Responding To The Brisbane Flood – An Insurance Perspective

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Abstract

The January 2011 flooding of Brisbane and its surrounds resulted in significant damage to residential and commercial property, as well as infrastructure and disruption to everyday life. Tragically, lives were also lost.

The insurance industry suffered considerable adverse response from the flood affected population and the media, and the Federal Government initiated a policy to have insurers provide flood cover under a uniform definition. An extensive investigation of the causal factors was undertaken by the Insurance Council of Australia (ICA). As a result, the industry has proceeded to prepare for the provision of flood insurance Australia wide.

The huge number of properties affected required a thorough assessment of the hydrologic factors leading to property inundation across extensive areas. In the interests of expediency, the hydrologic analysis was initiated by completing "overarching" reports describing, at a regional level, the key rainfall characteristics that led to inundation, and the timing of inundation relative to the causative rainfall. Where a claim warranted further investigation, detailed site specific inspections were carried out to ascertain the cause and timing of the inundation at the property in accordance with specific policy definitions of storm, flash flood and flood.

In assisting with the understanding of the magnitude of flooding, emerging techniques in GIS-based hydraulic interpolation were used to reproduce the 2011 flood surface from available design flood modelling of the Brisbane River. Aerial photography captured near the peak of the flood showed a very close match between the generated surface and the actual flood extent. The surface provided hydraulic gradients along the river, as well as indicative flood depths, which proved valuable in determining of the cause of inundation of properties (ie "storm", "flash flood", or "flood").

A new technique for rapidly assessing flood risk across the full range of probabilities was also developed. The technique is based on hydraulic analysis of digital elevation models using probabilistic rainfall to quickly provide indicative flood levels and depths across the entire catchment. This technique is being used by the industry to enhance the understanding of flood risks, particularly in areas where little or no flood information currently exists.

Introduction

The January 2011 flooding of Brisbane and its surrounds resulted in significant damage to residential and commercial property, as well as substantial damage to infrastructure and disruption to everyday life. Tragically, lives were also lost.

Faced with the vast numbers of flood affected policy holders making (or likely to make) claims after the event, individual insurers and the industry as a whole responded in a range of different ways. The main aim in all aspects of the response was to rapidly, but with a degree of certainty, determine what had caused inundation of properties in relation to the varied definitions of “storm” and “flood”.

Initial responses in the first few days after the event involved determining the meteorological factors that had caused the event with the results being presented as an “overarching report”. This report was designed to provide a regional perspective on the storm event and subsequent inundation.

Once insurance claims began to be lodged, further investigations were required to determine the cause of inundation (in relation to each insurers definition of “storm” versus “flood”) on an individual property basis. The investigations generally took the form of a property specific interpretation of the findings of the overarching report. Where the overarching report did not provide sufficient detail to determine the cause of inundation, a site inspection was carried out.

GIS-hydraulic techniques were applied to reproduce the peak flood surface along the Brisbane River which in turn was used to assist in determining the cause of inundation at properties. This surface provided valuable information in regard to quantifying the impacts on properties.

Concurrent to the processing and investigation of claims, changes to Government policy were mooted and a national flood insurance directive appeared likely. This led some insurers to take steps to quantify the likely flood risk and hence, be able to price and offer flood insurance on a national basis.

Meteorological Factors

The Brisbane flood event was preceded by a period of significant rainfall. The Bureau of Meteorology (BoM) characterised the rainfall deciles in the Brisbane River catchment between October and December 2010 as either “very much above average” or “the highest on record”. This meant that the rainfall that led to the January 2011 flood fell on an already saturated catchment.

The event itself was caused by the combination of two weather systems. The first was a localised low pressure system caused by a monsoonal trough which developed near Mackay. This moved southwards towards Fraser Island, and continued to move closer to the coast forming a trough that spanned from Northern NSW to Mackay. This trough dissipated, but the low pressure system intensified and moved towards the coast. This system resulted in moderate rainfall in the lower Brisbane River catchment.

The weather system then combined with a monsoonal trough moving southwards from Northern Queensland into Central Queensland. The combined system, fed by warm moist air from a high pressure system near New Zealand, resulted in intense rainfall in the upper Brisbane River catchment.

The combined system eventually moved west, releasing intense rainfall on the western side of the Great Dividing Range.

The manner in which the combined system developed resulted in rainfall intensities with an Annual Recurrence Interval (ARI) of between 50yr and 100yr in the upper Brisbane River catchment, near Toowoomba. In the middle catchment, near Ipswich, rainfall intensities were of the order of 10yr to 20yr ARI. In the lower catchment, around Brisbane City, rainfall intensities were of the order of 1yr to 2yr ARI.

Policy Definitions – Storm Versus Flood

There are a range of policy definitions of "flood" versus "storm" that have been adopted by the various insurers. In essence, if inundation was considered to be "storm", an insurance claim would generally be paid. If the inundation was established to be due to "flood", an insurance claim would only be paid if the claimant had specifically selected "flood insurance" (if available), or if the insurer offered "blanket" flood coverage. The distinction between the two terms generally relates to the source of the water causing inundation (eg did it come from a recognised watercourse) and the timing at which the inundation occurs relative to the onset of the causative rainfall.

In assessing claims, each insurer was interested in relating the physical drivers of inundation to their policy definitions.

"Overarching" Reports

The aim of the overarching reports was to provide a regional overview on the causes of inundation throughout the catchment, in relation to an insurers' policy definitions. A report would generally include a commentary on the meteorological factors driving the event, antecedent conditions, as well as recorded rainfall (including timing) and river levels throughout the affected area.

The regional analysis was then distilled into classification bands of inundation type, providing an indication of areas that, on a regional basis, could be considered as "flood" or "storm", as well as highlighting areas that were identified as being within the transition between "storm" and flood". Again, these classifications were based on the insurers' policy definitions.

The overarching reports were usually prepared within the first few weeks after the event and provided a means for insurers to rapidly respond to the large number of claimants where the cause of inundation could be well defined from the regional analysis.

Property Inspections

Where the cause of inundation could not be clearly determined from the overarching report, or where a claimant requested further investigation of a claim, property inspections were carried out.

Property inspections were carried out to provide a detailed assessment of the factors causing inundation at an individual property level. Inspections were carried out in teams of two, led by an engineer experienced in hydrology/hydraulics.

Property inspections were usually preceded by a desktop review of the meteorological factors that led to the inundation in the vicinity of the property. A study of available mapping information may have also been carried out to gain an overview of potential local and regional flow behaviour.

Site inspections commenced with a discussion of the claimants recollections of the event. These discussions often provided valuable information that was used to connecting the causative rainfall and runoff to the timing of initial and peak inundation of the property.

While onsite, the inspection team would attempt to ascertain the causes and timing of inundation by looking for and measuring a range of hydrologic and hydraulic indicators such as:

- Proximity of site to, and capacity of, local drains, overland flowpaths, creeks and rivers
- Potential flowpaths to and from the site
- Local catchment size, shape and steepness
- Peak inundation levels evidenced by debris lines and 'mud marks'
- A review of photos/videos (as available) provided by the claimant
- Evidence of flow direction and likely velocities such as differential water level marks around obstructions, water level differences across the property, presence and orientation of debris on fences and vegetation, sloping (or "pushed over") vegetation etc

Property specific reports were then prepared linking the site investigation and claimants comments with available rainfall and river gauge data, indicative hydraulic profiles, elevation information, and the overarching reports. This complete dataset was used to determine the timing and cause of inundation, with consideration of both peak and initial inundation, where appropriate. This was then classified using the insurers policy definitions and used by the insurers in their claims processing. The reports did not provide explicit advice as to whether the claim should be paid or not.

Brisbane River Flood Surface

The Queensland Department of Natural Resources and Mines (DERM) created GIS layers of flood extents digitised from aerial photography flown near the peak of the flood. These layers were made available to the insurance industry along with LiDAR DEM's for the purposes of assessing claims. While the flood extents provided an indication of the number of properties potentially affected, they did not provide an indication of the degree of affectation of properties, that is, the depth of flooding.

GIS-based techniques that have been used in flood forecasting systems for some time were used "in reverse" to re-create a water surface representing the peak of the flood along the Brisbane River. The 1999 Brisbane River Flood Study provided MIKE11 model results for a range of design flood probabilities. GIS water surfaces were created by triangulating between upstream and downstream cross sections, and intersecting them with the digital elevation model, across the range of probabilities modelled.

The flood forecasting tool within waterRIDE FLOOD Manager was used to interpolate an approximation to the actual flood surface using the recorded peak level at gauges along the Brisbane River and the "library" of design flood surfaces. The tool selects the two surfaces from the library that are immediately above and below the gauge level and uses the relative ratio between these surfaces and the gauge level to interpolate a surface across the entire modelled area.

For reference, the surface was assumed to represent Brisbane River flooding only, with constant backwater automatically applied along smaller tributaries. This approach yielded a surface that matched flood extents along the Brisbane River to within "half a house" for the areas extending from Moreton Bay to the confluence with the Bremer River (the upstream limit of available modelling).

Figure 1 shows an aerial image captured by NearMap just after the peak of the flood in Brisbane. The floodwaters can be clearly seen along with "mud marks" on roads where floodwaters had receded. Figure 2 shows the same aerial image overlaid with the re-created flood surface. As can be seen, there is very close agreement between the re-created surface and the actual flood extent.

Figure 1 – Aerial Image captured just after the peak of the flood – Source: NearMap.

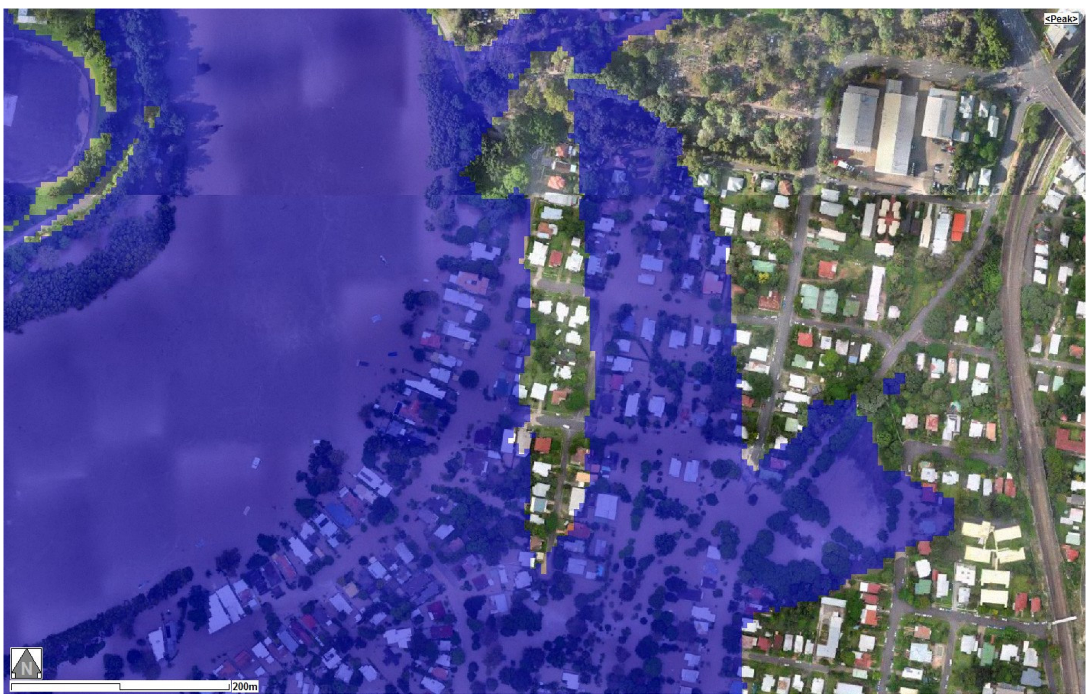

Figure 2 – Re-created flood surface extent from waterRIDE FLOOD Manager.

This surface allowed the insurance industry to readily determine the likely flood depth at any property from a "Brisbane River flooding only" perspective. Such information allowed insurers to rapidly process claims where inundation of the property was clearly caused by Brisbane River flooding only, where depths were too great, or floor levels too high to be affected by "storm" inundation.

Flood Insurance

The media reported significant public anger, frustration and confusion as to why some insurers were paying claims and others were not. There were also many reports of claimants who purchased their policy under the impression that they were covered, only to find out that their claims were denied.

In response to such reports, the Government commenced an investigation into making it mandatory for all insurers to offer "flood insurance". Whilst the *National Flood Insurance Database* (NFID) provides access to flood risk profiles calculated from the results of formal flood studies across Australia, the coverage of this database varies between states, and is almost exclusively limited to *mainstream* flooding only.

In order to offer flood insurance, insurers must understand their exposure, and be able to price the risk accordingly. Given the "gaps" in the NFID, a novel approach for generating *indicative* flood surfaces was created for the industry, by using a tool known as *GridFlow*. The approach expanded on the earlier work of *McConnell et al (2011)*[1] and was designed to provide indicative flood depths across a range of probabilities using a DEM, probabilistic rainfall intensities, the Rational Method, and Manning's equation.

At any location on the DEM, the upstream catchment can be determined from a simple flow accumulation analysis. This involves determining the number of upstream cells passing through a cell by tracing the path that a "drop" of water placed in each cell would follow. Combined with the Rational Method, this provides a flow rate which can be used with Manning's equation and a backwater profile to determine indicative flood depths across an entire catchment.

This approach provides an indication of both traditional "mainstream flooding" risk and "overland flooding" risk, which is less commonly understood. The approach was designed to be used to rapidly identify indicative flood risk country-wide. *McConnell et al (2011)*[1] found that this approach provided a reasonable match to more rigorous 2D modelling, provided the DEM delivered a good representation of actual ground levels, and provided the cross sections used in the analysis were sufficiently spaced to define hydraulically significant changes in channel dimensions and slope.

This approach provided insurers with a consistent means with which to price flood risk, especially in areas where the NFID does not provide coverage.

Key Learnings

Due to the massive number of claims that required assessment, the events following the January 2011 flood established the importance of determining the distinction between the timing of any initial stormwater inundation versus the timing of ultimate flooding. It also established the importance of identifying the contribution of local catchment stormwater runoff to peak flood levels. The shape of the Brisbane river (high banks with lower floodplain areas), particularly in urban areas around the CBD led to an interesting mechanism for floodplain inundation.

Many claimants noted that prior to inundation, water was “bubbling” out of stormwater drains before the river had broken its banks (if indeed it did break its banks). To the claimant, this appeared to be stormwater flooding as the water (sometimes clean) was coming from the stormwater system. In most cases, such surcharging was caused by waters in the river flowing back up the stormwater system.

Adding to the confusion was the perception held by many claimants that this water, at least initially, was “clean”. This was likely a result of local catchment flows being pushed “back up” the stormwater system. Ultimate inundation, as reflected by mud-marks on walls and vegetation was evidently by “dirty” water.

It was important to confirm the levels that the volume of local rainfall would reach in such “basins” on the floodplain, versus the actual flood peak reached. This was usually confirmed by also comparing the peak water surface along the river at the location of the stormwater outlet with the approximate peak flood level measured at the property in the field.

In some situations, the likely cause of inundation of the property resulted from river or creek flooding that originated well away from the property. Identifying the cause of inundation at each property usually involved looking well beyond the immediate vicinity of the site. During the course of property inspections, the lack of understanding of general flood behaviour in some of the community became evident. Many claimants were adamant that the observed flooding could not have been caused by the river as it “was a long way away”, or couldn’t “even be seen” from their property, or “there was high/dry ground between the river and my property”.

The magnitude of “flood affectation” in certain areas provided some insight into the social and emotional impacts of “large floods”. During the site inspection process, many claimants commented that the flood “had changed their lives”. Some were looking to move prior to the flood but were now concerned that their property had become “unsellable”. Others had experienced the 1974 floods and were shocked at being flooded again, in under 40 years. Others were quite emotional when speaking about the event and the personal, irreplaceable items that they had lost. In some cases claimants said that they would be unable to afford to rebuild, and were waiting in angst to determine if their claims on their insurance policy would be paid.

Conclusion

The January 2011 flooding in Brisbane resulted in widespread damage and social disruption. The insurance industry responded rapidly to determine the cause of inundation at claimants properties and to process claims.

A range of new approaches were applied to improve the efficiency of the claims assessment process and, in particular, in terms of identifying the cause of inundation. These new approaches led to the development of new tools to assist in quantifying flood risk in areas where no information currently exists. These tools were shown to generate reliable flood surface mapping that facilitated more efficient assessment of the cause of flooding, and more rapid response to insurance claims.

References

[1] McConnell, D, Druery, C (2011), *A Rapid Approach to Modelling Overland Flood Risk,* Proc. 2011 IAHR Conference, Brisbane, Australia.