Risk Frontiers’ Australian Bushfire Loss Model

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In the history of natural disasters in Australia, bushfires abound, each perceived as being of an “unprecedented” magnitude by contemporary witnesses. Unlike the recent 2009 Black Saturday fires in Victoria, earlier iconic events -- the 1939 Black Friday fires in Victoria, the 1967 Hobart Fires in Tasmania and the 1983 Ash Wednesday Fires in Victoria and South Australia -- all occurred before catastrophe loss modeling had become common currency in the insurance industry.

Risk Frontiers was created in 1994 to foster amongst other things the development of Australian catastrophe (CAT) loss models. Early fruits came with the release of the first Australian Hail loss model, HailAUS, now up to version 6.1, soon to be followed by models for earthquake (QuakeAUS) and tropical cyclone (CyclAUS). At the time of 2009’s Black Saturday fires, a bushfire loss model had been on Risk Frontier's R&D agenda for many years.

Early on Risk Frontiers realized that historical data was key to improving our understanding of natural hazards in this country. With industry support, Risk Frontiers directed its efforts towards developing PerilAUS, a database of historical natural disasters, descriptions and data gleaned from newspapers and primary information sources such as police, coronial and other official reports. The PerilAUS database is now managed by a full time archivist, Lucinda Coates, and is considered the most complete of its kind in Australia. The first written record of an Australian bushfire, for example, comes from Abel Tasman's log in 1644.

Risk Frontiers’ growing analytical capabilities in the early 2000s led to detailed analyses by my colleagues, Keping Chen and John McAneney, of the 2003 Canberra bushfires and a review of earlier fire losses: the 1983 Ash Wednesday fires, the 1994 Como-Jannali fires and the 1967 Hobart fires that had been already studied by the researchers at Aon. This work resulted in landmark publications that quantified and documented the vulnerability of a property to bushfires as a function of its distance to the forest boundary. This was soon followed by a national spatial analysis exercise by Keping that quantified the vulnerability for every single address.

Further research was undertaken by Ryan Crompton and others in adjusting the recorded historical bushfire losses to take account of societal and demographic changes over the last 100 years. When corrected for changes in exposure, bushfire damage in terms of the number of destroyed buildings appears remarkably stable over time. This suggests that the growth of exposure has been the main driver for increasing numbers of properties lost in bushfires.

By 2009, Risk Frontiers had a wealth of data and supporting research on bushfires so that a catastrophe loss model seemed within easy reach. But, unlike earthquake or tropical cyclone, bushfire behaviour is even more difficult to model.

Fire spread is complicated: the turbulent fire front evolves according to governing equations that are not well-understood, is highly sensitive to localized conditions such as sudden wind changes and may be influenced by human intervention through arson, back burning or fire fighting.

In short, predicting fire behaviour for a particular event is difficult. To perform a CAT-model-like simulation for many events over a long time interval is as impossible as it is pointless. Some have attempted to assign random variables to ignition locations and wind directions and other unknowable quantities but, without being informed by empirical data, such models easily become a convoluted way of stating that fires may occur any day, anywhere.
Shortly after the 2009 Black Saturday fires, Risk Frontiers started the development of the first Australian Bushfire loss model: FireAUS. The constraints on bushfire behaviour were clear from the beginning: fire propagation models were considered and discarded as unverifiable and which, if relied upon, would quickly turn any model into nothing better than a random number generator. Moreover, it would be pointless to use a highly contrived model while ignoring the wealth of high-quality data available in PerilAUS. On the other hand, using historical data alone in a purely statistical approach would not be much better than the actuarial calculations already used by insurers. An innovative approach was needed.

The insight that CAT models are statistical, not physical, representations was fundamental to the successful development of FireAUS. The ground motion component of an earthquake model, for example, is a statistical model in which probabilities of ground shaking at a distance are conditioned by the physics of wave propagation. This simple principle is easily forgotten if models are viewed as oracles, but being conscious of it releases us from the necessity of a physical model when data provide a better guide to reality. This is the case with bushfire. As a result, Risk Frontiers’ bushfire loss model was conceived as an experiential model where probabilities are informed by empirical evidence.

FireAUS exploits all data and knowledge developed by Risk Frontiers, including information in PerilAUS on some 12,000 homes destroyed since 1900. First, this historical data was used to quantify where and with what probability bushfire loss events have occurred. This required an extensive analysis of the PerilAUS database to smooth and explore temporal clusters of events in order to define events within reinsurance hours clauses: for example, locations over 2000 km apart which burned in the same week have been observed historically in time windows of up to 10 days for a fair number of fires in NSW and WA. The last case recorded of such contemporaneous fires was the Quorrobolong (NSW) and Roleystone (WA) fires, both on 4th February 2011!

The next step was to quantify the probability of damage. Once again, we took advantage of a wealth of data and supporting research. We assumed that properties are burned randomly in a bushfire, this being clear from our post-event surveys where we observed, for example, that neighboring homes are not always equally impacted by the fire front. Such behavior is not captured if we were to model fire propagation as fire footprints and, more particularly, damage footprints are generally not regular ellipses. Instead, the best predictor of bushfire vulnerability is distance of buildings from the bushland interface together with the local probability of an event loss.

In this way FireAUS builds up a stochastic event simulation that results in a synthetic event catalog of bushfire event losses for which damage has been calculated probabilistically.

FireAUS was released in March 2010. It’s the result of over 20 years of research by Risk Frontiers: efforts that have been supported by Risk Frontiers’ sponsors: IAG, Suncorp, QBE, Guy Carpenter, Aon Benfield, ARPC and Swiss Re. FireAUS Version 2.0 was released in August 2013.
As a survey of damage to buildings, property and infrastructure in the Marlborough region was carried out over two days by means of drive-through inspection of the greater region with more detailed inspection of areas/buildings deemed to be most significantly damaged. Blenheim, Seddon and Ward were surveyed as well as the epicentre at Lake Grassmere. Here we focus on impacts to the wine sector, the major industry in the region and producing approximately 70% of New Zealand’s wine by volume.

Most of the damage observed and reported by the wineries was to the wine vats and barrels holding product. The loss of product is a sensitive issue as it can affect product sales, so most winemakers were reluctant to give an estimate of the amount of wine lost. Reports suggest the loss of wine was insignificant on a regional/national level, although this loss was not uniformly distributed, and the losses at some wineries may have a significant impact.

Wine vats vary in size from 30 000 to 300 000 litres and are made of thin stainless steel. For the large scale producers tanks are usually stored together in ‘tank farms’, the largest being hundreds of metres in size. Depending on the size and design of these tanks, they were either bolted to the floor on concrete plinths or free standing on legs (Figure 1). After the July 2013 Cook Strait earthquake, some wineries began to strengthen legs of the wine vats by welding struts between the legs. Other companies with bottling plants in Auckland began shipping wine out earlier than normal to reduce the amount of wine stored in the region.

Damage to the wine vats was variable; however most damage was reported to be sustained in wineries closer to the epicentre of the earthquake. In a number of cases seismic bolts that kept vats secured to the floor failed due to the tensile stresses and either broke or suffered significant plastic deformation. Freestanding vats appeared to be the most damaged, with the legs buckling under the weight and movement of the vats (Figure 2).

Less damage was reported for barrel stored wine, with the wineries we spoke to reporting losing no more than 12 barrels. The loss of barrels was strongly correlated with the storage method; two wineries using ‘earthquake proof’ barrel racks reported no loss of barrels during the earthquake. The older, traditional style of barrel storage was not as secure as more modern storage methods, with many barrels lost when stored using this method (Figure 3).

After the earthquake, power was lost to most wineries for at least 2 hours. This complicated recovery efforts to pump wine from damaged vats into undamaged empty vats. Another complication to the recovery effort was damage to the access gantries running along the top and between the vats, making access impossible or unsafe. A large concern for grower groups and certain wineries were the workplace health and safety issues during aftershocks while product was still being moved between vats.

From a risk management perspective, approaches to risk reduction varied between wineries. Some were confident in their procedures and had made no changes following the July Cook Strait event. Most wineries visited had made some attempts at risk reduction; common examples were to strengthen vat footings, anchor wine racks to walls or ship wine out earlier for bottling in other locations. Winery
managers, industry experts and leaders tended to agree that the damage could have been much more significant if it had occurred at different stages of the winemaking cycle. During harvest, resulting loss of power would lead to an almost total loss of product, and the effect of sloshing in half full vats could have caused more widespread and significant vat damage. In August, vats are generally full or empty, which would have reduced the effect of sloshing within the vats.

From a long term impact point of view, industry representatives were concerned about the damage to housing within Seddon and Ward, which is used to house temporary labour needed during peak seasons. The other concern was the requirement for a large number of vats to be inspected for structural damage before the grapes are harvested next.

Figure 3. Traditional style wine barrel racks (top) and an example of modern, more secure wine racking system (bottom).

Wednesday 30th October, 2013
at the Museum of Sydney, Cnr Bridge & Phillip Streets, Sydney
2.00pm until 4.40pm followed by light refreshments

Provisional Programme

1. Prof. Mary Comerio (University of California, Berkeley) will speak about measures of performance suggested by the recovery experience in both developed and developing countries and engineering challenges to resilience identified after recent earthquakes.

2. Felipe Dimer de Oliveira (Risk Frontiers): Updated FireAUS V2.0 and field validations

3. Foster Langbein (Risk Frontiers): a progress update on RMS (one)

4. Katharine Haynes (Risk Frontiers): The L’Aquila saga and trial

5. Prof. Vijay Varadharajan (Professor of Computing at Macquarie University): cyber terrorism (to be confirmed)

Registration forms can be found on our website: www.riskfrontiers.com.