Australian Storms and Floods: White Paper

“A land... of droughts and flooding rains”

A Special Report by Zurich Risk Engineering, Australia & New Zealand

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*Dorothea Mackellar: “My Country”*
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Introduction

This White Paper has been written by the Risk Engineering team at Zurich to help you understand the potential risks and outcomes of Floods and Storms, and to help you plan and prepare for the event, and prevent damage to your assets, and resultant interruption to your business.

To put everything into context, we will first take a look back at previous weather events, around the world, within Asia Pacific, and more closely here in Australia, so that we may start to understand the increased frequency and severity of weather events. All Australians are affected by these severe weather events – be it directly or indirectly from the financial impact that reverberates afterwards through the economy.
Weather events around the world

It would seem that every time we watch the TV News or read on-line bulletins, the world seems to be devastated by severe weather events, almost weekly.

Indeed, whether the apparent increase in the number of severe events is due to “climate change” or just improved recording of data and reporting of events through news channels, there is no denying that people and property are impacted extensively from these natural peril events. While governments, relief agencies and charities step in to assist those affected, insurance companies also have a significant role in the financial recovery after these events.

It is evident that natural disasters in the Asia Pacific region, and not just Australia and New Zealand, have a significant impact to both the local and global economies and communities, and the cost of insured loss catastrophes is increasing. Natural weather events in Japan and China, for instance, may seem far removed from Australia. However, much of Australia’s GDP relies upon these two countries through their raw materials purchases, and so a ‘knock-on effect’ to Australia’s mining and resources industry is inevitable.
“The 2011 floods in Thailand – the highest-ever economic loss for the country from a natural disaster – are one of the latest examples of a country’s high exposure to weather-related natural catastrophes in Asia Pacific. In general, weather-related catastrophes have more than tripled over the last 30 years. In China alone, weather-related disasters have more than quadrupled since 1980.

With growth in population, continued urbanisation in exposed areas and increasing wealth, we also expect economic losses to rise further. Meanwhile, insurance density remains very low in many countries of the region. On average, only 6% of natural catastrophe losses were insured over the last 30 years.”*

In 2011, the Asia Pacific region bore the brunt of natural catastrophe losses. “80% of all economic losses from natural disasters in the first nine months occurred in Asia Pacific. With the earthquakes in New Zealand and Japan, the floods and cyclone in Australia, and flooding across many countries in Central and South East Asia, the economic losses in the region came to US$ 259bn in the first nine months of 2011, approximately US$ 52bn of which was insured. Worldwide economic losses from natural disasters amounted to US$ 310bn for the first nine months alone, making it the costliest year ever. Of these losses, approximately US$ 80bn was covered by the insurance industry.”*

Over the last 30 years, Asia Pacific has experienced more than 50% of all fatalities from natural catastrophes, almost 40% of all economic losses but less than 9% of the insured losses. With increasing wealth in the region, awareness and access to insurance, this proportion is likely to grow.”*

* Munich Re Media Relations, “Weather-related catastrophes on the rise in Asia Pacific” 11 November 2011
Previous Australian flood and storm events, and their financial impact

Floods affect more people around the world each year than any other form of natural disaster. Indeed, many of the most costly insured events to take place in Australia in the past 50 years were flood-related events. The 1974 Brisbane floods, triggered by heavy rainfall from a weakening Cyclone Wanda, still ranks fourth in the Insurance Council of Australia’s (ICA’s) most costly insured events (normalised to 2011). The 2011 Queensland floods rank fifth.

ICA HISTORICAL NATURAL DISASTER STATISTICS – MOST COSTLY INSURED EVENTS

<table>
<thead>
<tr>
<th>Event</th>
<th>Catastrophe Number if declared</th>
<th>Date dd/mm/yy</th>
<th>Location</th>
<th>State</th>
<th>Cost (AUD$)* 2011 Normalised</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hail</td>
<td>CAT NSW 99/1</td>
<td>14/04/1999</td>
<td>Sydney</td>
<td>NSW</td>
<td>4,296,000,000</td>
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<tr>
<td>Cyclone Tracy</td>
<td>CAT 88</td>
<td>24/12/1974</td>
<td>Darwin</td>
<td>NT</td>
<td>4,090,000,000</td>
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<tr>
<td>Earthquake</td>
<td>Not available</td>
<td>28/12/1969</td>
<td>Newcastle</td>
<td>NSW</td>
<td>3,240,000,000</td>
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<tr>
<td>Cyclone, Wanda Flood</td>
<td>Not available</td>
<td>25/01/1974</td>
<td>Brisbane</td>
<td>QLD</td>
<td>2,645,000,000</td>
</tr>
<tr>
<td>Flooding</td>
<td>CAT 105,111,112</td>
<td>21/12/10 to 14/01/11</td>
<td>QLD, Brisbane, Toowoomba, Lockyer Valley</td>
<td>QLD</td>
<td>2,387,624,000</td>
</tr>
<tr>
<td>Hail</td>
<td>Not available</td>
<td>18/01/1985</td>
<td>Brisbane</td>
<td>QLD</td>
<td>2,063,000,000</td>
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<td>Severe Storm</td>
<td>CAT NSW 07/3</td>
<td>08/06/07-10/06/07</td>
<td>Newcastle &amp; Hunter Valley</td>
<td>NSW</td>
<td>1,742,000,000</td>
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<tr>
<td>Cyclone Leah</td>
<td>Not available</td>
<td>4/03/1973</td>
<td>Northern Australia</td>
<td>QLD/NT/WA</td>
<td>1,492,000,000</td>
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<tr>
<td>Bushfire Ash Wednesday</td>
<td>Not available</td>
<td>16/02/1983</td>
<td>Not available</td>
<td>VIC</td>
<td>1,489,000,000</td>
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<tr>
<td>Cyclone Yasi</td>
<td>CAT 114</td>
<td>02/02/11 to 07/02/11</td>
<td>QLD</td>
<td>QLD</td>
<td>1,412,239,000</td>
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<tr>
<td>Hail</td>
<td>Not available</td>
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<td>Sydney</td>
<td>NSW</td>
<td>1,297,000,000</td>
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<tr>
<td>Victorian fires</td>
<td>CAT 09/2 &amp; 09/3</td>
<td>7/02/2009</td>
<td>VIC</td>
<td>VIC</td>
<td>1,266,000,000</td>
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<td>Melbourne Storm</td>
<td>CAT102</td>
<td>6/03/2010</td>
<td>Melbourne</td>
<td>VIC</td>
<td>1,160,000,000</td>
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<tr>
<td>Perth Storm</td>
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<td>22/03/2010</td>
<td>Perth</td>
<td>WA</td>
<td>1,019,000,000</td>
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<td>Cyclone Ada</td>
<td>Not available</td>
<td>18/01/1970</td>
<td>Bowen &amp; Mackay</td>
<td>QLD</td>
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<td>Inundation and Storms</td>
<td>CAT 133</td>
<td>21/01/13 - 31/01/13</td>
<td>QLD</td>
<td>QLD</td>
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<td>Christmas Day Storms</td>
<td>CAT 118</td>
<td>25/12/2011</td>
<td>Melbourne</td>
<td>VIC</td>
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<td>Bushfire</td>
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<td>18/01/2003</td>
<td>Canberra</td>
<td>ACT</td>
<td>660,000,000</td>
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<tr>
<td>Hail</td>
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<td>10/11/1976</td>
<td>Sydney</td>
<td>NSW</td>
<td>650,000,000</td>
</tr>
<tr>
<td>Cyclone Althea</td>
<td>Not available</td>
<td>24/12/1971</td>
<td>Townsville</td>
<td>QLD</td>
<td>648,000,000</td>
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In 2011, economic losses from natural disasters amounted to US$380BN globally, making it the most costly year in history, and the second most costly for the insurance industry. Whilst the most costly year for insurance was 2005, due to Hurricane Katrina, the 2011 economic losses are actually two thirds higher than 2005. The difference lies in the gap between insurance covered losses in Asia compared to the rest of the developed world.

80% of the 2011 global economic losses occurred in Asia Pacific. Over the last 30 years, Asia Pacific has experienced almost 40% of all economic losses. Further, the cost of natural disasters has risen significantly in that time, as per the graphs below.

From the end of 2010 and throughout 2011, there was a climax of weather events across Australia and New Zealand. Some of these events ranked in the top 10 Natural Disasters of 2010, and the natural disasters that occurred in Australia and New Zealand that year contributed to a third of the financial costs associated with catastrophes over AUD$1 B that year.

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4 Source: Munich Re Company News, “Weather-related catastrophes on the rise in Asia Pacific” 11 November 2011
In late 2010 and early 2011, there were severe floods that impacted the east coast of Australia and in particular, South-East Queensland. Many thousands of people were evacuated from towns in the Brisbane metropolitan area and Toowoomba and Ipswich districts. In all, 70 towns had some level of evacuation and hundreds of thousands of people were affected by the floods. The flood-affected area that was declared a “disaster zone” was approximately two-thirds of the state of Queensland or over 500 thousand square kilometres. More than 56,000 claims were received by insurers and payouts exceeded $2.5 B.

“The second half of 2010 and early 2011 was characterized by one of the four strongest La Niña events since 1900. Strong La Niña events are often associated with extreme rainfall and widespread flooding in eastern Australia.

An extremely wet spring (September to November) meant that catchments were already saturated before the December 2010 and January 2011 rains.”

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6 Article: The 2011 Brisbane Floods: Causes, Impacts and Implications, Robin C. van den Honert and John McAneney, Risk Frontiers, Macquarie University, Australia
The amount of rainfall during the spring of 2010 was unusually high. Toowoomba Airport experienced record falls (for period of records from 1996-2013) in August 2010 with 88 mm against a mean of 34 mm, and subsequent months also produced heavy rains.

Notably, at Toowoomba Airport, the annual rainfall for 2010 was the highest on record at 1161 mm, while the annual rainfall 2009 was a record low of 433 mm against a mean of 739 mm (for period of records from 1996-2013).

For Brisbane, the months leading up to the floods in 2010 had record falls (records 1999-2013) in September of 104 mm (against mean of 30 mm), October of 306 mm (against mean of 81 mm), and December of 480 mm (against mean of 148 mm).

“A series of floods hit Australia, beginning in December 2010, primarily in the state of Queensland including its capital city, Brisbane. The floods forced the evacuation of thousands of people from towns and cities, with at least 70 towns and over 200,000 people affected. Damage was initially estimated at around A$1 billion, and the estimated reduction in Australia’s GDP is about A$30 billion.”

“Three-quarters of the state of Queensland was declared a disaster zone. An unexpected flash flood raced through Toowoomba’s central business district, and water from the same storm devastated communities in the Lockyer Valley. A few days later thousands of houses in Ipswich and Brisbane were inundated as the Brisbane River rose and Wivenhoe Dam used a considerable proportion of its flood mitigation capacity.”

“The 2010–2011 floods resulted in the deaths of 35 people in Queensland. As of 26 January, an additional nine people were still missing. The state’s coal industry was particularly hard hit. The Queensland floods were followed by the severe Flood events in the state of Victoria which saw more than fifty communities in western and central Victoria also grapple with significant flooding.”

The January 2011 Queensland floods impacting Brisbane, Toowoomba and the Lockyer Valley rank fifth in the Insurance Council of Australia’s (ICA) most costly insurance events and were devastating for many people and businesses. They claimed 35 lives and over 200,000 people were directly affected. Property damage was estimated at $2.4 billion but the wider impact was to the nations’ Gross Domestic Product (GDP). Some of the hardest hit industries included mining, agriculture, construction, transport, tourism and retail.
In January 2011, the Wivenhoe Dam reached record levels of 188.5% (2,196,474 Ml) of the “Full Supply Capacity” (1,165,238 Ml) on the 12th January as it held back flood waters. When the dam is full “Full Supply Capacity”, there is an additional 1,450,000 Ml Flood Storage Capacity. The catchment area is 7,020 km².

“During a flood situation, Wivenhoe Dam is designed to hold back a further 1.45 million megalitres as well as its normal storage capacity of 1.15 million megalitres. Floods may still occur in the Ipswich and Brisbane areas but they will be rarer in occurrence. Wivenhoe’s flood control facility, together with the existing flood mitigation effect of Somerset Dam, will substantially reduce the heights of relatively small floods.

It is anticipated that during a large flood similar in magnitude to that experienced in 1974, by using mitigation facility within Wivenhoe Dam, flood levels will be reduced downstream by an estimated 2 metres.”

In the Brisbane metropolitan area, Ipswich and along the Brisbane River Valley, an estimated 18,000 properties were flooded or inundated to some degree.

The flood levels in the Brisbane Central Business District in January 2011 reached 4.46 m which was not as high as the 1974 Brisbane flood and not as high as the 1893 and 1841 floods (both of which had 8.35 m peaks). This is approximately 6.5 m above the highest tide level. Both the 1893 flood and the 2011 flood were caused by heavy rains from decaying tropical cyclones (Tropical Cyclone Buninyong in 1893 and TC Tasha in 2011) and there were 35 deaths in each flood.

“The frequency analysis found that the 2011 flood had a return period of approximately 120 year ARI with Wivenhoe and Somerset dams in place (post dam) and a return period of approximately 100 year ARI under pre dam conditions.” - Brisbane River 2011 Flood Event – Flood Frequency Analysis.

With climate change factored in, it is expected that there will be an increased occurrence rate of these severe flood events.
Toowoomba which is located 100km west of Brisbane was hit by a series of sudden, heavy rainfall storms in January 2011 after three weeks of persistent rain had saturated the ground. The central business district sits in a small valley with two traversing creeks which flooded after more than 160 mm of rain fell in a 36 hour period. The flooding occurred despite Toowoomba being approximately 700 m above the sea level, as natural catchments fed waters toward it.
The small rural town of Grantham in the Lockyer Valley was hit by a wall of water that the Queensland State Government Premier described as an “inland tsunami”. The Lockyer Creek rose to a record height of 18.92 m exceeding the 1893 Queensland flood height.

In Toowoomba and the Lockyer Creek catchment, 23 people drowned.

The Queensland floods of 2011 were not isolated events. According to the ICA, inland floods historically account for nearly a third of insured losses in Australia, with the worst affected states from an insurance perspective being NSW and Victoria, followed by Queensland and Western Australia. The flood with the highest loss of life was the Gundagai flood in inland New South Wales that occurred in 1852 with 89 deaths. The ICA says the worst time of year for flooding in Australia generally is between April and October. However, in northern Australia (including Queensland), the highest rainfall months (which are the months more likely to cause flooding) are October to April, coinciding with the monsoon season.

In addition to these flood events, some weather events categorised as “storms” in Australia have included significant inundation and flash flooding, particularly around coastal, urban areas. The 2007 Newcastle storms and inundation rank seventh on the ICA list for most costly natural disasters.
Lessons learnt for property owners and occupants

Businesses that managed the flood event well had planned for such an event and had systems in place. They had good communications protocols and escalation processes. They had up-to-date contact lists and had set up agreements with preferred suppliers who would be needed in the clean-up and restoration of the site. Businesses that had back-up power and retained services on site (e.g. water tanks, gas bottles, fuel) were able to do more when the primary power was disconnected. These are all details of flood contingency plans.

A key lesson learnt from recent flood losses in the Asia Pacific region is that the details of flood contingency plans need to be developed so that greater losses are avoided. Examples of these details include having well-defined trigger points for enacting stages of a flood contingency plan. Otherwise, the time to act may be missed and when action is finally taken, it may be too late to enact plans fully. The amount of time estimated to relocate critical and susceptible assets to higher ground or to elevate them needs to be realistic and should take into account likely resources available (number of forklifts, vehicles, personnel, etc). Also, consideration needs to be given to whether personnel can actually be able to access the site at that time and whether some might have to leave site for personal reasons. Also, the flood event may occur in the middle of the night or on weekends when key personnel are absent. There needs to be a clear and tested plan for communication, including how to recharge mobile phone and UHF radio/VHF radio/satellite phone batteries when there is no power to the site or the area. A loss of power in general can be a problem for many reasons. Without power, communications can fail, lighting is not present and other utilities and services may not be operable.

If the business has actually suffered a major flood loss in the recent past, then it is not difficult to determine the susceptible assets and the potential interruption to business. The 2011 Queensland floods and other major Australian floods have been studied and some lessons have been learnt. Often losses to a business were suffered when planning and preparation were inadequate for the magnitude of the particular flood events. However, since it is difficult to predict the magnitude of the event it is difficult to adequately plan for it.
Identifying the hazard and quantifying its impact to the business is the first step but unless protection measures are actually put in place, tested, reviewed and maintained then the hazard may not adequately be controlled. There are physical flood protection measures that can be put in place permanently or activated at a particular point in time, either manually or automatically. Permanent measures are better because, assuming the measures are well-designed and maintained, they will be there and ready for the flood when it occurs.

Manual measures as part of a contingency plan require human intervention which needs the plan to include details on trigger points and their definitions. Also, since contingency plans rely on people’s response, it is difficult to predict how people will behave under an emergency situation. That is why training is important and one can expect sites that implement the contingency plans in real-life situations will have better chances of reducing damage due to experience.

These are all details of flood preparation and planning that were frequently lacking in recent the flood events in Australia at the site level.

Zurich Risk Engineering has produced a Flood Contingency Planning Risk Topic with more details on how to prepare for a flood event.
Lessons learned by Governments from recent floods in Australia

There are some common lessons that can be taken from the recent floods in Australia. To begin with, the actual flood hazard levels are too often not known and recognised by property owners and occupants. Governments have a role to play in developing flood hazard map information and making it available for the general public so they can be better prepared. There are flood protection measures that can be taken at the site level by property owners and occupants and there are protection measures that can be taken by governments such as local and regional councils, state governments and the federal government. These can include flood levees, dykes, dams, retention basins and underground storage. Councils can also prevent development in flood prone areas, acquire flood prone land from property owners to use as parkland and increase the threshold for ground floor levels of buildings further above flood hazard levels.
There were several reviews of flood mitigation and adaptation in Australia following the Queensland and Victorian floods, including the Queensland Floods Commission of Inquiry\(^1\), Brisbane City Council’s Flood Response Review\(^2\), the Victorian Parliament’s Inquiry into Flood Mitigation Infrastructure in Victoria\(^3\) and the Victorian Floods Review\(^4\).

On-Line Academic & Research website “The Conversation”\(^5\) looked at four recent reviews.

“The last few years provided plenty of data to help us reform our approach to floods. With devastating flooding in Queensland and Victoria in 2011 and 2013, as a Nation we should have learned a great deal about which approaches to flood mitigation work and which are less effective. A review of four recent Australian studies of mitigation and adaptation, and a comparison to overseas recommendations, shows for the first time that Australia is lagging behind international practices in a number of important areas.”

“These reviews varied greatly in scope, and all produced a comprehensive list of considered and much-needed recommendations to improve Australia’s resilience to floods in the future.”

However, none of them dealt with future climate impacts. “Government reviews are expensive, and the cost is justified if they identify long-lasting reforms which improve society.” By not taking into account the risk of future climate change, increased weather event intensity and the exacerbation of flood risk, opportunities may be missed to help mitigate physical and financial impact upon the community.

“In the United States 15% of federal funding is allocated for ‘betterment’; here there are virtually no resources to plan for, relocate or strengthen flood prone infrastructure to make it more resilient.”

“The Australian approach to ‘flood proofing’ communities is to build levees. Levees essentially take the same body of water and squeeze it into a smaller space. They don’t encourage evaporation, and they push water to higher levels. They work well in small floods, and under those conditions are very effective at protecting communities. … In bigger floods the levees are often overcome, and the potential for serious damage becomes much greater than it would be without them.”

“‘Non-structural’ or ‘ecosystem’ approaches to flood mitigation work much better than structural measures like levees. But in Australia, we rarely consider these types of measures.”

In areas of China, USA and the Netherlands where cities and towns are vulnerable, the government diverts the river into agricultural land around the town. In a flood season the city is protected and agricultural areas are flooded instead. The farming communities are paid by the government to forgo income during floods, but still use the land at all other times. Australian research has shown that for graziers, more frequent flooding can actually improve farm incomes.”
Levees are one form of flood protection but others include large underground retention systems and dam lakes. Dam lakes also play a part in mitigating the flood hazard by holding back waters that would otherwise reach the flood plains. However, as with the Wivenhoe Dam example, the dam water levels need to be relatively low prior to the heavy rains so that water can be retained below the maximum capacity of the dam. If water is released from dams at inopportune times as in the Thailand floods, it can exacerbate the flood levels downstream. The dams are used for potable water for cities and therefore need to retain adequate supplies for drought periods. There is a balancing act performed which relies on good forecasts. So levees and lake dams are some forms of flood protection but both have their limitations. Underground retention systems can be more localised and built on a smaller scale to fit into existing development in towns. Dredging of rivers, particularly at outlets, can also be a measure to reduce the flood hazard level.

A finding from the Victorian Floods Review⁸ was that there was a lack of clarity on responsibility for flood warning systems and flood mitigation infrastructure for agencies and government bodies and this meant that there were inadequate arrangements made during the 2010-11 Victorian floods. The “Review of the 2010-11 Flood Warnings & Response” report in Victoria reiterates this finding.

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¹² The Conversation is funded by CSIRO, Melbourne, Monash, RMIT, UTS, UWA, Canberra, CDU, Curtin, Deakin, Flinders, Griffith, JCU, La Trobe, Massey, Murdoch, Newcastle, QUT, Swinburne, Uni SA, USC, USQ, UTAS, UWS and VU.
Following the 2011 Queensland floods and other floods in Australia, the Federal Government set up a Natural Disaster Insurance Review (NDIR).

“Measuring flood risk by way of flood maps has been raised with the Review Panel by:

• insurers, as a necessary input to enable them to assess and price flood risk;
• homeowners seeking to assess their personal flood risk; and
• councils as part of their planning and risk management.”*

This raises the question of “how best to deal with the legacy of poor land-use planning decisions that has left some home owners in locations now designated as high risk. Development in the low-lying areas along the lower Brisbane River, for example, has occurred despite the city’s history of severe flooding.”*

What can be done now that development has been allowed in flood-prone areas by local councils?

“The Need: Local councils are held accountable for bad land-use planning decisions

One very positive initiative of the local council in Grantham, involves a land swap for flooded residents.

It is expected that 70 to 80 percent of residents formerly living on the floodplain will move into new homes from December 2011. Nowhere else in Australia are … Local Government authority assisting a disaster-struck community in this way.

Another positive signal to come out of the 2011 flooding has been a decision by the Brisbane City Council to raise the Defined Flood Level (DFL) for rebuilding purposes using the January 2011 peak flood level in most areas. Prior to this the flood control levels were based on the notional (modeled) 1-in-100 year flood. The new minimum habitable floor level for residential development was changed to 500 mm above the DFL except where the existing level was higher. These specifications are now imposed upon all new residential, industrial and commercial developments, and will serve to reduce the city’s vulnerability to future flooding.

Needless to say the larger floods are still possible.”*

*Article: The 2011 Brisbane Floods: Causes, Impacts and Implications, Robin C. van den Honert and John McAneney, Risk Frontiers, Macquarie University, NSW 2109, Australia
Key messages:

- Know your flood exposure for your current property and check for flood hazard maps when looking at new property prior to purchasing/relocating.
- Understand that local councils may have allowed development in flood prone areas even if buildings are relatively new.
- Councils & State Governments should have, or be in the process of developing, robust Flood Prevention and Mitigation Plans, as well as Emergency Response Plans for Natural Disasters. Be aware of these, as they will help you determine your own Action Plan for natural disasters.
- Make sure you develop a flood mitigation plan and make your property more flood resilient.
- Make sure you develop a flood emergency response plan and define trigger points for enacting stages of the plan.
- The hazard of pluvial flooding from heavy precipitation can increase over time as towns become more developed due to the prevalence of hard, impervious surfaces.
How to increase your business’ resilience and resistance to floods

Given the high prevalence of flooding in Australia, many people and businesses are inevitably exposed due to being located in flood-prone areas, for example, in close proximity to a river/natural waterway (whose banks can overflow), near the coast (vulnerable to storm surge or king tides) or situated in low-lying urban areas, where flash floods can occur during heavy rainfall.

Without a doubt, the best flood minimisation strategy is to find an elevated location. However, given most Australian towns are located adjacent to rivers or by the coast, that’s not always possible.

Property owners can construct new premises or modify an existing building with flood resistant materials and products to increase its capacity to withstand water inundation and reduce flood damage. Quite often, there are also relatively inexpensive measures that can be taken to improve the flood resistance of an existing property and make the premises habitable and operable in less time following a flood. The following sections will discuss these measures.
Before even considering what protection measures are to be applied, contingency plan, permanent protection structures, mobile methods, semi-mobile methods, etc., the flood hazards have to be identified, such as:

- potential sources/types of flooding
- likely frequency of flooding
- predicted maximum flood levels for the location
- likely flood duration.

The type and impact of potential flooding as well as available resources will determine the degree of flood protection that should be installed in the premises. The first stage in the planning and design strategy is to determine the types or sources of flooding and which of these is likely to impact on the site. Flood sources can include:

- creeks, rivers, streams, natural watercourses ("riverine" or "fluvial" flooding)
- the sea / storm surge
- groundwater
- overland flow, flash flooding, ("pluvial" flooding)
- ruptured town water mains
- blocked or overloaded drains and sewers (roof drainage, site drainage or off-site drainage).

While these sources can act collectively, one or two will usually represent the greatest threat to a particular property.

Development has increased the risk of flooding from rivers and streams in many areas by reducing the natural capacity of flood plains to dissipate water and increasing the rate of overland surface water run-off into drains, rivers and streams. Indeed, urbanisation with the introduction of hard landscaping with impervious ground surfaces can increase and large building areas water runoff by two to six times above what would be expected to occur on natural terrain.

Also de-forestation of land in rural areas upstream increases the hazard level in a couple of ways. Removing natural vegetation allows water to flow quickly across the land and filtration into the soils is reduced. Removing plants with deep roots also allows soils to be more easily eroded. When the soils are washed away, they silt up rivers at the outlets, reducing the rivers’ capacity to release water to the ocean.

As towns and cities become more populated and land close to the Central Business Districts becomes scarcer, unfortunately flood-prone land is reconsidered for development, industrial parks, and the flood hazard importance can be understated.
There are several potential information sources that can help businesses determine their site’s potential maximum flood level and the likely frequency/duration of flood events. These include previous flood records and flood hazard maps based on hydraulic modelling, which may be available from the local council, local water authority, state/territory government department responsible for emergency planning and/or an insurer. Flood hazard map availability varies widely from state to state in Australia. This is also the case in New Zealand and other countries in Asia Pacific. Note that the benefits of previous flood records are limited as they provide information on the history of flooding. What is needed is information about future probability of the event occurring and its magnitude, particularly when variables are changing.

Besides this theoretical information, a site survey is recommended to improve the understanding of the nature of the topography between the potential threat (water body) and the site. Additionally, geotechnical investigations can be conducted to determine the threat of groundwater flooding and potential measures to be implemented to waterproof the structures and guard against potential seepage of water retained from behind the flood protection structure into the site.

Initially, try contacting your local council to determine the type and magnitude of the flood hazard the property might have and, for Australia, visit the Bureau of Meteorology website (www.bom.gov.au) to understand the rainfall patterns contributing to the potential for flash flooding. More rainfall information can be found at the Australian Rainfall and Runoff Guide website, www.ncwe.org.au/arr/index.html

To properly appreciate the future flash flooding hazard, more than rain records are needed. A site survey is needed to understand the main topographic features in the vicinity of the site. Other useful information would be gained from a review of a topographic map to become familiar with the regional surface flows, a check of urban development plans to gain insight into future development of the area, an analysis of local drainage designs, etc.

Many local councils have engaged hydrologists and flood consultants to develop flood hazard maps that show areas where the waters from a certain return-period flood event would cover (as opposed to historical flood maps). Additionally, links to some flood studies and maps are available on the federal government’s web site http://www.ga.gov.au/flood-study-search/.
After identifying the flood hazard, businesses need to work out what the main impacts of this event are likely to be on their operations, such as:

- personal injury or death of staff
- exposure to hazardous materials
- loss of business records
- damage to stock, plant and equipment
- damage to furniture, floor coverings and fittings
- loss of business and loyalty with customers
- damage to reputation or image
- time taken to resume operations
- loss of production
- cost of clean-up and debris removal
- customers and suppliers unable to physically access premises
- employees unable to come to work.

Businesses need to put in place a contingency plan to help mitigate these risks.
Flood resilience and resistance measures

Floods can be devastating for property and business owners, but the extent of damage can often be significantly reduced with some good planning and preventative measures.

Numerous options are available to help your businesses make their existing buildings more resistant to flood damage. Permanent/automatic measures, which require no intervention, can include measures like installing back-pressure reflux valves on drains. It can also include permanently locating hard-to-move equipment and critical machinery, stock and spares in elevated areas. Resources can be lower than usual during a flood and the less that needs to be done in the hours before the water levels rise, the better.

Meanwhile, contingent flood-proofing measures (i.e. activated when there’s a threat of flooding) can include things like putting in flood gates, movable flood walls and barriers to protect buildings from water and debris.

Fast installation flood gate systems can allow the owners and occupants to store system components on the premises and rapidly deploy a temporary wall in an emergency if resources are available at the time prior to the flood. See sections below for more examples of permanent and contingent flood-proofing methods.

Deployment time depends on the system design and resources available.

### OVERVIEW OF THE DIFFERENT SYSTEMS

<table>
<thead>
<tr>
<th>System types</th>
<th>Max.protection height (manufacturers specs)</th>
<th>Manpower req./100m/h* for erection</th>
<th>Investment Fr./m²*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sandbag systems</td>
<td>2m</td>
<td>40 people</td>
<td>100-150.--**</td>
</tr>
<tr>
<td>Board systems</td>
<td>0.5M</td>
<td>4-8 people</td>
<td>50.--100.-</td>
</tr>
<tr>
<td>Tube systems</td>
<td>1.2m</td>
<td>4 people</td>
<td>250–500.--**</td>
</tr>
<tr>
<td>Basin systems</td>
<td>1.5m</td>
<td>4-8 people</td>
<td>400–450.--**</td>
</tr>
<tr>
<td>Fold-out systems</td>
<td>2m</td>
<td>2 people</td>
<td>350–400.-</td>
</tr>
<tr>
<td>Support systems</td>
<td>2m</td>
<td>4-8 people</td>
<td>500–600.-</td>
</tr>
<tr>
<td>Dam systems</td>
<td>1m</td>
<td>4 people</td>
<td>550-600.-</td>
</tr>
<tr>
<td>Modular concrete systems</td>
<td>1m</td>
<td>4 people</td>
<td>250.-</td>
</tr>
</tbody>
</table>

*based on 0.5m protection height

** excl. the costs of acquiring and transporting the sand

Fr = Swiss Franc

FLOODS

Queensland Maritime Museum during Brisbane River floods
Source: Zurich Risk Engineering

Queensland Maritime Museum with no flood conditions
Source: Zurich Risk Engineering
Designing flood-resistant buildings

If a business is constructing a new building, some relatively simple design measures can make the premises more flood-resistant. These include:

- locating the building and assets above flood-prone land. Note: Consider site access for flood event.
- designing the facility to be elevated on walls, piers, columns or compacted fill above the predicted maximum flood level
- ensuring drainage designs divert water away from buildings as directly as possible
- installing permanent flood protection barriers (walls, berms, levees, etc)
- locating service entry points and meters (e.g. gas, electricity, water and telephone) above predicted maximum flood levels to prevent water ingress and to minimise services equipment damage
- locating lower floor level windows above predicted flood levels
- installing solid, water-resistant external doors
- avoiding the use of glass doors, large windows or large glass areas that are not impact-resistant (as these are susceptible to damage from hydrostatic and hydrodynamic forces or impact from water-borne debris)
- fitting anti-backflow valves on sewers and drains
- avoiding the use of water-susceptible plasterboard and gypsum-based materials at ground-floor levels
- coating lower sections of external walls with a water-resistant membrane or render

Consideration also needs to be given to design features that can enhance or speed up the drying process in the event of flooding. These range from installing and plugging additional weep holes at the bottom of cavity walls (to allow water to drain out after the flood more easily) to using low permeability lime-based paints (to allow walls to dry out more quickly) and installing periscope air vents in walls. If the risk of flooding is significant, it may be worthwhile pre-purchasing dehumidifiers and blowers (with fuel supply) to enable a swift recovery. These should be part of the flood contingency plan.
Installing permanent/automatic flood measures

- Installing non-return check valves in sewerage waste pipes and outlets to prevent backflow into the facility.
- Reinforcing wall structures to resist water pressure where the anticipated flood depths could compromise the structural integrity.
- Reinforcing wall structures to resist impact from water-borne debris.
- Sealing/facing/rendering walls to prevent or reduce seepage into the building’s interior.
- Building watertight walls around key or susceptible equipment/work areas.
- Installing watertight external doors.
- Landscaping the site to divert flood waters away from buildings.
- Building bunds, walls or levees around the site or buildings for expected flood levels.
- Elevating small buildings on walls, piers, columns or compacted fill.
- Installing permanent submersible pumps in basements (with a fuel supply) to remove flood waters.
- Installing a diesel generator (with fuel supply) for back-up power above expected flood levels. Cabling must be watertight and designed to prevent short-circuit.
- Installing computer/server equipment in elevated position.
- Backing-up computer data regularly and storing it in a safe, off-site location.
- Purchasing dedicated hydraulic lifts to raise key equipment prior to flooding.
**FLOODS**

**Contingent / manual interventions**

- Enacting the facility emergency shutdown procedure and isolating services (e.g. gas, electricity & water)
- Closing cylinder tank valves, oil drums and other fuel containers and securing gas cylinders
- Raising dangerous (i.e. flammable, explosive or toxic) chemicals.
- Installing watertight barriers (e.g. flood shields, gates, skirts or covers) to prevent passage of water through openings (e.g. doors, windows, air vents etc).
- Temporarily seal off or block sewerage drains inside the building if there are no non-return (reflux) valves fitted to stop water entering building via this means.
- Erection of movable flood walls and barriers.
- Sealing around doors and low openings.
- Installing temporary submersible pumps to remove flood waters (with associated fuel and power supplies).
- Moving mobile plant/vehicles to higher ground.
- Raising machinery/equipment on dedicated hydraulic lifts.
- Raising sensitive stock off the floor and above expected flood levels.
- Unplugging portable electrical equipment and storing at higher levels.
- Moving equipment that is outside to higher ground pre-determined location (identified prior to event and known to emergency response team),
- Securing equipment that could float away (especially if fed by electricity, gas or water lines).
- Securing and filling tanks with stored product that cannot be readily moved but may float away.
- Filling windows, doors or other openings with water and impact-resistant materials, such as concrete blocks or bricks (assuming the structure can withstand flood waters and ground conditions preclude seepage under the barrier).
- Ensuring a back-up generator is operational and there is a secured supply of fuel.
While severe storms may be a fact of life in many parts of Australia, there are some simple measures you can take to minimise your property damage and reduce your risks of business interruption.

The word ‘storm’ is used to describe a variety of severe weather events that involve atmospheric disturbance. These range from tropical, summer and winter storms to more severe weather events with high wind and heavy rain conditions, associated with tornado and cyclone activity.

Cyclonic storms are characteristic of the northern regions of Australia, where the low lying coastal areas are often subject to storm surge from the sea. Whereas in the southern regions, storms are often associated with thunder and lightning activity, heavy rains, localised flash flooding, land gales and destructive gusts or squalls. Coastal areas may also be susceptible to hailstorms, such as the one that hit Sydney’s east in 1999 and caused billions of dollars in damages.

What types of storm are most risk to you? That really depends on the property’s location and the types of storm that are prevalent in that geographical region. This will in turn determine what damage mitigation measures you should take.
Preparing for approaching storms

Probably the most important thing you can do to protect property against storm damage in the first instance is to make sure that the building envelope, roof and wall claddings, windows, doors, skylights, etc. are intact and don't leak. Pay particular attention to windows and doors as once these have been broken, internal pressurisation of the building can lift off sections of roof cladding and even the roof structure in strong winds. The resulting water ingress can cause major damage to the building contents.

If you haven't already done so, you should prepare an emergency plan that can be activated at short notice in the event of a severe storm warning. Some of the basic things you need to address in their plan include:

- identification of meteorological resources that forecast weather conditions
- knowing how to tune into severe weather-warning services and radio broadcasts
- designating a person responsible for monitoring severe weather-warning services within the organization, as well as trigger levels and associated response actions.
- preparing (and rehearsing) evacuation procedures
- pre-packing an emergency kit that includes important contact numbers (key staff, broker, insurance company etc.), a portable radio, torch, spare batteries, manual wind-up chargers or solar chargers for mobile phones, first aid kit and plastic bags (for clothing/valuables)
- having emergency equipment on standby (tarpaulins, rope, nails, hammer, timber, sandbags) to protect plant, stock and other building contents in the event that the storm damages the roof or wall structure
- isolating water, gas and electrical power supplies when severe storms are forecast to prevent further damage and personal injury from ruptured pipes or fallen power lines.
- acquiring a back-up (diesel) generator or generators (and fuel supply) to provide power for clean-up.
If your property is located in an area that is prone to strong winds and severe storms, in advance, it is worth getting building contractors or suppliers to assess:

- how well the roof, windows and doors are secured to the building wall structure
- how well the wall and roof claddings are fixed to the wall and roof structures
- the building’s ability to withstand the potential maximum wind forces characteristic of the location
- compliance with the wind load requirements in the Building Code of Australia guidelines (as well as AS 4055-2012 and AS/NZS 1170.2-2002).

The roof’s attachment to the wall structure is critical. It is also important to make sure that any gable roof frames have adequate bracing at the gable ends. In turn, ongoing maintenance is also vital (regularly inspecting the sheet metal or tile roof cladding to ensure that it’s secured properly).

The cyclic nature of the wind load can lead to the progressive deterioration of fastener strength over time. Also, weather conditions and UV light can advance corrosion or deterioration of roof cladding and fasteners. If cladding deteriorates around fasteners or fasteners loosen and pull out, windborne roof and wall cladding debris can cause further damage to surrounding buildings. After severe wind events, you should always check the roof and walls for damage.

Other simple but effective measures that can help reduce a property’s risk of wind damage include:

- fitting glass windows and doors with storm shutters
- installing security mesh or robust, well-fitted insect screens on windows
- protecting skylights with mesh screens
- reinforcing roller doors with bracing to withstand strong winds.

After checking the structure is secure, it’s important to inspect the building’s surroundings.

Remove any overhanging branches or adjacent trees (with council permission) that could fall on the building in high winds or following a lightning strike. If space permits, plant windbreaks of trees on the prevailing windward side but well away from buildings.
STORMS

When a storm threatens, be sure to secure any loose property in the yard, including lightweight sheds, empty drums or containers, metal sheets, roofing material, signs, outdoor furniture, bins and other items that could blow away and cause further damage. Once building envelopes are breached, winds enter through this breach and try to find an exit. In many cases, this causes an over-pressurisation in the building. The roof cladding or roof structure lifts off and becomes wind-borne, causing damage to other buildings in a domino effect.

“A notable example of damage from wind-borne debris is from Tropical Cyclone Tracy in 1974. Debris damage was so severe that 90% of the homes in Darwin, Australia, a city of 40,000, were made uninhabitable (Minor and Behr, 1994). Mitrani et al. (1995) reported that window breakage and door failure on the windward side of buildings caused most of the roof failures, which were the most important damage due to Tracy.”

Protecting against water leaks

In the event of a storm, small water leaks can rapidly turn into gushing torrents, which is all the more reason to routinely check the condition of your roof and perform any necessary building maintenance. Some of the key things to be on the lookout for include:

- broken masonry tiles/slates, loose iron sheet cladding or lifted flashing (especially on low sloped roofs)
- corroded galvanised iron sheet roofing, particularly where buildings are located in industrial or salt-laden, coastal localities (or below dripping air-conditioning units)
- membrane damage on concrete roofs, especially around edges that are susceptible to being lifted by strong winds or where plant and equipment have been installed
- moved aggregate stone coverings following a storm, exposing the membrane
- blocked or rusted roof guttering and drainage systems.

It’s important to make sure that roof guttering and drainage systems, including downpipes and rain heads, are adequately sized for sudden downpours and hailstorms. Secondary overflow downpipes or overflows through external walls can prevent water backing up in roof box gutters and finding a way inside the building. A licensed roof drainage contractor can provide expert advice in this area.

They may also recommend that you install adequate flashing for saw-tooth roof guttering. To prevent gutters from filling up with leaf litter and small branches, regularly trim overhanging tree branches and consider installing a gutter guard.

If you currently have old asbestos roof cladding or old translucent sheeting, consider replacing it with sheet metal or newer translucent cladding to avoid hailstones punching holes in the roof. When replacing roof cladding (especially tiles), it’s a good idea to install a secondary water-protection layer in the form of sarking.

Be sure to also check around windows and door frames for any gaps, where water seepage commonly occurs, and seal these also.

Finally, blocked or inadequate stormwater drainage pits can cause water to back up from the ground level up during a downpour. Ensure that your stormwater capacity is adequate for your property’s needs. At the same time, identify whether any interior pits or basements require sump pumps.

13 Windborne Debris Missile Impacts On Window Glazing And Shutter Systems”, Nirav Shah, University Of Florida 2009
In Australia, the Bureau of Meteorology is an enormous source of weather information. The Early Warning Network provides severe weather email or SMS alerts from data in the Bureau of Meteorology web site to those wishing to register or subscribe. There are other sources of alerts and river height gauge levels that can be found such as those in the table below. These systems can provide notification of inclement weather in a timely manner with good lead times prior to an event.

### National Warning System Sources

<table>
<thead>
<tr>
<th>Sources</th>
<th>Contact Information</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early Warning Network</td>
<td><a href="http://www.ewn.com.au/">www.ewn.com.au/</a></td>
<td>Register for email alerts for severe weather events. EWN also has subscription SMS alerts.</td>
</tr>
<tr>
<td>Emergency Alert Government website</td>
<td><a href="http://www.emergencyalert.gov.au/">www.emergencyalert.gov.au/</a></td>
<td>Website has links to State authority websites with alerts posted</td>
</tr>
<tr>
<td>Bureau of Meteorology (BoM) Telephone Line</td>
<td>1900 926 113</td>
<td>Charged call with recorded message alert service.</td>
</tr>
<tr>
<td>ABC Radio</td>
<td><a href="http://www.abc.net.au/reception/">www.abc.net.au/reception/</a></td>
<td>ABC Frequency Finder for local and national ABC Radio.</td>
</tr>
<tr>
<td>ABC Website</td>
<td><a href="http://www.abc.net.au/news/">www.abc.net.au/news/</a></td>
<td>See website alerts in your area.</td>
</tr>
</tbody>
</table>

### State Warning System Sources

<table>
<thead>
<tr>
<th>Sources</th>
<th>Contact Information</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Queensland Disaster Management Centre</td>
<td>disaster.qld.gov.au</td>
<td>Flood level predictions and cyclone warnings</td>
</tr>
</tbody>
</table>
Subscription Weather Alert Services:

The subscription-based EWN All Alerts are delivered via SMS and email and include warnings issued by the BoM and state fire authorities but filtered by EWN alert managers.


Sky Weather provides a subscription SMS alert system once they are received by the BoM.

weatherzone.com.au/services/smsweather.jsp

Weather warnings sent to your phone as soon as they are issued by the BoM and Wind reports from over 300 locations nationally.

Twitter accounts can also send notification alerts from particular emergency services.

Weather Alert & Information Apps

DisasterWatch

The “DisasterWatch” phone app provides publicly available news and information about disaster events in Australia via direct feeds from a range of authoritative sources in the States and Territories and nationally. The information is regularly updated. Note this app does not provide direct emergency alert warnings to users.

WeatherZone
apps.weatherzone.com.au/weatherzone/

This is a free app for iPhone and Android.

apps.weatherzone.com.au/weatherzone-plus/

This is a subscription app for iPhone and Android with more information.

Road closures:
New South Wales

State Emergency Services
The following State and Territory Emergency Services also have alerts and warnings:

- Dept of Fire & Emergency Services (WA) [www.dfes.wa.gov.au/Pages/default.aspx](http://www.dfes.wa.gov.au/Pages/default.aspx)
- State Emergency Service Telephone 132 500 (from anywhere in Australia)

Useful references

Good sources of further information include:

- AS/NZS 1170.2: 2011 “Structural design actions - Wind actions”
- AS/NZS 3500.3:2003 “Plumbing and drainage - Stormwater drainage”
- Local Council website
Zurich Risk Engineering – Who we are

Our risk management services are delivered by a Risk Engineering team made up of industry experienced safety and risk management professionals. The Australian team has access to best practice solutions from around the world through the Risk Engineering Network which now has over 800 engineers and specialists in 33 countries around the world. Our local team is spread across Australia with engineers in all key capital cities.

Our Risk Engineers are able to offer advice and guidance on a range of mitigation measures to avoid or reduce the impact of Natural Perils. We have access to a large global network of knowledge, as well as internal technical references, and useful tools to help evaluate exposures.

Roger Hancock represents Asia Pacific on Zurich Risk Engineering’s Global Technical Centre for Natural Hazards.

Our Risk Engineering Network is committed to the systematic identification, assessment and improvement of a wide range of risk exposures. Our application of these principles to natural perils risk management is well reflected in the International Standard for Risk Management ISO: 31000.