctance to release data is most prevalent in Queensland, where, unfortunately, no central repository exists.

A litany of reasons is given for withholding data. At times it seems that refusal stems from a view that insurance is innately evil. This is ironic in view of the gratuitous advice sometimes offered by politicians and commentators in the aftermath of extreme events, exhorting insurers to pay claims even when no legal liability exists and riverine flood is explicitly excluded from policies.

Sometimes councils express concern over the quality of their flood data but this should not be a deterrent for releasing it. Dealing with uncertainty is an essential part of providing insurance, so this fear is not a legitimate reason for withholding data. The NFID database contains descriptions for each catchment expressing the degree of confidence in the underlying data.

At other times, liability concerns are invoked. These may be real as in the past some councils have encouraged or not actively limited property development on floodplains. However, development mistakes of the past will be revealed in the next large flood irrespective of insurance. As we have seen in Brisbane, nature has little respect for the sensibilities of councils and land developers; the bigger issue is reducing the practice of allowing development in harm's way.

Another issue is that many councils only undertake flood modelling in order to create a single *design* flood level, usually the so-called 1-in-100 year flood. (For reasons given later, a better term is the flood with an annual likelihood of 1% of being exceeded.)

Inundation maps showing the extent of the 1% annual chance flood are increasingly common on council websites, even in Queensland. Unfortunately these maps say little about the depth of water at an address or, importantly, how depth varies for less probable floods. Insurance claims usually begin when the ground is flooded and increase rapidly as water rises above the floor level.

At Windsor in NSW, for example, the difference in the water depth between the flood with a 1% annual chance of exceedance and the maximum possible flood is nine metres. In other catchments this difference may be small, of the order of a few tens of centimetres. The risk of damage is quite different in both cases and an insurer needs this information if they are to provide coverage in these areas.

The '1-in-100 year flood' term is misleading. To many it is something that happens regularly once every 100 years -- with the reliability of a bus timetable. It is still possible, though unlikely, that a flood of similar magnitude or even greater flood could happen twice in one year or three times in successive years.

The calculations underpinning this are not straightforward but the probability that an address exposed to a 1-in-100 year flood will experience such an event or greater over the lifetime of the house – 50 years say – is around 40%. Over the lifetime of a typical home mortgage – 25 years – the probability of occurrence is 22%. On these timescales, these are not good odds.

Recently, there have been calls for better elevation mapping and new flood studies. Both will ultimately lead to a better understanding of the nation's flood risk. But a simple and effective solution at least in the short-term would be to compel councils to release existing flood data. Until this is done, there is very little incentive for insurers to widely accept riverine flood risk unless at very conservative (high) premiums.

Lastly, if flood data were more widely available then issues such as what does and does not constitute a flood for insurance purposes would become less of an issue. The exact definition would quickly lose relevance as flood insurance for water damage in all its guises inevitably becomes more widely available and appropriately priced for.

The Rising Cost of Natural Disasters

Nationally as well as globally, the cost of natural disasters is increasing (Swiss Re 2010; Munich Re 2010). In attempting to unravel the reasons for this increase we need first to acknowledge that the risk to property from natural disasters is multi-faceted: it is a function of the *hazard* – the magnitude/frequency relationships that characterise the peril; the *exposure* in terms of the capital values and spatial distribution of assets at risk; and the *vulnerability* of these assets and communities to the peril.

Thus it should be clearly understood that even if the frequency and magnitude of natural perils were unchanging, the economic cost of natural disasters will increase as the value and concentrations of property assets in exposed areas increases. Growth in population and wealth has certainly occurred throughout south east Queensland and northern NSW (Figures 1a and b). This area represents one of the most rapidly developing regions in Australia. Concentrations of population at risk pose particular challenges for emergency management in terms of the number of people and the time required for evacuation in the case of an impending flood.

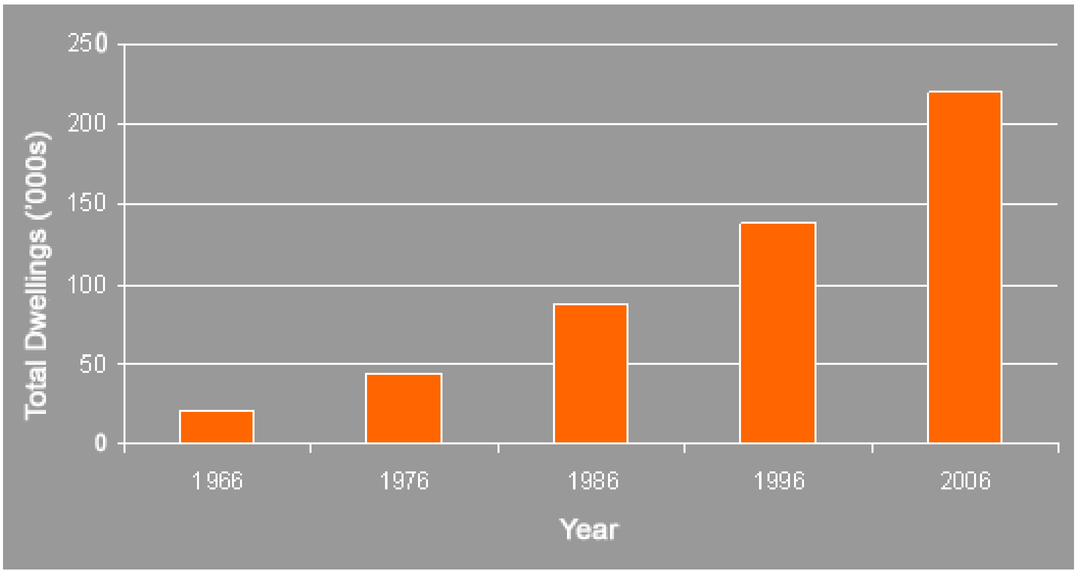

Figure 1a: Increase in the number of dwellings in the Gold Coast-Tweed Heads area (source: Australian Bureau of Statistics (www.abs.gov.au)).

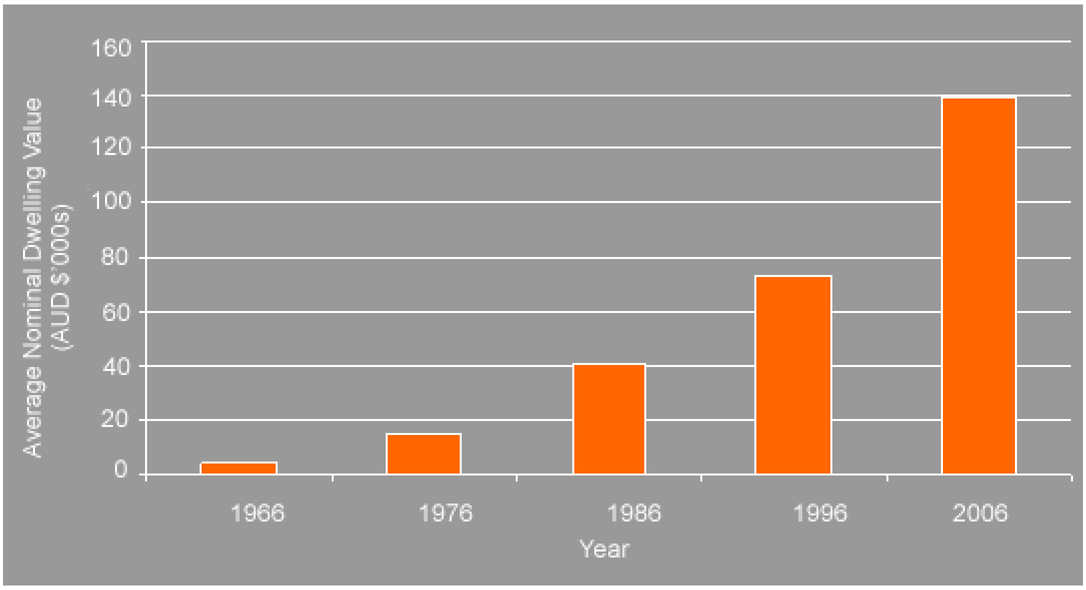

Figure 1b: Increase in the national average nominal value of dwellings (source: derived from Australian Bureau of Statistics data (www.abs.gov.au)).

Insured Losses – What Would They Cost Today?

The Insurance Council of Australia (ICA) maintains a Natural Disaster Event List, a database of natural hazard events in Australia that have caused significant insured losses (Figure 2a). The list begins in 1967 with the Hobart bushfires and although the threshold loss for inclusion in the database has varied over time, most refer to events with insured losses in excess of $10 million. Figure 2a shows the time history of losses (in the dollars of the day) excluding five non-weather-related events – four earthquakes and one tsunami. Annual losses have been calculated for years beginning 1 July to take account of the southern hemisphere seasonality of the main meteorological hazards.

Figure 2b gives the *normalised* values (Crompton and McAneney, 2008) which are the original losses adjusted for changes in the number of dwellings, their average nominal value and, in the case of tropical cyclones, the impact of improved construction standards stemming from investigations of engineering failures identified as contributing to building losses in Cyclone Tracy in 1974 (Walker, 1975; Mason and Haynes, 2010). Loss normalisation is the process of estimating the impact of past events on present society and is necessary for determining whether the devastation inflicted by particular events, such as the 2011 Brisbane floods, is truly anomalous or not; whether this event provides a glimpse of the future under expected changes in climate; and more broadly what policy changes might prove effective in reducing the impact of future disasters.

Figure 2b reveals that no time trend remains after normalisation and Crompton and McAneney (2008) concluded from this that the increasing trend in unadjusted losses (Figure 2a) is largely accounted for by changes in the number and value of dwellings.

The 1974 Brisbane flood insured loss (Tropical Cyclone Wanda) normalised to year 2006 values is $2.1 billion (Crompton and McAneney, 2008). Normalising the 1974 loss to year 2011 values using the Crompton and McAneney (2008) methodology results in an insured loss around $3 billion. Current industry provisions for the 2011 Brisbane floods are $2.3 billion, which sounds reasonable given that the recent event peaked at the Brisbane River City Gauge 1 m lower than the 1974 event. In making these comparisons we note that no change in insurance policy conditions have been considered.

It is not clear how the 1974 and 2011 Brisbane flood losses compare in economic loss terms. Previous but flawed attempts have been made to estimate the economic costs of natural disasters in Australia (e.g. Bureau of Transport Economics (2001)) but these efforts have neither been updated nor their errors – not accounting for increases in wealth and ad hoc adjustments for inflation – corrected.

The conclusion of Crompton and McAneney (2008), that societal changes are the principal factors responsible for increasing losses to date, is consistent with the conclusions of Höppe and Pielke (2006) and Bouwer (2010). The latter study reviewed 21 weather-dependent international loss normalisation studies across multiple hazards and jurisdictions.

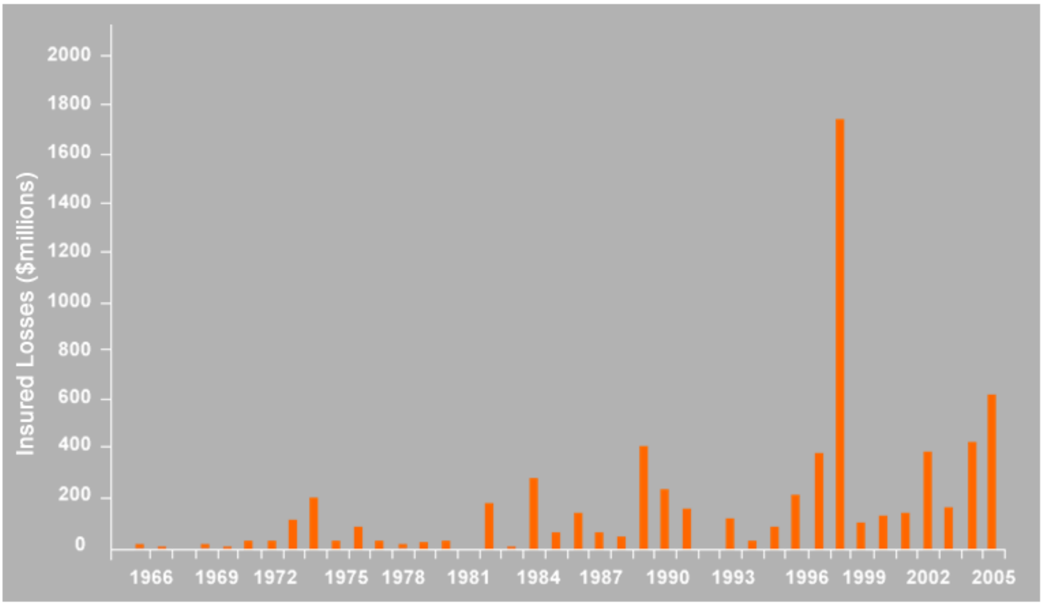

Figure 2a: Original annual aggregate insured losses ($million) for weather-related events in the ICA database for 12-month periods beginning 1 July (source: Crompton and McAneney (2008)).

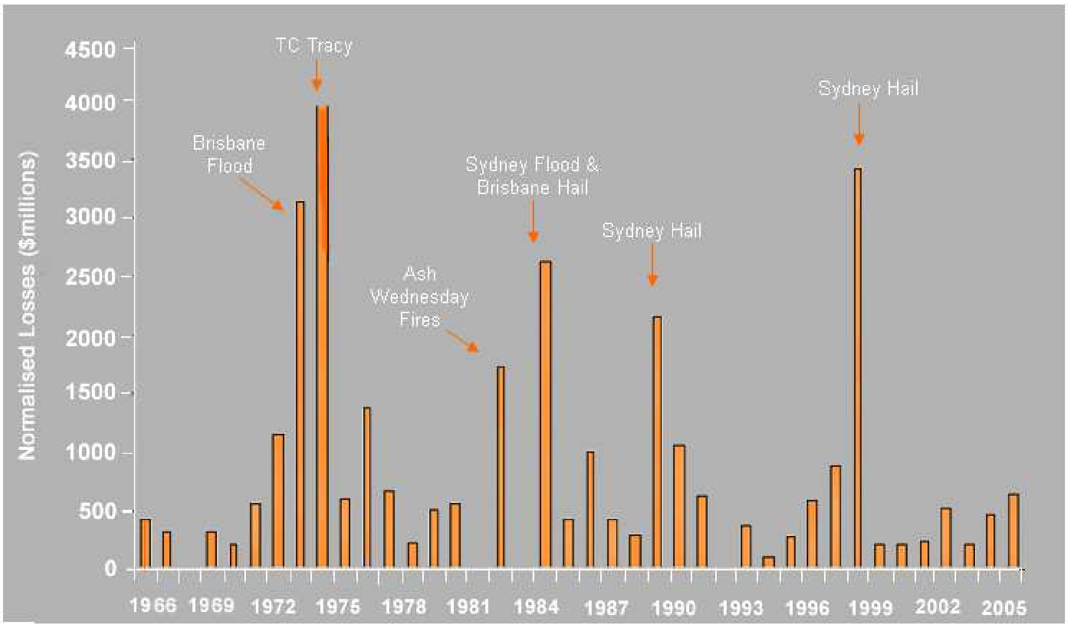

Figure 2b: As for (a) above but losses have been normalised to 2006 values (source: Crompton and McAneney (2008)).

The Importance of Risk-informed Land Use Planning in Reducing Disaster Losses

Whereas insurers are compelled by regulation to prove they have the financial resources (in terms of retained capital or reinsurance) to deal with a 1-in-250 year event loss, land use planning for flooding in Australia is often unduly preoccupied with the 1-in-100 year event. These authors take the view that land use planners (and emergency management) should also consider lower frequency / higher severity events. This is a point also made by the Joint Flood Taskforce in their report to the Brisbane City Council in March 2011 in advocating a more comprehensive risk-based approach.

The best example of disaster risk reduction in Australia, other than the movement of some towns off the floodplain (e.g. Gundagai, NSW, after successive large floods in 1852 and 1853 killed 89 of the local population of 250) and the more recent raising of key evacuation roads in some flood-prone areas (Hawkesbury-Nepean Floodplain Management Committee, 2004), is the regulated use of the Building Code for residential homes introduced in cyclone-prone parts of the country following engineering investigations into the damage caused by Tropical Cyclone Tracy (Walker, 1975; Mason and Haynes, 2010). A study undertaken for the Australian Building Codes Board (McAneney et al., 2007) suggests these changes have potentially reduced Australian cyclone losses by some 65%, and in the event of a similar event to Tracy would avoid the need for the wholesale evacuation of three quarters of the population of Darwin as occurred in 1974 (Mason and Haynes, 2010). These changes have impacted the construction of residential homes throughout Australia.

In short, reducing disaster losses is largely a function of how and where we build; in other words, risk-informed land use planning decisions and good building codes and construction practices are needed.

If we truly want to reduce our vulnerability to future natural disasters in the short and long term, then policies and research should be directed towards helping communities adapt to the more extreme expressions of climate. And we need land use planning policies based on risk. This is a critical issue and the canonical 1-in-100 year event should be viewed as only one manifestation of a spectrum of possible flood depth outcomes.

Manual of Operational Decisions for Wivenhoe Dam

The operators of the Wivenhoe and Somerset Dams (SEQWater) control outflows from the dams with reference to "the Operations Manual": *Operational Procedures for Flood Mitigation at Wivenhoe Dam and Somerset Dam, Revision 7, November 2009.*

This document lists the flood mitigation objectives, in descending order of importance, as

- Ensure the structural safety of the dams
- Provide optimum protection of urbanised areas from inundation
- Minimise disruption to rural life in the valleys of the Brisbane and Stanley Rivers
- Retain the storage at Full Supply Level at the conclusion of the Flood Event
- Minimise impacts to riparian flora and fauna during the drain down phase of the Flood.

The document also lists four main Strategies (and several sub strategies) for water releases from Wivenhoe Dam depending on the predicted reservoir level. These strategies were designated as W1A through to W1E, W2, W3, and W4A and W4B, each representing an increase in the predicted quantity of water in the flood compartment of the dam. For each Strategy the document lists the maximum release rate for the predicted reservoir level. That maximum is subject to certain other constraints, including downstream river heights and downstream river flow rates.

Revision 7 of the document, dated November 2009, allows the selection of release strategy to be based on the ***predicted*** water levels, whereas the previous revision (Revision 6) used ***actual*** levels. This means that during an event where the dam levels are rising a particular operating strategy would normally be selected earlier under Revision 7 than it would have been under Revision 6.

Predictions about water levels are based on inflow rates, and inflow rates are based on expected rainfall in the catchment. This rainfall information is typically received from the Bureau of Meteorology (BoM). The rainfall forecasts are made using the best available meteorological practice, but cannot and should not be expected to be exact. They should be interpreted as *probabilistic* *estimates* of rainfall, rather than as deterministic point values, since there is likely to be some uncertainty in the forecast.

From a statistical viewpoint a probabilistic estimate of some variable is generally represented as an interval within which there is, say, a 95% likelihood that the true value of the variable will lie. These confidence intervals, whether expressed or not, will be large and this uncertainty needs to be taken into account in SEQWater's decision making.

Decision making by rules may work well in a library but is dangerous in a dynamically changing situation.

Timing is also crucial. A BoM forecast of 100 mm of rainfall over a certain area in a certain time interval several hours in the future will obviously contain uncertainty. However as time goes by the BoM forecasters will be able to upgrade the forecast as more information becomes available. This improved forecast should allow dam operators to make a more accurate decision about an appropriate water release strategy. This is known to statisticians as "Bayesian updating". This can be done iteratively.

It is not clear from an examination of the Operations Manual whether or not uncertainty in rainfall estimates were considered when developing the decision rules contained in the "Wivenhoe Flood Strategy Flow Chart" (Page 23 of the Operational Manual). It is likely that the flow chart could be amended to incorporate the output of research (possibly a series of Monte Carlo simulations) into the impact of varying levels of uncertainty in rainfall on dam water level and downstream flows. This is likely to be useful in helping to optimise the water release strategy.

Thus, the way in which uncertainty in rainfall estimates is assimilated and processed might have a direct bearing on the strategy that is followed for water release.

Flood Warnings

Although time constraints prevented researching this question in any detail, the previous Director of Risk Frontiers, Emeritus Professor Russell Blong, recalls that a high proportion of the insured losses to residential property occasioned by the 1974 Brisbane flood comprised moveable items. This was despite the fact that the floods had been very well forecast with a 21 hour lead time.

Accuracy in terms of a forecasted flood levels at the Brisbane River City Gauge is one thing, but a forecast cannot be termed *effective* unless it translates into appropriate action by the public. In 1974 this did not happen and in 2011 not much had changed: Risk Frontiers' Rapid Field Assessment team found that even where people had attempted to raise belongings prior to the arrival of floodwaters, few had any idea of how high flood waters might rise at their location. Flood warnings need to be personalised.

In general, it seems very difficult for warnings to translate into effective actions as reflected in the words of Governor Lachlan Macquarie who in 1819 and in respect to flooding berated "Settlers" in NSW who did not pay "due consideration of their own interests." Perhaps the issue is that few people understand the risks to which they are exposed and again this has to come back to the lack of openness of councils to provide flood information, apathy on the part of homeowners, or a combination of both.

Similarly, the weather conditions during the Black Saturday bushfires were very well forecast and accurate warnings were issued to emergency responders, politicians, and the public prior to February 7. What Black Saturday clearly demonstrated is that despite accurate weather forecasts and significant emergency/bushfire planning and response, there is always the potential for large-scale life and property loss (Crompton et al., 2011). Providing warnings is only one step in a very complicated chain. The difficulty is achieving adequate preparedness and risk reduction among the community so that people can respond effectively when warnings are given (Crompton et al., 2011).

Councils need to be open about the flood risks. A flood warning is fine, but the next important question is "what does this mean for me?" People need to understand the risk to their home and family. Surveys conducted after the 1974 Brisbane flood showed that 46% of respondents' first indication of flooding came from watching water rising and 44% first thought that their home might be inundated when they either noticed water had entered their grounds or was under the house (Short, 1976).

And most importantly, councils need to avoid amplifying the risk by inappropriate land use planning decisions.

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