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Fit For Disaster

A guide for actuaries supporting management of general insurance business in the face of inevitable natural disasters

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Abstract

This paper highlights the important role that actuaries can play in helping insurers prepare for and optimise financial decisions in the face of inevitable natural disasters.

By focusing on some key questions that actuaries are asked during and after the panic and confusion of a natural disaster, we examine general principles that are useful for those working in this field. Topics include the understanding of exposures, reserving, reinsurance, pricing, and sustainability. Examples from Cyclone Larry have been used to demonstrate these principles. The principles have been reinforced by examining some of the learnings from significant events in New Zealand like the recent flooding in Manawatu, Matata and Queenstown.

Over the last 3 decades, a natural disaster costing in excess of $200 million has hit Australia or New Zealand every couple of years. Although the insurance industry has managed these events well from a customer perspective, there is still room for improvement in insurers' internal disaster management processes. Indeed, if current predictions regarding climate change hold true, we can expect either more frequent or more severe natural disasters in the future, reinforcing the need to be well prepared.

The material covered in this paper will help actuaries identify and consider issues before disasters hit. The proactive approach will enable them to counsel and support insurers who manage catastrophic risk, particularly during the challenging and often chaotic period immediately after an event.

1.1 Purpose

Benjamin Franklin (1817) is well remembered for saying

"In this world nothing can be said to be certain, except death and taxes."

We would suggest that this list should also include natural disasters. It appears that we may have been lucky down south over the last 15 years, with only a few natural disasters having a significant financial impact. The last 40 years would suggest a disaster costing in excess of $200 million hits Australia or New Zealand on average every two years. The insurance industry provides an extremely valuable natural disaster risk transfer mechanism and has serviced customer needs effectively in the past; however it can at times be surprised by events (it is one thing to know it could occur, but another to know when and where) and is therefore not always fully prepared to deal with the situation.

In this paper, we seek to

1) explore the important role that the actuary has in providing support to an insurer managing inevitable natural disasters.
2) discuss some of the principles that can help an actuary provide this support.

The role of the actuary in disaster management is many and varied, ranging from reserve estimation, pricing, strategy, claims reporting, Approved Actuary and risk management responsibilities to providing help to teams under strain.

1.2 About the Authors

The authors have quite different responsibilities, backgrounds and involvement in disaster management as actuaries for IAG, but all have a Commercial insurance focus.

Laurence O'Neill – Commercial Short Tail Research Manager for CGU/IAG

Responsible for:
→ reserve estimation and consolidation of claims reporting for Cyclone Larry
→ statistical pricing and strategic advice for natural peril cover on Commercial portfolios. This included in the field building structure vulnerability research immediately following Cyclone Larry impact.

David Traill - Commercial Pricing Manager for IAG New Zealand.

Responsible for:
→ reserve estimation in Manawatu, Matata and Queenstown events, including providing "in the field" assistance to claims teams
→ pricing and strategic advice for natural peril cover on Commercial portfolios.
→ development of IAG NZ premium liabilities modelling process including catastrophic event assumptions.

Andrew Matthews - Commercial Head Actuary for CGU/IAG

Responsible for:
→ Managing a team with responsibility of providing decision support to optimise success and the meeting of our financial promises for the long term. This has included considerations relating to natural perils in respect of pricing, reinsurance capital management and reserving for events like the 1999 Sydney hailstorm, the 2006 Cyclone Larry and range of other natural perils.

The views presented in the paper do not represent the views of the Insurance Australia Group, but rather the attitudes and ideas of the authors themselves.

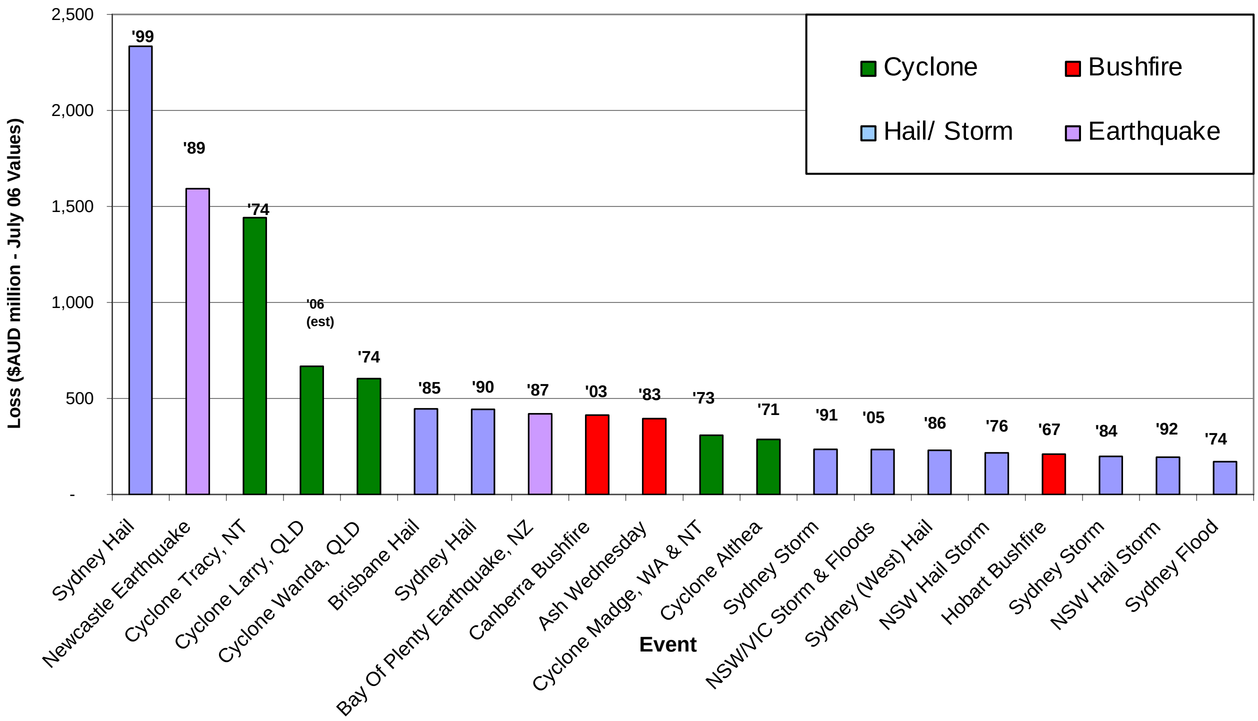
1.3 Context

This paper was sparked by a comment from Morgan Stanley Research in a 25th August 2006 investor briefing pack:

"… natural catastrophes in Australia that give rise to claims in excess of A$200m are reasonably frequent … we are puzzled why the insurers continue to refer to A$200m~A$300m events as though they are infrequent occurrences."

Firstly we investigated the veracity of this statement about disaster frequency by gathering historical event data from the Insurance Disaster Response Organisation and the Insurance Council of New Zealand. These losses were inflated to 1 July 2006 values in line with changes in Australian AWE figures. The largest 20 insurance disasters can be seen below.

Figure 1 – Top 20 Insurance Disasters in Australia and New Zealand since 1965



Source: Insurance Disaster Response Organisation and Insurance Council of New Zealand, August 2006.

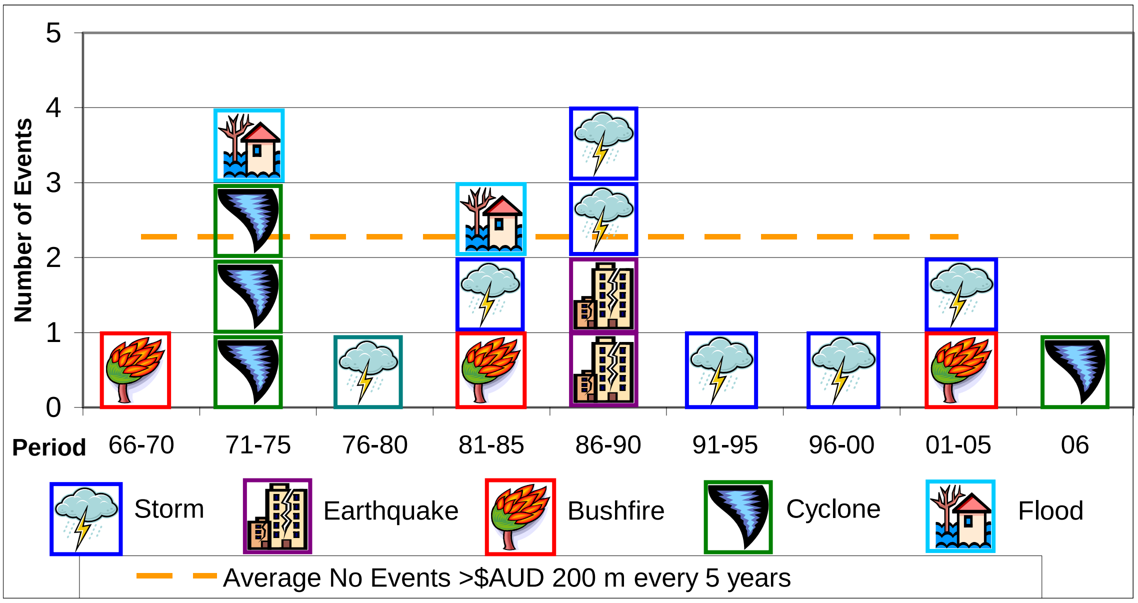
It should be noted that a limitation of using AWE to inflate losses is that it ignores changes in exposure driven by changes in wealth, population and building construction standards and therefore generally underestimates the likely cost of these events if they were to reoccur. It is commonly thought that the cost of a magnitude 5.6 earthquake hitting Newcastle again would cost somewhere closer to $4 billion.

We noted that the 20 largest insurance disasters have all been natural event disasters such as hail or wind storm, cyclone, bushfire or earthquake. The April 1999 Sydney Hail event was the largest, costing the insurance industry $2.3 billion in July 06 values. The 1987 Bay of Plenty Earthquake was the 8th largest event with a July 06 cost equivalent of NZ$490 million.

To put this in perspective, a $500 million loss on Australian property portfolios (which would be the 6th largest loss) would result in an approximate increase of 8% in the annual emerging property gross loss ratios nationally. Figures are based on $6.1 billion gross written premium for property portfolios in the 12 months to December 2005 (source Table 7, APRA December 2005 half yearly bulletin). An equivalent impact on emerging loss ratios in New Zealand would require a NZ$110 million loss (the equivalent of the Manawatu Floods). Figures are based on $1.4 billion gross written premium for property portfolios in the 12 month period to June 2006 (source June 06 ICNZ data with 10% loading for QBE which is not an ICNZ member). Earthquake premium makes up approximately 16% of the property portfolios, and has been included in the estimate above.

Since 1990, there have been relatively few catastrophes in Australia and New Zealand. One interpretation is to consider this a benign natural disaster period. To some extent benign periods can lull insurers into a false sense of security that natural disasters are a rare occurrence. However, Figure 2 shows that over the last 40 years, between Australia and New Zealand the insurance industry has averaged almost one $200 million natural disaster loss every two years (or 2.3 events every 5 years).

Figure 2 – Historical Natural Disasters in Australia and New Zealand



A disaster provides an insurer with a great opportunity. By demonstrating commitment to policyholders and claimants in times of need and presenting a strong, united and composed message to external stakeholders, it is possible for an insurer to create one of its most memorable and successful customer and investor marketing campaigns.

Unfortunately, at times, insurers and investors can become preoccupied with the search for an explanation as to why the loss occurred or why the loss was so large. Disasters often become a burden for many stakeholders and distract from the immediate (and possibly more crucial) portfolio management and strategic issues for a long time after they occur. For example, product managers and executives may find themselves getting bogged down in the aftermath and miss emerging portfolio trends. An insurer that can deal with the event in an efficient and consistent manner will be much better placed.

Due to the complex, and at times quite technical, nature of disaster risk, we see the actuary as fundamental in providing senior management and executives with the advice required to make the optimal financial decisions in relation to managing that risk. Actuaries in an organisation are affected by disasters in a multitude of ways, from reserving, technical risk based pricing, pricing and product strategy, creation of data assets, reinsurance strategy, claims reporting, exposure monitoring, to policy submissions on the impact of climate change and helping to reduce risk in the community.

There are many stakeholders involved in an insurer's preparation for, or response to, a disaster. These include policyholders, market analysts, distribution heads, claims staff, reinsurers, regulatory and industry bodies, product and underwriting managers, executives, communications, finance, treasury and the public at large. Each of these stakeholders may have differing and often conflicting needs, agendas and opinions. Providing unbiased and independent advice on many of the issues that arise is a challenge for any actuary.

Natural disasters are inevitable and with increased regulation and public scrutiny over insurers' actions there is an even greater need for independent and objective advice on many of the related issues. This paper is intended to provide some support to actuaries operating in this field in order to optimise the insurer's response when a disaster occurs.

1.4 Structure of the paper

The core actuarial functions in relation to the management of catastrophic risk include:

1) Exposure Monitoring and Management Information
2) Reserving
3) Pricing
4) Reinsurance and Capital

In this paper, we highlight many of the practical issues and obstacles that only come to light when seeking to perform these functions following a significant disaster.

This paper seeks to consolidate our learnings into a set of key principles that can be used to support actuaries providing advice prior to, and following, future natural disasters. In doing also we provide a discussion on where actuaries can play a lead role in issues for the greater good of the community, such as the long term sustainability of insurance as a means of providing risk transfer for natural disasters.

Best practice requires that insurers take a proactive approach to disaster management, and as such, this paper aims to help facilitate a more proactive management style. It would seem, however, that many insurers find themselves first thinking about many of the issues that crop up, only once a disaster has occurred.

The paper uses the Cyclone Larry impact as a disaster example and follows a chronological approach, starting at the time of first notification of the event, to explore the questions and demands from key stakeholders, and discussing the key principles that emerged through this process. Questions arose from many areas of the business in three distinct phases (the Initial Shock, Clean-up and Disclosure and Post-Event Review). We have structured the paper in line with these phases in our discussion of questions, for example:

> The Initial Shock (Section 2) - "*What is our exposure?*", "*How much will it cost?*" and *"What will be the claims volumes?"* when trying to gain an initial understanding of the financial impact and tailor a claims response.
>
> Clean-up and Disclosure (Section 3) - "*How will we reserve for it?"* from a claims estimation and provision setting regard, and
>
> Post-Event Review (Section 4) - "*Are we adequately priced for cyclone risk?*", "*Should we change our reinsurance program?*" and "*Is climate change having an impact on cyclone frequencies?*"

Although the paper makes use of several examples from Cyclone Larry, we have also incorporated learnings from Sydney Hail, and other New Zealand events such as the Manawatu, Matata and Queenstown floods.

To the authors' knowledge, this is the first paper that attempts to highlight many of the practical issues that may not be on an actuary's radar when providing support to insurers following natural disasters. The intention is not to discuss the issues in depth, but rather to raise them to provide a starting point for further discussion.

We begin with the questions an actuary faces on the first notification of an imminent event impact.

2 The Shock – An event occurs

"Your practice is fit for calm, but is it fit for disturbance?" - (Zen saying)

The Shock refers to the period when the event is imminent or has just occurred. This is a time of heightened anxiety and uncertainty, in which the impact of the event on the insurer remains unclear. The insurer's processes may work very well on a month to month basis, but when a catastrophe hits an organisation's process is pushed to the limit, with those better prepared for disturbances coming out on top.

A number of questions will be asked of the actuary during this period. For example, the CEO, the Board or the stock market for a listed company may urgently want to know:

- What is our exposure?
- How much will it cost? What is the likely range?
- Are we reinsured? Will we hit our retention?
- Where are we hit the worst?
- Can you provide a brief for each stakeholder (management, executives, claims, finance)?

At the same time the Claims teams want to know:

- Can you tell us where our policyholders are located?
- What are the likely claims volumes? What is extent of damage?
- Can you help us with claim reporting?

The Shock reveals areas of process that are not quite up to scratch. In this section we discuss some of the issues likely to be faced following an event shock and highlight the three key principles we believe are crucial to providing appropriate and timely advice to an insurer. They are:

Principle 1 – Understand your Exposures

Principle 2 – Put Frameworks in Place to Assess the Size and Location of Potential Losses

Principle 3 – Understand your Operational Environment

We will now examine these principles in more detail. Where appropriate, we will use recent Cyclone Larry experience as an example.

Principle 1: Understand your Exposures

Acquiring a complete grasp of an organisation's exposures and associated risks is a complex task. It assists not only in managing natural disasters but can aid in many areas of insurance management (such as monitoring growth in key areas and identifying where competitors may be focusing) It is worth considering each of the following:

Measure	- e.g. Count (by policy or risk location) and Value (sum insured or number of hectares)
Granularity	- the detail to which each risk is identified, i.e. is location at a ICA/Cresta zone, postcode, town, street address or latitude/longitude geo-code? Can exposures also be split by portfolio type, age and material of construction, etc.?
Completeness	- all exposure information from subsidiaries, schemes/facilities and bulk processing sources are integrated together with nothing missing
Consistency	- standard measures and granularity across all exposure information
Accessibility	- readily available exposure information can be gathered and dissected to the required level
Accuracy	- data needs to be up to date. Current active policies are ideal.
Extent of exposure	- policy wording, terms and conditions and limits

In light of these considerations, the following discussion highlights some of the key issues that can arise when trying to understand exposure.

Beware Bulk Processing - The issue of bulk processing of exposure records for schemes and facilities, especially for Intermediary based insurers that have a large amount of their policy processing completed by the brokers themselves, can be a significant problem. Two common problems are: i) that brokers' systems may not capture, or easily facilitate data upload at an individual policy or risk level, and as such most of the rating information is lost (building types and rate factors), and ii) exposures transferred to the insurer's system can be all coded with location in the closest capital city, rather than their actual location.

A central repository for exposure monitoring is a necessary risk management tool. For large parent companies there can be a significant number of different data sources from subsidiary companies, schemes and facilities. Exposures from one or more sources can easily be missed with poor decisions then being made from incorrect or inadequate information. It can be useful to set up a process that regularly feeds exposure data from each source into a central database that is at a consistent level of detail and has the flexibility to be accessed by a range of tools. Many insurers are now utilising a range of flexible Geographic Information Systems to analyse exposure accumulations and optimise reinsurance and strategic decisions.

Proactive claims service. It is quite possible to use geo-coded risk information immediately following an event to plot out the exact location of all insured risks so that the claims team can determine their optimal service route and possibly go straight to policyholders rather than waiting until claims have been lodged. This is a great service that can be offered because often following a disaster communications can be extremely limited – with radio being the only means.

Granularity of location provides ability to assess risk. Due to potential impact from storm-surge from Cyclone Larry we were asked "*how many ocean fronting risks do we have in the cyclone region?*". The risk of natural perils such as flood and storm surge is highly sensitive to the exact location of risk. A few hundred meters along one street can be the difference between no flood or surge risk and a 1 in 20 year event risk with a significant claim following an event. Techniques such as geo-blocking which group exposures in very small grid squares are becoming more common practice. It is also becoming common for insurers in the US to refuse to write business if the insured cannot provide them with full address details (and geo-code) for every location. This data enables them to accurately monitor concentration risk in high regions and halt growth or reduce exposure where appropriate.

Gathering highly granular exposure data on a number of risk factors can be very cost effective. In the US, most insurance companies geo-code their home insurance policies; they collect data in Florida on year of construction, foundation type, floor covering, wall type, roof type and shape (hip vs gable), roof deck attachment, roof to wall restraints (clips), opening protection (shutters), secondary water resistance, number of stories, size of living area, and details on outhouses / structures other than the main residence. When the 04/05 hurricanes hit, those companies who fared better were those who collected and used more data. Anecdotal reports suggest that one insurer made a return on investment of 500% for the cost of collecting this data due superior risk selection.

Be realistic about what you are covering. It is one thing to have a measure of exposure, but does the insurer have clarity over what events they are actually covering? When will they pay? Are policyholders fully aware of what they are not covered for? Or will the public pressure result in them paying out on events that were excluded from the contractual agreement and therefore not priced or managed? It is crucial that the organisation decide in advance how it will react under a range of different scenarios.

Problems with Rural Regions/Zones. Cresta zones in New Zealand originate from the regional areas that each provincial rugby union team can source players from. This meant that rural zones (ie. those outside metropolitan cities) can cover vast regions. A good example is the Waikato zone, where large towns and cities (like Hamilton) are combined with a significant amount of rural land into one Cresta zone. Reliable exposure monitoring and potential loss estimation for these regions is particularly challenging. For instance, a geocoding on farm is still not adequate to assess the flood risk on the 5 different buildings that could be anywhere in the many acres of the farm.

Principle 2: Frameworks to assess the size and location of potential losses

With a clear understanding of the exposures, the next step is to evaluate losses resulting from a current or potential event.

The task of forming a view of the likely cost of an event prior to impact can be quite challenging. The varying physical nature (intensity, track, shape, decay rate and diameter), local topography and shielding alone make the central loss estimate extremely uncertain. Also, it generally takes several months for the scientific community to agree on the exact force and spread of the event. Providing the range around a central estimate is crucial. It is very difficult to translate exposure at ICA/Cresta zone into a reasonable estimate of the likelihood and cost of a potential event. Events may hit 5% of one Cresta zone or affect 5 different Cresta zones.

Although the underlying techniques of some of these calculations can be quite sophisticated, a simple framework can be put in place for assessing potential losses. The table below presents an overview of a possible framework and Appendix 4 shows an example of it could be used to estimate the impact of an event given no information on factors such as vulnerability curves.

Table 1: Framework for Assessing Size of Loss and Average Annual Loss in a given region

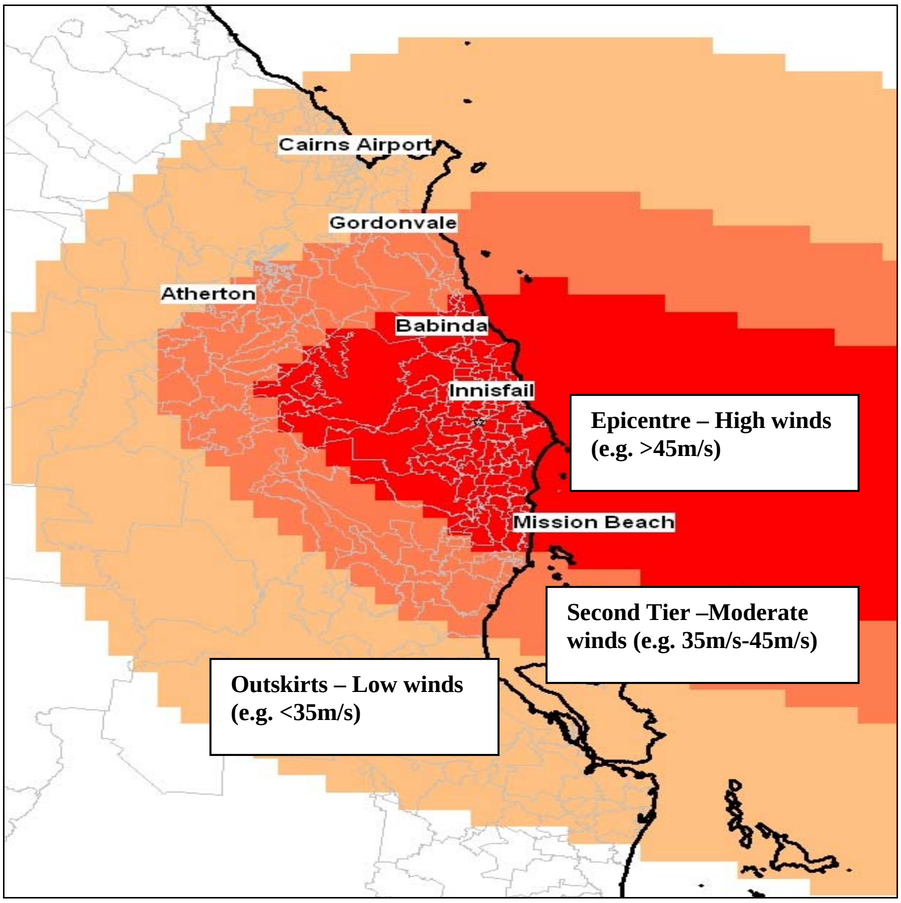
	Event Severity Region			
	Epicentre	Second Tier	Outskirt	Total
Number of Risks	500	300	400	1,200
Sum Insured ($M)	700	300	300	1,300
Average Sum Insured (000's)	1,400	1,000	750	1,083
Approx Damage Ratio	37.30%	8.30%	2.90%	22.60%
Approx Claim Frequency	95.00%	60.00%	30.00%	64.60%
# of Claims	475	180	120	775
Average Claim Size	548,947	138,167	71,500	379,613
Size of Loss ($M)	260.8	24.9	8.6	294.2

The most flexible and powerful means of filling in assumptions to this framework is by building a full peril risk model internally (including event hazard sets, simulation model and vulnerability curves). Obviously this can be very costly. One alternative is to make use of available external catastrophe models such as RMS, EQECAT or SEA where models exist for the required peril. This is common practice for many insurers.

Following initial warning of the Cyclone Larry impact, we wanted to determine an indicative estimate of the likely loss. One approach was to run a simulated event (with the physical characteristics advised by the Bureau of Meteorology) through the region and all exposures for which we had geo-code level data and had already developed vulnerability curves. Cyclonic wind damage vulnerability curves provide the link between wind speed and average loss as a proportion of the sum insured. For the remainder of the exposures where postcode level was the best detail available, we isolated the key impacted postcodes and formed a rough view of the damageability of assets in each region. The second approach provided quite uncertain estimates, primarily because one or two days is not enough time build a fit for purpose exposure based estimation model. This model could have been set up a long time in advance.

This was the driver for us to consider a more basic alternative if no access was possible to external information or exposure information was of differing granularity. The approach is to create a set of loss band assumptions for the event for different regions affected. It focused on 3 types of affected region: epicentre regions (those hit directly), second tier regions (those in close proximity to the worst affected areas) and outskirt regions (those still affected but more distant from the main damage). Figure 3 shows an example of how the region impacted by Cyclone Larry could be broken down using this framework. Like all exposure based models there is a huge degree of variability, however sensitivity testing your assumptions can help you to be clear on how uncertain your initial estimate may be and may allow you to present a view on some possible outcomes. Appendix 2 has been included as a working example of how an insurer may go through the process of quantifying an estimate of incurred cost for a large cyclone hitting New Zealand's Bay of Plenty.

Figure 3: Possible Severity Regions for Cyclone Larry



To increase the chance of providing reliable potential loss assessment advice with quick turn around, without the cost of building an internal model, it is worth considering the following:

- identifying all key natural peril risk regions
- keeping up to date exposure measures (risk numbers and sum insured for each region by key portfolio types)
- developing a set of event claim frequency, average claim size or damageability assumptions for each key portfolio type for each severity region (Epicentre, Second Tier, Outskirt) or for a range of likely events in key geographic areas (for example Category 3,4 or 5 Cyclones hitting Bay of Plenty).
- different peril types will have very different geographic damage profiles. For instance bushfires are generally localised with most risks in the clearly identified region either being affected or not affected, whereas the ash from volcanic eruptions can cause significant amounts of damage to risks hundreds of miles away.

If this information is maintained for each key natural peril type, an exposure based central loss estimate can be developed given the attributes of an event. By also recording a variation parameter due to the uncertainty of the assumption, you can also determine a loss estimate range for any event. Unfortunately, these parameters are very difficult to acquire. They are generally formed by either re-running catastrophe models with varying assumption scenarios or relying on the range of estimates provided by a few different catastrophe models.

To take this framework one step further so that it provides an indication of the average annual loss, the annual probability of a likely range of events is also required. The same comments as above apply for forming these assumptions, however, the underlying atmospheric, terrain or tectonic plate modelling required falls more into the realms of scientific research than financial modelling.

In any case, once developed this exposure based framework can be very powerful and used to assist

- assessment of likely cost of imminent or possible event (or very prompt assessment of impact after an event)
- likely claim numbers from an event in each region, facilitating claims team briefings
- monitoring of accumulations and exposure to catastrophes
- assessment of capital requirements and allocations
- risk based technical pricing and pricing strategy
- reinsurance pricing, structure and strategy
- growth/withdrawal strategy

Note that we have made no mention of the impact of post-event demand surge that results in higher prices for labour and material following an impact. The implicit assumption is that damage ratios include an allowance for post-event demand surge. In reality, most catastrophe models do not incorporate post-event inflation into vulnerability curves, but instead add it to the final calculation. This factor can have a significant impact on ultimate costs depending on the economic environment, geographic region and the size of the disaster. Following Cyclone Tracy, the cost of building nearly doubled, however there was very little demand surge following the Newcastle earthquakes due to a building recession in NSW at that time. Communicating the model limitations and confidence intervals with regards to post-event inflation and any other uncertainties are an integral component of the actuary’s advice.

Principle 3: Understand the Operational Environment

Following a disaster, executives and senior management need an estimate of the losses and an appreciation for the potential range of ultimate losses, uncertainties around the assumptions and any key risks. In order to provide a reliable view of ultimate costs, uncertainties and risks, it is sensible for the actuary get on top of all available information surrounding the operational environment, which includes the process and integrity of the claim management function.

Additional questions from the Claims Department were:

- Can you help us get a handle on claim numbers and claim costs?
- Do you know where we are being hit hardest (eg. by region)?

The following are some considerations that may assist in better understanding the Operational Environment:

Understand the claims assessment process. To deliver effective reserving advice the first step is to understand the claims assessment process and form a view on how the current event has affected the integrity of the claims data and process. This includes gaining a credible understanding of:

- The process used to move from claim lodgement, actual claims assessment, builders’ or repairers’ cost quotes, settlement and finalisation.

- The case estimation philosophy. Are claim estimates best estimates or conservative? Are the estimates based on phone calls with the insured, claims assessors' reports or the builders' job quotes?
- How the process is being centrally managed. Are the assessors keeping records off the system (paper or spreadsheets)?
- If data is being maintained off the standard system, then who is responsible for maintaining it? Who enters the claim data onto the spreadsheets? When does it get transferred to the system? How long is the delay? How reliable is the coding of the catastrophe flag (on spreadsheets and on the system)? What is the process for verifying accuracy of this flag?
- How many different sources of claim data are there (especially relevant for large insurers who may operate two or more insurance systems or have bulk loaded information provided from third parties)
- The contact responsible for data integrity at each source
- Monitoring of the number and size of claims as they move through the lodgement to finalisation process.
- What is the definition of the claim (one per policy, one per address location, one per building?). Consistency must be ensured.
- Monitor heterogeneous product types separately (eg. Personal Buildings/Contents Vs Commercial Property/Business Interruption) due to differences in average claim size, development patterns, and case estimation philosophy.
- How particular features of an event have affected the process, in particular
  - delays in registration due to the absence of phones/power in affected areas
  - delays in assessing due to lack of resources
  - delays in inputting data onto the system
  - post event inflation driven by additional demands for labour and materials and subsequent bad weather
  - any strategic/marketing initiatives like waiving or reducing excesses, increasing limits, and widening coverage due to public pressure
- It is also important to remember that claims teams also practise continuous improvement and it may be that new processes have been created after reviewing subsequent events, and that historical development patterns may no longer be relevant.

Keep in regular contact with the claims teams and build relationships. After an event has passed it is important to keep in close contact with the claims team for two main reasons:

- Firstly, these events tend not to develop in a uniform way and making the assumption that typical or average development patterns can be applied is dangerous. Without feedback on some of the unique features of an event from a claims officer's point of view, it may be difficult to build in the appropriate assumptions for the development of the event.
- Secondly, following a major disaster the political atmosphere within an insurance company can also heat up. Given this, it is important to have built relationships with individuals who are working at the coal face in order to get a clear understanding of the messages that the claims team's senior management may be passing on to other units (including your own) throughout the disaster. Sometimes the only way to develop these relationships is to go out and spend some time with the assessors.

Get out there. Along with giving you an opportunity to get to know some of the people who can give you different views of what is happening, getting out in the field with assessing teams gives you an opportunity to:

- *Establish pricing data asset*. Rare events provide invaluable data that facilitates research on the drivers of different building vulnerabilities from significant events and allows catastrophe model calibration. Assessors are generally too busy to collect the information you have asked for, or may not see its value, so it may be necessary to get out there and collect your own data. The day after Cyclone Larry hit, before debris was removed and tarpaulins erected, we conducted on site investigations of our policyholders' buildings. By photographing damage and noting structural weaknesses that led to damage and likely reasons for a lack of damage occurring, we created a powerful data asset where all claim costs were matched to individual exposure records in the region. This data asset has provided several calibration points for our internal cyclonic wind vulnerability curves for each portfolio.

- Get a *"scouts eye" view of the disaster zone*. Often it is hard to visualise how badly parts of a town were hit or why. Getting out there gives you a chance to observe factors which may not be recorded in your insurance system (like terrain or property maintenance issues). When creating any model of how much an event may have cost these observations may allow you to tailor your model more effectively based on unique factors affecting the disaster (eg developing a model that predicts what exposures were and were not affected)
- *Sell the importance of data integrity* to the claims team and assessors. They may not understand how it affects what you do as much as you expect.

Beware "File Clean-Ups". It is common to hear claims managers talk of significant "file clean-ups" that have occurred in order to help explain increasing reported claim costs. The actuary needs to be quite conscious that although claim managers may think that file estimates are unlikely to increase further, the cost development of historical events and the presence of post event inflation may suggest otherwise. The actuary needs to form his or her own view of where ultimate costs are likely to settle. It can be sensible to raise two reserve estimates: one that relies on advice from claims that no further increases in average claim sizes will occur and the other based on actuarial development patterns and judgement, with an explanation of why the numbers differ. Executives are then in a better position to make a call on what figure to adopt. It is also important to note that in the past file clean ups have also involved the closing and re-registering of some claims. This can affect any models you have of the total number of claims.

Reinsurers' requirements can easily be overlooked in a catastrophe. It is also very important to remember that reinsurers will also have information requirements. This can easily be overlooked in a catastrophe as an insurer focuses on being there for the customer. In general a reinsurer will typically look for a robust way to identify claims covered within the treaty and will want to get regular updates of the costs and development for their own modelling and analysis. Reinsurers may also want to perform a post event audit to ensure that only claims covered by the treaty were included, making it critical to ensure data quality from the outset.

Whilst catastrophe coding is now common practice, there have been instances in the past where a proportion of the claims from a catastrophe were identified by the date, type and location of the loss rather than the catastrophe identifier. Depending on your reinsurer there may be complications in getting these claims included under the reinsurance treaty, and likewise it is important not to jeopardise your relationship with reinsurers by accidentally including claims that should not be covered.

This makes it critical that an insurer understands what information reinsurers may require if an event exceeds the catastrophe deductible. There have been situations in the past where claims that have appeared to be valid have been subsequently thrown out of the pool once reinsurers have started to audit and validate the claims. Understanding a reinsurer's requirements and helping the claims team to integrate this into their processes is well worth the effort as the reinsurer may start their audit 3 – 6 months after an event, making revisiting claims a logistical nightmare both for the claims teams and for the reinsurance and actuarial teams who deal with the reinsurers.

3 Clean up and Continuous Disclosure - The Wake of The Disaster

"300 mph winds smashed my house apart" – Innisfail Resident

The full process of assessing the building damage, getting builders out to quote on and then fix or build can sometimes take over a year. Once the initial chaos has subsided and most of the claims have been lodged, stakeholders start searching for answers and the insurer needs to disclose their ultimate loss to the market. This phase can last from a week or two after the event up to several months, when a reliable estimate of the ultimate costs can be formed.

Continuous Disclosure following disasters is a significant issue for insurers. It is a legal requirement in Australia that an insurer informs the public of any issue that may materially affect the share price as soon as it comes to light. Throughout the post-disaster period the pressure on executives to understand and communicate all issues that arise can be intense. The actuary should play an integral role in this issue awareness and cost estimation process.

The current and prospective shareholders of a listed company may want to know:

- How will loss impact ability to deliver insurance margin?
- How much did it cost us?
- What reinsurance do we have?
- How many claims are we going to have?
- When will cost estimates finally settle?

The Finance and Accounting Teams want to know:

- How will we reserve for it?
- What is the appropriate risk margin?
- How do we allocate reinsurance recoveries?
- What payment pattern should we expect for the Larry Reserve?

Insurance Disaster Response Organisation needs an update on

- How many claims? How much did it cost?

The wake of the disaster focused on pulling claims reporting and trying to nail down the ultimate loss cost. Following a large disaster, this is characteristically an iterative process with each piece of extra information providing a clearer picture of the magnitude and complexity of the impact. The key principle that we found useful during the process was:

Principle 4 – Form an Objective and Accurate View Early

We will now examine this in more detail.

Principle 4: Form an Objective and Accurate View Early

Following a catastrophe it is not unusual to hear conflicting views, with many stakeholders (including claim staff, product managers, distribution heads, reinsurance departments and policyholders) putting forward differing opinions on the level of damage and ultimate costs. Often, many people argue with a range of reasons that the ultimate costs should be lower than your estimate, but few say that it should be higher. With lots of information coming in it is important that the actuary does not get trapped into making ill-informed pressured decisions, such as setting an ultimate cost estimate too low and then having to continually revise it upwards. Rather, it is sensible to set up a process where regular discussion about available information can occur in a systematic way, enabling an objective view to be formed. In their June 2005 loss report, the Progressive

Corporation sum up the primary objective in the cost estimation and reserve setting process very well.

"Ensure total reserves are adequate to cover all loss costs while sustaining minimum variation from the time reserves are initially established to the time losses are fully developed."

To assist an actuary in achieving this objective following a disaster, it is worth considering the following points:

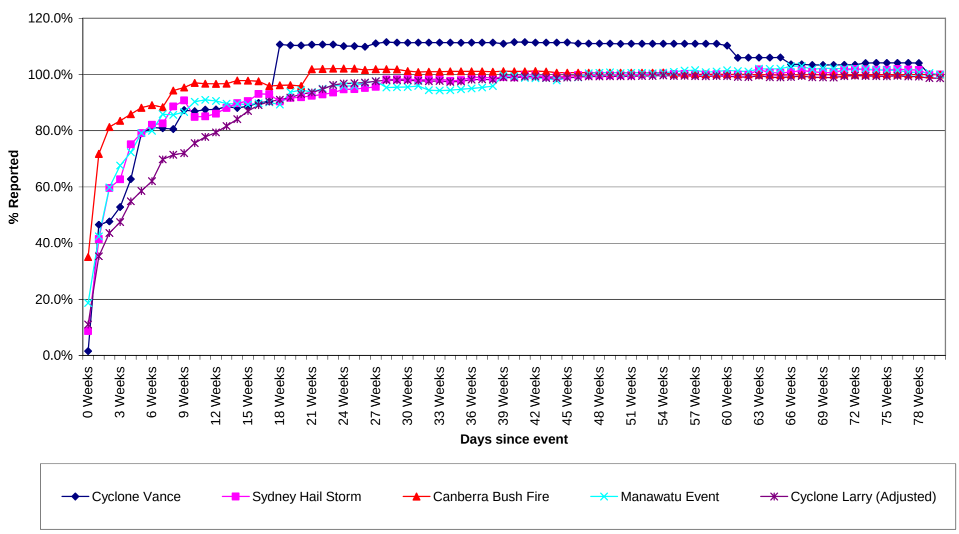
Many factors may influence claim reporting patterns. Event types such as bushfire, hail and floods, where damage is easier to assess, tend to have faster claim reporting patterns than cyclonic, wind storm and earthquake events where structural damage may go unnoticed at first only to be discovered later following detailed inspection. There were many examples from Cyclone Larry where, during the strong winds, roof structures had lifted away from fixings without full failure, allowing significant water ingress to damage battens, trusses and walls before settling back down. This damage was difficult to assess from the outside or inside with often limited access to roof cavities. The damage only discovered when builders or home owners removed roofing and examined damage months down the track. There were several observations of damage from previous cyclones (e.g. Cyclone Winifred) which led to structural failure during Cyclone Larry. It is important that when forming a view of future development the assumptions you choose needs to reflect the circumstances of the event.

Post–event demand related inflation of labour and materials plays a significant role in the increase of claim costs when compared to typical claims on smaller more localised damage. Key drivers of post event inflation are the:

- magnitude of the event (volume of claims)
- proportion of immediate region impacted
- distance from a major city not affected by the event
- economic environment (especially labour capacity in the builder/construction market)
- attitude of builders/tradespersons and their relationships with the insurance industry
- subsequent bad weather that delays repair work or increases the cost of repairs

Figure 4 shows a few historical development patterns. It is important to note that cost development from the Cyclone Larry impact was far slower than we had seen in other events. This was primarily due to the significant post-event demand inflation arising from a combination of the magnitude of the event, its relative geographic remoteness and significant delays in repair due to poor weather. There were less than five days without rain within the first ninety days following the event. Not only did the continued rain delay repair, but it also resulted in further building damage.

Figure 4 – Historical Event Incurred Cost Development Patterns



Appendix 1 provides further illustration of the variability in development patterns from a range of Australian and New Zealand events that have impacted IAG. We have also shown the variability resulting from applying a chain ladder or a simple gross up factor based on a weighted average from historical events.

Higher than standard, but decreasing risk margins. Due to the increased uncertainty over ultimate costs from a disaster soon after impact, standard risk margins should not apply to reserves for catastrophic events. Post-event inflation can easily exceed 100%. Assessors may not be able to incorporate post-event inflation into the cost of repair and hence will significantly underestimate the cost of a claim. It can be considered reasonable that an initial estimate may be up to 100% below the ultimate result. As time passes and claims have second assessments and builders review the damage and lock in a quote, the confidence in file reserves increases. As a result the confidence in the central estimate decreases. There is a risk margin run-off (as % of central estimate) in line with elapsed time even without payments being made. If the standard 75% sufficiency risk margin for a portfolio is 10-15%, the margin for a catastrophe reserve only a few weeks after the event may be 5 times higher.

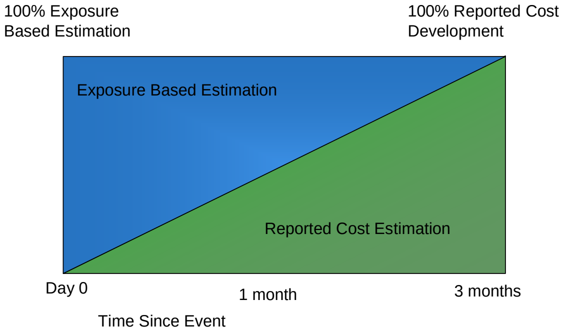
Risk margins will be higher for the Gross estimate than Net. Where gross costs have already reached the reinsurance retention, it is reasonable to assume that risk margins are not required on the net central estimate. The risk margin required on the central estimate of reinsurance component would therefore be higher than the risk margin on the gross costs. This is more likely to be an issue where an internal captive reinsurer is being utilised.

Exposure versus Reported claim based estimation. It is very difficult to determine a reliable estimate of ultimate costs within the first couple of weeks of a significant event. Your options are to remain with an exposure based model, or move to a model that relies more heavily on reported claim costs. The physical nature, intensity, range and location of an individual event is very difficult to model. It often takes weeks or months before consensus is reached on the magnitude of the event in different regions and the reliability around this. This suggests that a reported costs model is possibly a more viable option. Unfortunately, traditional actuarial approaches to modelling the development of incurred costs also have significant issues that need to be dealt with.

When using standard actuarial techniques it is common to find that the development pattern for reported claims and incurred cost development varies significantly between different types of events. Beyond this, payment patterns are almost impossible to model due to the unique differences in each event and as such many of the traditional actuarial models like Payment per Claim Incurred (PPCI) and Paid Claim Chain Ladder models are inappropriate if used as the only estimate of an event's size.

It is not unrealistic that most insurers in the wake of an event will progress from using mainly exposure based estimates, to using mainly reported cost based estimates. The duration for doing this will vary, but our initial thoughts are that at the one month stage it would not be unrealistic to still be using both models with approximately equivalent weightings.

Figure 5: Exposure Vs Report Cost Model Trade-Off



As discussed, various actuarial techniques can be applied to the development of the total incurred for an event. Each has its own unique set of advantages and issues, however in general the following approaches have been considered for use within IAG.

Exposure Based Models

Exposure based models require an assessment of all possible exposures that may have been affected by an event. Assumptions around the magnitude of individual losses are then applied to each exposure in order to derive an estimated total cost. These models are generally used when claims data is not available, usually just before or just after the event has hit.

The exposure based model that IAG have considered was:

Estimated Probable Losses per Exposure – As discussed under Principle 2, this involves identifying all exposures that may have been affected and applying an assumption on average losses. It will possibly be an insurer's first guess about how severe an event may be (especially in events that have damaged communication in the affected area). These models will not be covered any further in this section.

Reported Claim Based Models

Reported Claim Based models use available claims information to predict the future development of costs within an insurer's systems. Many of these models are based on standard actuarial techniques that reserving actuaries have been using for many years. However due to the uniqueness of each event it is important to complement these techniques with non-standard monitoring tools that allow individual components of an event (like zero-cost claims and large claims) to be monitored easily.

Some models that IAG have used or considered are:

Reported Claim Chain Ladder – A basic actuarial technique that applies chain ladder development factors to the number of claims reported to date in order to estimate the total number of claims. This model is less variable than other models discussed here as the estimate is only of total number of claims. This model generally forms part of a total incurred cost model and is used in conjunction with other models in order to estimate how much an event will ultimately cost. This model may need to be adjusted for influences like the inability of insureds to register a claim or internal resourcing issues within a claims team. Also insureds through intermediaries may try to contact their broker in the first instance and that can cause significant differences when contrasted against a direct portfolio. File clean ups can also be a problem if they result in the re-registering of claims on the system.

Incurred/Paid Cost Chain Ladder – similar to the reported claim chain ladder but it applies chain ladder development factors to either the paid to date amount or the incurred amount (paid to date + system estimate of outstanding) in order to estimate the total expected cost. Incurred cost models would usually be used as they are the fastest to develop, however care does need to be taken as development factors used will usually be the average of previous similar events. Care should be taken to build in appropriate adjustments for event specific factors (processing delays/improvements, post event inflation etc).

Payment per Claim Incurred (PPCI) – A standard reserving technique that applies a standard development pattern to the ultimate number of claims. As previously mentioned, its use is highly questionable due to the huge variability around payment patterns due to individual event factors and it still requires an average claim size assumption (which varies immensely between events).

Projected Case Estimate (PCE) – Another standard reserving technique that looks at the typical run-off of case estimates on the system. As with PPCI, due to individual influences the application of these techniques is highly questionable as it requires implicit assumptions around how much conservatism/optimism is inherent in the case estimates.

Average Claim Size Development – Not a standard technique but is useful for tracking average reported claim sizes over time. When contrasted with current and historical operational claim practices, it may be useful in developing a view on how average claim sizes tend to develop. Again care needs to be taken, especially if your data suggests a traditional downward trend in reported claim sizes, as post event inflation could easily reverse this trend.

Incurred Development per Claim Incurred (IDPCI) – Not a standard technique but is a possibility for adjusting a PPCI model in order to make it usable for these events. Basically this model operates in the same way as a PPCI, but instead of using paid claims it uses incurred development.

It should be mentioned that Incurred Cost based models will typically stabilise more quickly than Paid Claim based models and will often give more sensible results than equivalent paid claim models in the few weeks right after an event. However it should be noted that some model of paid claim development should be done in order to assist with the investment of any provisions that are required to run off the event. Typically this isn't an issue for medium sized events but could be quite critical for any large catastrophes.

Other Model Analysis

Claim Band Analysis – A monitoring framework for understanding how many claims currently fall into typical claim bands. Allows monitoring of large claims and withdrawn (zero) claims relatively easily and allows a basic claim size distribution to be developed and tested. A useful complement to monitoring average claim sizes. See Appendix 2 for an illustration of how the analysis may be presented.

Finalisation Analysis – A useful monitoring tool for looking at the number of open/closed/IBNR claims for an event. Allows more certainty to be formed around the total cost of an event after a few weeks. Reopenings may also be of interest in situations where the claims team is under pressure to get things back under control.

Post Event Inflation Analysis & Monitoring – Given that much has been said about the impact of post event inflation on the final cost, it would be sensible to include a tool for assessing its actual or anticipated impact. There is limited scope for developing real time monitoring tools for this, however significant work can be done on creating a framework for assessing the probability of post event inflation occurring (possibly based on factors such as remoteness, size of event, etc). This tool is likely to be integrated into an exposure based model.

In order to select assumptions for any of these models it is important to have a good understanding of how a particular event is developing. One way of doing this is to compare actual development against comparable historical events and against the typical development for claims within the portfolio. However, analysis will be strengthened by sharing your views with the claims team and seeking their input into the reasons why development differs for expectations. The quality of input will be strongly influenced by the strength of the relationship you have with the claims team.

An example of a potential modelling and reporting suite for dealing with extreme catastrophes may include:

- One exposure based model – helps to define affected areas, potential range of likely outcomes, potential effect of post event inflation and helps assist claims team with proactive claim identification initiatives.

- One reported claim chain ladder model – to help define how many claims are expected. This will assist with workload prioritisation in claims teams and in building a view on the total incurred.
- One incurred claim chain ladder model – a high level estimate in order to create several potential estimates of total incurred.
- One ACPC development tool – for monitoring how average claim sizes are tracking. When combined with the reported claim chain ladder model it gives a secondary estimate of the total incurred for an event.
- One paid claim development model - probably a paid claim chain ladder. Useful in running off the provisions set up to manage the event. It may be used as a further cross check of your incurred cost models.

In addition to these it would also be beneficial to access:

- Information not held on the system (such as number of claims in each stage of assessment).
- Finalisation information, once clean up has begun, so that a degree of comfort can be given around estimates and how quickly claims are being settled.
- A secondary incurred cost development model (for example an IDPCI model); in order to attempt to isolate issues with the main incurred cost models used.
- Field reports from claims teams- covering such information as delays due to resource constraints, targets for completing assessments, claim severity and frequency feedback, and evidence of post event inflation.

Until a more robust disaster reserving model is developed it is very worthwhile splitting out the costs from an event impact from your standard reserving process and considering each of the issues discussed when setting post event reserves.

4 Post Event Review & Closure – Looking Towards the Future

It took about four months for ultimate cost estimates to stabilise following the Cyclone Larry impact. It was then important for everyone to reflect on all aspects of how well we managed the response to the Cyclone Larry impact as well as the management of catastrophic risk more generally. The period when large events are fresh in people's minds is an opportune time to initiate change, as there is a general willingness to endorse and run with processes that are likely to help mitigate the risk of future devastation.

The Commercial Actuarial Team at IAG took the opportunity at this point to form a view of what they had learnt through the disaster. These ideas as well as previous disaster experiences formed the basis of this paper.

At the same time Senior Management and Executives had some fundamental pricing considerations to address

- Are we adequately priced for cyclone risk?
- How confident are we about our underlying price?

Meanwhile, Head Office Underwriting wanted to improve their rating structure so that premiums charged to individual policyholders more closely aligned to the underlying risk or cost of cover. They asked:

- What types of buildings were worst affected? How should we rate them differently?
- If we charge what you suggest straight away, it will put us right out of the market! Are you telling us we cannot write business in this region?
- How much do we need to charge just to cover our reinsurance premium?
- Is climate change having an impact on cyclone frequencies? And what is the likely future impact?
- How often should we expect an event this size to occur?

The post event review highlighted five key principles that had helped us in the past and would, with a disciplined approach provide significant assistance in the future. They are:

Principle 5 – Three-Rate Pricing Model

Principle 6 – Reinsurance meets Objectives

Principle 7 – No Surprises

Principle 8 – Facilitate the Sustainability of Insurance

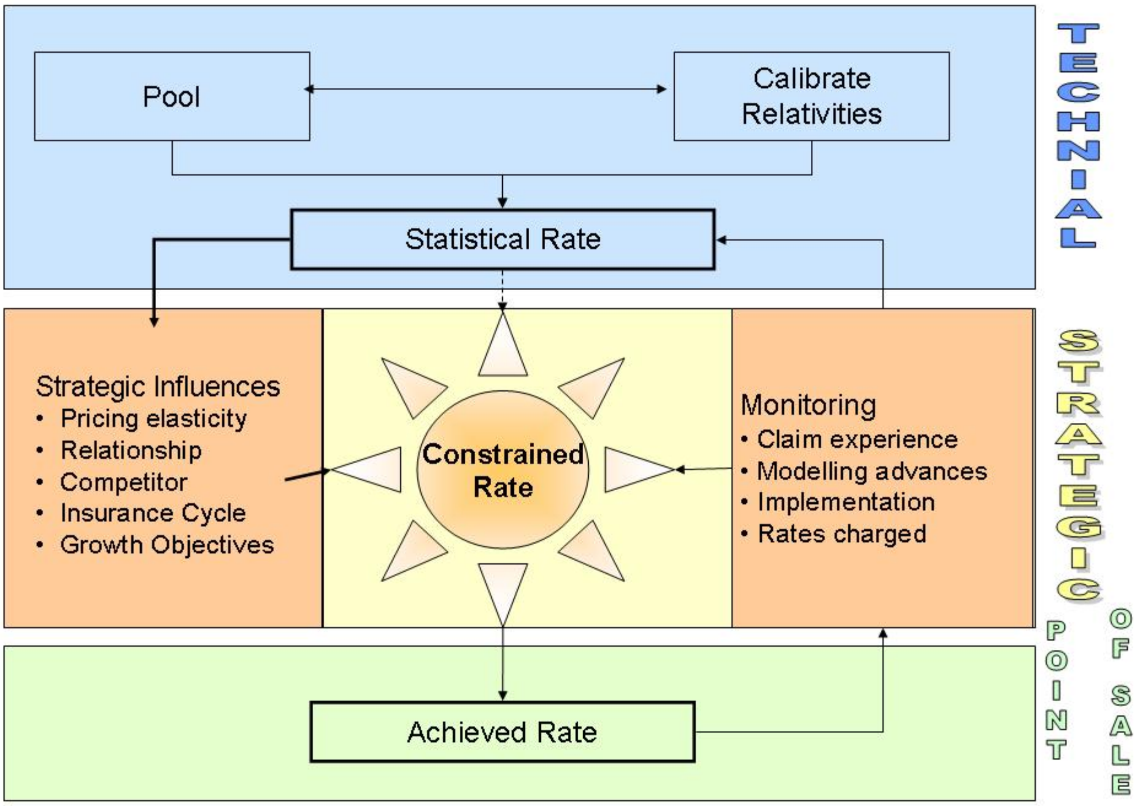
We will now examine these in more detail.

Principle 5: Three-Rate Pricing Model

Briefing management and executives on the above issues requires distinction between the underlying cost of cover and the premiums that are actually charged to policyholders.

In an attempt to improve discipline around the pricing process more generally, several years ago we developed a framework that clarifies the key responsibilities of the actuarial department, head-office underwriting and branch offices (if they exist) in the rate setting process. This framework has been especially useful recently in helping facilitate greater transparency over pricing decisions and identifying gaps in our current pricing process in relation to cyclone and other natural peril risks.

Figure 6: The Three-Rate Pricing Model



The three key premium rate types identified can be defined as follows:

1) *Statistical or Technical Rate* - the premium rate needed to cover all claim costs, expenses and provide enough profit equivalent to the target return on capital required to write the business. These rates can be the responsibility of the actuarial team and will include a combination of statistical research and business discussion.

   Statistical rates comprise an average (or pool level) funding rate and, if sophisticated enough, will include a set of risk factor relativities to distinguish between homogeneous risk segments. Any statistical rate should also include an assessment of uncertainty, taking the form of assumption sensitivity analysis or the confidence range around the central premium estimate.

2) *Constrained Rate (aka Book rate)* – the premium rate implemented in electronic auto-rated systems and rating tables or guidelines.
   The constrained rates are the responsibility of the Head Office Underwriters. In forming these rates, Head Office will consider the statistical rate, and the confidence in the statistical rate. They will also then consider the many practical issues including:

   - competitor actions
   - price elasticity
   - customer/broker relationships
   - insurance cycle
   - system implementation and
   - strategic growth objectives.

3) *Achieved Rate* - the actual premium charged to a specific risk to cover their individual risk characteristics. These rates are the responsibility of branch underwriters.

   Where there is no possibility of a premium other than the constrained rate being charged, there will be no difference between the achieved and the constrained rate. Where the heterogeneity of risks supports underwriter discretion in premium setting, (a common situation in Commercial insurance), the achieved premium will vary from the constrained premium. The constrained rates that Head office set are used as a benchmark for branch underwriters to deviate from.

Forming Statistical Prices Distinct from Constrained Prices

The Three-Rate Pricing Model can be used to monitor adequacy, and implementation, of total premiums or the process for pricing individual components of the premium. In the case of pricing for natural disasters it is useful to form separate statistical rates for each peril covered under the contract offered to policyholders (i.e. Earthquake, Flood, Cyclone, Tsunami, Storm, Bushfire, etc). Ideally, statistical rates will include a claim frequency and a claim severity model, however, depending on the use, incurred costs as a rate per unit of exposure can often suffice.

The statistical rates for an individual peril need to incorporate a separate allowance for the full underlying average annual loss (or risk premium) due to that peril, including the annual cost of:

1. Claims from small to medium events that in aggregate do not reach the reinsurance retention limit
2. Funding of the deductible for very large events exceeding the retention level
3. Claims that are covered by reinsurance (i.e. above the retention limit and below the top limit for the program)
4. Claims from the rare but extreme event that may blow out the top limit of the catastrophe treaty.

Where resources are not available to build an internal catastrophe model, some of the following tips may be worth considering:

Reinsurance premiums provide proxy for the cost of large events above retention limit. These premiums incur significant profit loadings (above the underlying estimated average annual loss of large events above the retention) due to the uncertainty over the estimate in the higher layers.

Most proprietary catastrophe models can be run on retention layers much lower than an insurers retention limit. These can give a good indication of cost of cover of those smaller events and the lower layer and higher layer costs of extreme events. The small to medium intensity catastrophe events are more common than the extreme events and therefore represent most of the data upon which most catastrophe models are calibrated. One would therefore expect that it is for these sized events that the models should be most reliable.

Carefully consider the possibility of event claim costs exceeding the limit of reinsurance cover. Important lessons were learnt by European insurers in December 1999 storms when, quite unexpectedly, significant capital was burnt as losses blew through their upper reinsurance limits. Most insurers structure their reinsurance around assumptions of theoretical "risk of ruin" periods, which highlights the need to consider and price for the possibility of these extreme events.

Transparency over, and uncertainties around, the cost of funding each component peril component is important in order to scrutinise each assumption, incorporate new research in a disciplined manner, gain credibility over risk premiums and, for executives and senior management, to decide what level of costs should be priced for.

Separate rates for separate perils. It is not uncommon for insurers to roll the cost of several perils into one assessment, especially where healthy profit margins exist. This technique generally only comes into question when a significant event hits, at which point it fails in its ability to adequately quantify and communicate the underlying cost of an individual cover. If an insurer is to meet their target return on capital over the long term a discrete allowance for the annual underlying cost of covering each natural disaster peril is crucial. Without it, surely confidence in the insurer's ability to meet long term return on capital objectives will be reduced.

Make use of rare opportunity for post-impact investigations. The benefits from improved statistical pricing and understanding of risk from sending research staff to the impact site immediately following Cyclone Larry far exceeded the small cost of the exercise. The on-site learnings and data acquired significantly increased our understanding, and ability to model, many areas of cyclonic risk, including the exposures we cover, the cyclone peril itself and the vulnerability of cyclonic wind to different structures.

Two of the additional benefits that arise when forming statistical rates are:

Statistical rates facilitate monitoring of price adequacy. One of the great benefits in forming statistical rates for each peril is that they can be used as a benchmark for assessing the adequacy of premiums charged either at a total product or policy level or for an individual peril risk component. By dividing the achieved premium by the statistical premium, a powerful measure of the pricing strength is formed. For example, a measure below 1.0 suggests that target profitability is not being met.

Statistical rates produce premium liabilities required for Technical Reserves. Constrained rates are not sufficient for this purpose. Another advantage of this framework is that it facilitates the monitoring of the adequacy of current pricing.

Disciplined Strategy around Implementation of Pricing

Often due to practical issues, competitive pressures and strategic initiatives it is easy to lose sight of how much of the underlying cost you are actually funding. To help facilitate the writing of long-term profitable business it is important to maintain discipline and transparency over pricing deviations from statistical rates. Some additional issues to consider are:

Short memories and diminishing pricing margins often result as the time since a disaster increases. It is common that the magnitude of the disaster lessons and therefore also does the perceived risk of another occurring (or alternatively increases dramatically following a single event). When pricing for frequent working losses it makes sense for an insurer to factor recent experience into pricing reviews. However this is not appropriate when pricing for rare events as the chance of 10 years without a significant event should do very little to change the likely size of 1 in 100 or 1 in 200 year event.

By leaving the statistical rate setting process separate, a view on the underlying cost of cover can be formed independently, and therefore provide a benchmark for disciplined monitoring of any strategic deviation from this rate. By monitoring the adequacy of your actual rate charged against the underlying cost of cover you can ensure stakeholders can make informed decisions as to the strategic pricing of those perils.

Forming a **pricing strategy that achieves an adequate price over the long term** greatly increases the confidence in long term profitability (or not) of a product in periods of the insurance cycle where statistical rates are not achievable in the market. If cross subsidisation exists within portfolios then it is essential that product managers create transparency around the process and clearly communicate what rate they are targeting (and why) and what level of long term return this will achieve.

Principle 6: Consider the Consequences of Changes to Reinsurance Programmes

Developing an optimised reinsurance structure to meet all your needs is an extremely complex task. A great deal of literature has been written on the matter and as such we will not tackle the issue in any significant detail in this paper. Instead, a discussion below highlights some of the specific issues that arose during some of our more recent post event disaster reviews.

Some of the questions we faced were:

- Have we allocated the right capital?
- Could we survive another one of these events?
- Should we change our reinsurance program?
- What impact does a change in reinsurance have on the Minimum Capital Requirements (MCR)?
- Is internal reinsurance just as adequate as external reinsurance?
- Did our reinsurance protect our company the way we expected?

Key discussion points are:

Increase in retention can cause double hit to capital requirement. Firstly additional capital is needed in order to meet MCR requirements (for example increasing a company's retention from $15m to $60m means maximum event retention and therefore capital requirements will increase by $45m times the company's MCR multiplier used to meet MCR objectives. Australian regulatory requirements suggest a minimum multiplier of 120%). Secondly, as you have now increased the volatility of your company's result there should be a higher demand on returns. This can put additional pressure on a company as not only do they need more capital, but they need to return more per dollar of it. This is offset by the "savings" in reinsurance premiums ceded to an extent, but all these need to be weighed up objectively.

Have you really transferred risk? Organisations with large subsidiaries and internal reinsurance profit centres face an additional challenge when setting up their reinsurance program. This issue pertains to whether the 'risk' has actually been transferred to another party. When using external reinsurers, the total losses from an event are capped at the catastrophe reinsurance limit. As long as gross losses do not blow out the top of the treaty and the organisation is comfortable with net losses, senior managers will have been considered to have managed their business well. When large catastrophe layers are insured internally, the parent company will feel a fair bit of heat on their bottom line and magnitude of their losses. The subsidiary that incurred the losses is also likely to feel the heat.

Understand the uncertainty in Reinsurance Pricing. As highlighted in previous sections there are areas of considerable uncertainty in any catastrophe pricing model. With the use of external models from independent agencies it is not uncommon to see a wide range of estimated outcomes, many of them seemingly contradictory. Part of any decision on the structure of a program is to understand both the inherent variability in the underlying catastrophe models and the effects this has on any risk of ruin assumptions.

Be aware that not all costs are covered by reinsurance. Any decisions made to extend coverage may ultimately hit an insurer's bottom line. A good example may be the decision to waive excesses in a catastrophe due to public or competitor pressure. This decision may not sit well with reinsurers and they may ultimately say that these extra costs are not covered in the arrangement, ultimately making the net cost of the event significantly higher than the retention limit. Any decision like this should probably be discussed widely as the consequences can be significant.

Principle 7: Minimise Risk from Potential Surprises

In a perfect world, executives would have a full appreciation for all key risks and the potential losses that the company is exposed to. The extent to which the executive level is taken by surprise can be thought of as a measure of the success of management and advisers, including the actuary, in understanding and communicating the risks faced. The legal requirement for continuous disclosure provides an even greater need for executives to be put in a position where they are not surprised.

Some of the following questions were actually asked prior to the post event review. However, we did not really learn how to handle them better until we reflected on the experience at a later date. These questions included executives trying to better understand:

- Why did the reserves keep going up/down?
- Why was the loss higher/lower than expected/competitors?
- Did this loss fall within our desired risk appetite?
- Was loss consistent with the organisation's strategic growth/withdrawal objectives?
- Can we afford to be hit by another one?

Later in the piece when we were setting next year's budgets, senior management wanted input on

- Whether budgeted loss ratios should include or exclude the catastrophe margin?
- How should business manager performance be adjusted in light of the event?

By putting executives in a position where they are not surprised, their job will be significantly easier. There are two strategies that may help with this:

1) Ensure all Stakeholders have Clarity over Goals and Objectives and are Comfortable with Desired Risk Appetite and Losses that may Occur

Warren Buffet, in his December 1994 address to Berkshire Hathaway shareholders, provides a classic example of the strong message a clear, quantified and well-communicated risk can send.

"All things considered, we believe our worst-case insurance loss from a super-cat is now about $600 million after-tax, an amount that would slightly exceed Berkshire's annual earnings from other sources. If you are not comfortable with this level of exposure, the time to sell your Berkshire stock is now, not after the inevitable mega-catastrophe".

Some ideas that may help the actuary in supporting an insurer are:

- communicate that a disaster reserve estimate is pretty much a 'best guess' in the first few weeks following a disaster, and that as time since impact increases, confidence in this estimate increases. An indication of the range, likelihood and sensitivity to assumptions of possible alternative ultimate cost figures, key reasons for estimate changes and assumption sensitivity at each update puts executives in a position to be proactive in their communications to the market and to optimise financial decisions.
- ensure strategic growth/withdrawal objectives are well defined and communicated through the organisation.
- get clarity over exactly what claims volatility and maximum event losses are required and therefore the requirements of the reinsurance structure
- identify exactly what the organisation's risk tolerance is in each geographic region to each peril type
- scenario test and therefore quantify impact of alternative exposure retention levels.

The actuary's role in each of these areas generally comprises risk quantification and risk awareness.

Differing expectations within an organisation as to the risk appetite and growth/withdrawal process can lead to a higher loss than expected as well as conflict following an event. If Head Office decide that accumulations are an issue in a given region and wish to limit exposures, this decision needs to flow through to all levels of management, underwriters and branch staff.

In portfolios where annual losses can be highly variable due to natural perils losses or large losses it is important to consider how this should be dealt with in budgeting and performance management, especially if reinsurance retentions are relatively high. If there is a large difference between the typical working losses of a portfolio and the average long term losses of a portfolio then care needs to be taken in interpreting current financial performance and setting budgets.

Budget setting generally has two schools of thought: those who think it is a target setting mechanism (traditionally the sales channels) and those who think it's a best estimate monitoring tool (traditionally the actuarial and finance areas). These two schools of thought are difficult to combine, and both have a very valid basis for argument. By setting budgets excluding long term average costs of unlikely events, you have a more meaningful comparison to actuals in those years where no events have occurred. However the danger to this is that you must therefore account for the long term costs in return on capital (profit) requirements and this can easily be overlooked or discounted, especially if there is considerable uncertainty around the long term average cost.

One possibility is to include any assessment of unlikely costs separately as part of any budgeting, reserving or liability adequacy testing process in order to allow those assumptions to be considered and discussed transparently. By reporting actual losses in terms of Working (common losses), Large Losses (single infrequent losses) and Disasters (widespread infrequent losses) you can create a framework for monitoring the profitability of a portfolio that allows clear and transparent portfolio management to continue within the business even throughout the handling of a large disaster.

A disaster can often provide a company with clarity over its true profitability. Companies reporting high profits in revenue accounts for several years may find that they still were not profitable enough to cover the large event losses when they occur. This can also work in the opposite direction for an insurer charging healthy margins for disaster risk that was not impacted as much as expected by a large event, and were in effect much more profitable than previously thought.

2) Act Congruently with Goals and Objectives

A common way to pick up a risk is to identify a lack of consistency. For example, where exposure limits have been set, but not adhered to, there is a clear accumulation risk that is no longer being managed. As a risk manager, the actuary can play a key role in monitoring and reporting on incongruent processes or behaviour. Although some of the points have already been discussed in this paper it is worth reiterating possible practices that can be reported on:

- gaps in reinsurance cover (between insurer's policy and reinsurer's wording)
- implementation of pricing changes against agreed strategy
- potential and maximum event exposures
- actual exposures by region against maximum exposure limits
- implementation of growth/withdrawal strategy
- implementation of post-event clam management process

Even reinsurance contracts that were thought to be tight can easily end up not meeting the insurer's intention. It is not uncommon for the extent of cover provided by reinsurers to be inconsistent with the cover provided by the insurer. These gaps in cover create a significant risk to an insurer's capital. The gaps arise in consideration of either the type of loss covered or additional conditions on terms of cover (e.g. reinsurers may or may not include storm surge from cyclonic events or natural action of the sea, include riverine and flash flood as well as inundation, or have an inconsistent definition of what constitutes a Pandemic outbreak). Even when the insurer and the reinsurer have consistent covers an issue can arise when an insurer. Following some events, where public pressure to pay out on events not covered under contracts occurs, an insurer must balance long term brand value objectives against short term financial gain goals. For these types of events, reinsurers are well within their rights to refuse reinsurance cover on claims that an insurer decides to pay. As result, the insurer is effectively exposed to the gross cost of these losses.

By encouraging the communication of corporate goals and objectives to all levels throughout the organisation, individuals' performance objectives can be aligned with the strategic vision. This can not only help to motivate and unite staff, who can then see how their own actions impact on company strategy, but can also significantly reduce the chance of behaviours that are inconsistent with corporate goals.

Principle 8: Facilitate Long Term Sustainability of Insurance

The long term sustainability of insurance of natural disasters is a hot topic for the industry. If the frequency and size of disasters continues to rise, as has been the case in the northern hemisphere and has been predicted in the southern hemisphere, then premiums may continue to rise to a point where they become unaffordable or coverage restrictions restrict insurance availability. For example, US insurers have been withdrawing cover or drastically increasing premiums in Florida and Louisiana; state run schemes are expensive and limited. In Florida and Louisiana alone, more than 600,000 homeowners' property policies have been cancelled or not renewed in the past year[*]. In Massachusetts and New York, private insurers have cancelled coverage for more than 80,000 coastal homeowners in the past two years[*]., even though it has been decades since the last major hurricane hit the region.

Also, the New Zealand Earthquake Commission (EQC) is a prime example of where the role of the insurance industry in community risk transfer and pooling has been reduced. The New Zealand Government has decided that they are better placed than the industry to provide this public service. If cover for storm damage were theoretically moved to arrangement similar to the EQC, then a significant amount of underlying property losses (and therefore premium and potential profit) would be lost from the industry.

Basic 'bare bones' policies are now offered though banks and micro-finance and to a lesser extent insurers that cover loss due to fire and theft and exclude the loss due to any type of storm or earthquake. This may indicate the beginning of a lower reliance on the insurance industry as a suitable means for risk transfer for low income earners.

Recently both the insurance industry and actuarial profession have started to include scientific research into their pricing and risk management processes. Reinsurers in particular are often seeking input from the scientific community on modelling the risks associated with accepting natural perils cover. There has been a lot of coverage over the last few years on the impact of such phenomena as global warming, climate change and El Niño/La Niña weather patterns. However there is certainly considerable disagreement over the long term consequences for the planet. Recent research has certainly highlighted changes in the environment over the last few years; however the jury is out on what it means for the planet and for the insurance industry in particular.

The following section illustrates some of the commonly voiced concerns around climate change and its potential impact on the insurance industry, with the following chart showing a distinct rise in average earth surface temperatures over the last 25 years.

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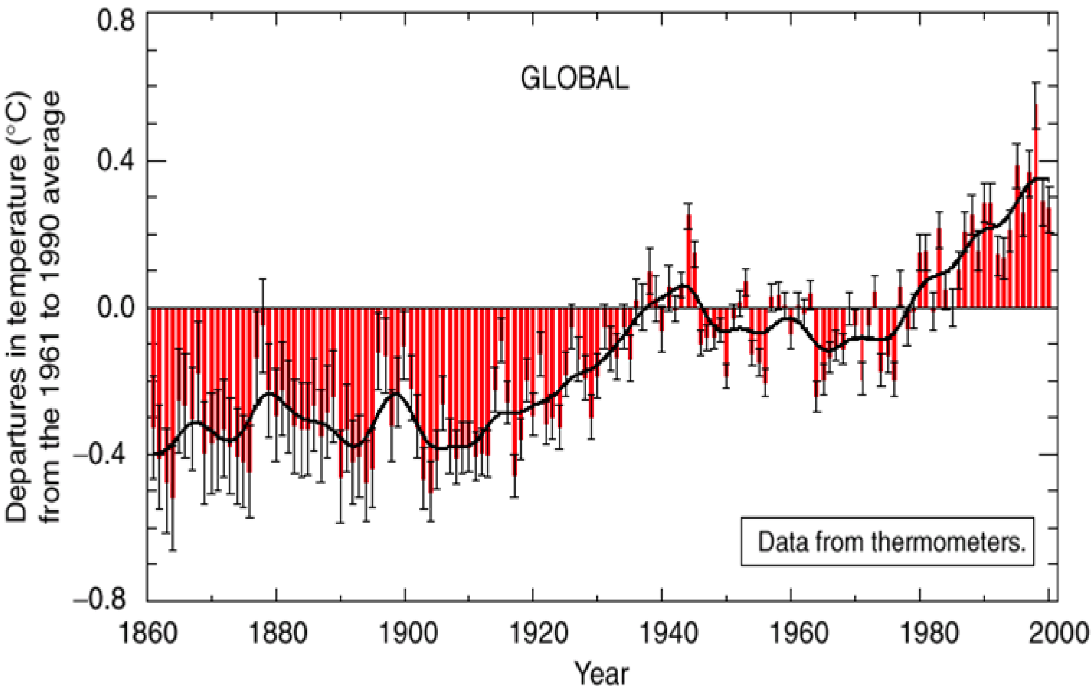
[*] Philadelphia Inquirer, ***"****Insurance Coverage Cut After Disasters", 7* October 2006

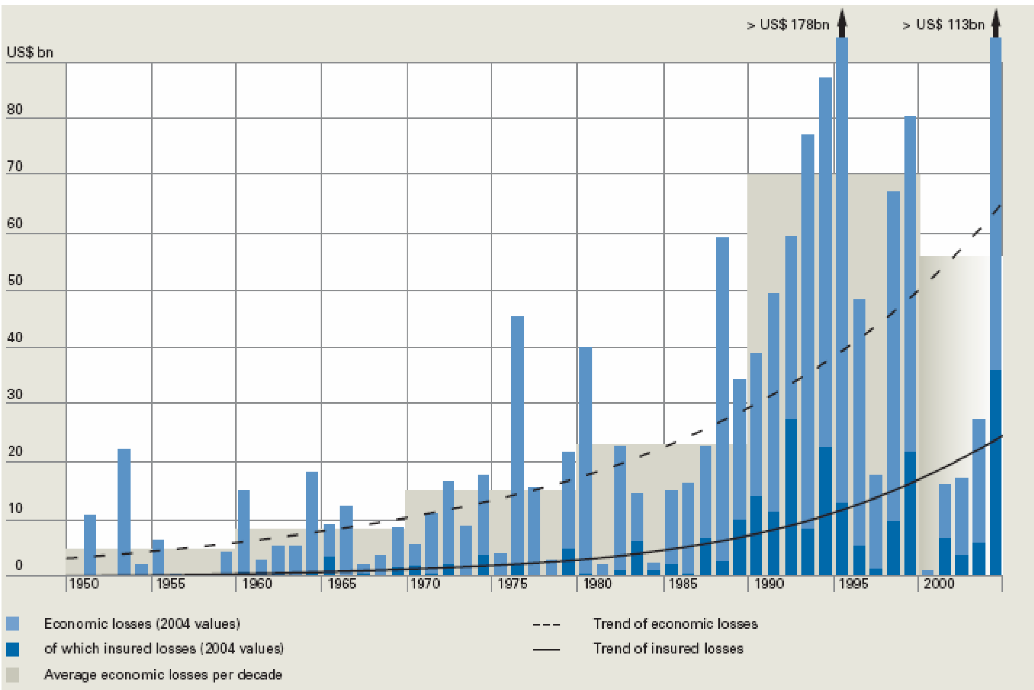
Figure 7: Variations of Earth's Surface Temperature over the past 140 years



Source: - Intergovernmental Panel on Climate Change, "Scientific Basis: 3[rd] assessment report"", 2001 (IPCC 2001)

Although there is no proof as to the extent of man-made influences on average temperature increases, the majority of the scientific community now generally accepts that human activity is a large driver of the change (IPCC 2001). These changes have been associated with increasing costs of extreme weather events over the past 15 years. See Figure 8 below.

Figure 8: Cost of Extreme Weather Events Globally



Source: Swiss Re, "Climate Change, Insurance and the New Zealand Business Community", September 2003.

It should be noted that this chart does not include the largest ever single event loss which was as a result of Hurricane Katrina in August 2005. Losses from Katrina are estimated at $125 billion (of which $45 billion was insured). Whilst the link between the historical global temperature increase and increased extreme weather event frequency in recent decades remains unproven, scientists have shown that a warming climate is likely to bring an increase in the frequency and/or severity of extreme weather events (particularly floods, storms and cyclones). In fact, it has only been in the last few years, due to heightened disaster activity, that the idea that climate change has contributed to an increase in disaster losses has started to gain acceptance. Prior to 2004, the significant increase in losses over the 1990s were often thought to be driven by shifts in demographics and significant rises in key risk region exposures

If scientific research proves to be correct, the insurance industry will certainly be impacted in a significant way. All insurers can play a role in helping to reduce the risk in the community and therefore facilitate lower premiums. Indeed, IAG have employed a 'sustainability' team to focus on, and help manage, many of these issues. To date, the group has taken steps to reduce carbon emissions and its impact on global warming through initiatives such as:

- *Government policy,* public education & debate- promoting the risks of climate change for society and focussing on the future impact of climate change under different climatic & policy scenarios, as well as proposing solutions. IAG has contributed to 2 climate change publications through membership of the Australian Climate Group (2004) and the Australian Business Roundtable on Climate Change (2006).
- *Research & support of energy efficient motor transport* – including pay as you drive insurance. IAG has also purchased over 100 Toyota Prius hybrid vehicles for our insurance assessors
- *Research 'Green' buildings*– initiate project to demonstrate the superior risk characteristics and long term social benefits of supporting 'green' buildings.
- *Internal Energy Management* – a focus on reducing energy demand in buildings occupied by IAG through improved energy efficiency, building design and the use of renewable energy.
- *Sponsorship of students to perform climate related research*
- *'Climate-help' initiative* – allows customers to purchase carbon credits to offset the carbon emissions from the their car.

In addition to this, the company has been active in decreasing the cost of extreme weather events by undertaking research and providing advice on risk reduction measures such as:

- *Safer & Stronger Buildings in Cyclone Regions* - Sponsored research at James Cook University Cyclone Testing Station and provided recommendation to Building Construction Standards board in order to highlight key factors that can reduce risk, such as the height, shape, construction materials or features of new buildings. For example buildings can be modified to significantly reduce risk (e.g. Cyclone rods, tie downs, wind locks on roller doors for greater resistance against cyclonic winds)
- *Stronger materials for Motor vehicles and Building roofing in Hail Prone Regions*- Designed and built a 'hail gun' to test the susceptibility of roofing materials to hail damage
- *Promoting discussion of high risk regions* with councils, home and business owners and the general public so that action can be taken in these regions to mitigate risk.

An issue to keep in mind is that given the regulatory and market reactions to the collapse of HIH, what do we think will happen if an insurer goes down from a natural disaster? Given how little we know about climate change, how much pressure are we going to be under as an industry in 10 years if things do develop as predicted? Are we doing enough planning for the future?

Australian actuaries and the insurance industry generally have historically been quite inactive (at least publicly) on climate change and the resulting risks for insurance. This has started to change. The complexity of the modelling and major ramifications for the industry if scientific thought proves correct provides justification for actuaries to play a key role in developing knowledge and policy in this field.

5 Conclusion

This paper highlights many of the issues that may not be on the radar when attempting to provide advice prior to and following a natural peril impact. We have chosen to focus on natural disaster issues that have been given little consideration in literature to date, and those which, based on our experience, we consider to be particularly important for actuaries working in this field.

The paper has identified and explored the following as areas where actuaries can add greater value in the advice and service they provide:

- *Exposure Monitoring and Management Information*

  Improve the integrity of exposure data – where? what type? and what are the potential losses?
- *Reserving*

  Understand claims environment, ensure minimum reserve variation and communicate sensitivity of assumptions
- *Pricing Research*

  Communicate underlying cost of cover, monitor pricing against statistical rates, formation of research data asset and provide underwriting advice on risk drivers
- *Reinsurance and Capital*

  Demonstrate implications of structure changes
- *Sustainability and making a difference*

  Be proactive and develop risk mitigation initiatives
- *In All Advice*

  Ensure clarity over, and actions congruent with, the organisations goals and objectives

This brings us to our final learning. The amount of value an actuary can add in each of these areas will be significantly increased by:

Principle 9: Getting Involved, Taking Responsibility and if Possible, Getting Frameworks in Place Prior to the Event.

One of the most important things that we can do is consider and take a stance on many of the issues discussed in the paper before an event hits. Resource constraints affect almost all actuarial units and can make it difficult to get the prioritisation for developing all these frameworks, however when a disaster hits, much of this work will need to be done anyway. Although the processes you build now will not be perfect (possibly not even close), they will give you a framework to start with and with which to test assumptions.

The best way to learn is first-hand. In order to respond appropriately to key questions about the disaster (including how much damage has been done?; what types of structures have major claims?; what impact has the weather on rebuilding?; what are key risk factors?) the actuary must get out there and have a look. Key pricing measures and strategy decisions that are made at head office could be strengthened by incorporating the insights and understandings of people on the ground.

There is plenty of scope for actuarial work in this interesting and exciting field, and as long as insurance companies cover natural disasters, there will be a need to investigate and improve processes to manage these issues. Actuaries cannot predict the future with respect to natural perils. We can however to a great deal to prepare for them.

We hope that people reading this paper have become more aware of many of the practical issues that affect insurers preparing for and managing through natural disasters, with result being that the reader will be more able to provide valuable advice and service.

Acknowledgements

Whilst the content of this paper has largely been developed through discourse between the authors, it is important to acknowledge the huge body of work that exists within both the actuarial and general insurance industries on natural perils and related risks. Many of our own ideas have been formed over years of informal discussions with experts and through reading much of the work that has been done in the past.

We believe this piece of work to be unique within the industry in the angle it has attempted to take. We would like to acknowledge the following individuals who have peer reviewed and offered advice (unfortunately not all of which could be included):

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Appendix 1

A1.1 Reported Claim Chain Ladder Patterns

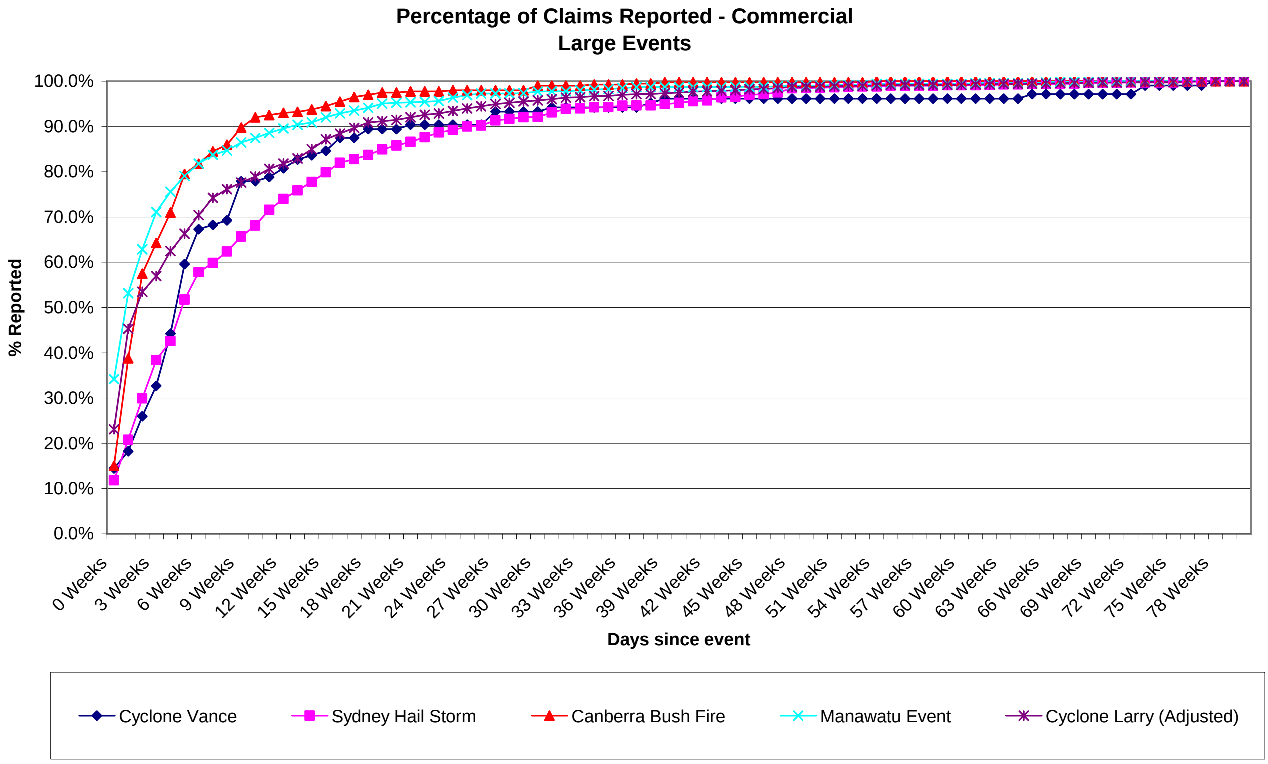
A1.1.1 Cumulative Proportion of Ultimate Claims Registered by Development Week

Development Week	Cyclone Vance	Sydney Hail Storm	Canberra Bush Fire	Manawatu Event	Cyclone Larry (Adjusted)	Average (Excl Larry)
0	14.4%	11.8%	15.0%	34.2%	23.1%	19.6%
1	18.3%	20.8%	38.8%	53.1%	45.3%	33.6%
2	26.0%	29.9%	57.5%	62.9%	53.5%	44.2%
3	32.7%	38.4%	64.3%	71.1%	56.9%	52.3%
4	44.2%	42.6%	71.0%	75.6%	62.5%	57.2%
5	59.6%	51.8%	79.5%	79.0%	66.3%	64.6%
6	67.3%	57.8%	81.8%	81.8%	70.4%	69.1%
7	68.3%	59.8%	84.5%	83.7%	74.2%	71.2%
8	69.2%	62.4%	86.0%	84.7%	76.1%	73.0%
9	77.9%	65.6%	89.8%	86.4%	77.6%	76.0%
10	77.9%	68.1%	92.0%	87.4%	78.9%	77.9%
11	78.8%	71.6%	92.5%	88.6%	80.6%	80.1%
12	80.8%	74.0%	93.0%	89.6%	81.8%	81.8%
13	82.7%	75.9%	93.3%	90.4%	82.9%	83.1%
14	83.7%	77.8%	93.8%	90.9%	85.0%	84.4%
15	84.6%	79.9%	94.5%	92.0%	87.1%	85.9%
16	87.5%	82.0%	95.5%	92.9%	88.4%	87.5%
17	87.5%	82.8%	96.5%	93.5%	89.7%	88.3%
18	89.4%	83.7%	97.0%	94.1%	90.9%	89.1%
19	89.4%	84.9%	97.5%	95.0%	91.2%	90.1%
20	89.4%	85.8%	97.5%	95.2%	91.4%	90.5%
21	90.4%	86.6%	97.8%	95.3%	92.0%	91.0%
22	90.4%	87.6%	97.8%	95.4%	92.6%	91.6%
23	90.4%	88.7%	97.8%	95.6%	92.9%	92.2%
24	90.4%	89.2%	98.0%	96.4%	93.4%	92.8%
25	90.4%	90.0%	98.0%	97.0%	94.0%	93.3%
26	90.4%	90.2%	98.0%	97.3%	94.5%	93.6%
27	93.3%	91.3%	98.0%	97.3%	94.9%	94.2%
28	93.3%	91.7%	98.0%	97.3%	95.2%	94.4%
29	93.3%	92.0%	98.0%	97.4%	95.5%	94.6%
30	93.3%	92.1%	99.0%	97.7%	95.8%	94.9%
31	94.2%	93.1%	99.0%	97.8%	96.1%	95.4%
32	94.2%	93.9%	99.0%	97.8%	96.4%	95.8%
33	94.2%	94.0%	99.0%	98.0%	96.5%	96.0%
34	94.2%	94.2%	99.3%	98.2%	96.7%	96.2%
35	94.2%	94.3%	99.3%	98.3%	96.8%	96.2%
36	94.2%	94.6%	99.3%	98.5%	97.0%	96.5%
37	94.2%	94.7%	99.5%	98.7%	97.1%	96.6%
38	95.2%	94.7%	99.5%	98.7%	97.2%	96.6%
39	96.2%	94.9%	99.8%	98.7%	97.4%	96.8%
40	96.2%	95.2%	99.8%	98.7%	97.5%	97.0%
41	96.2%	95.6%	99.8%	98.7%	97.7%	97.2%
42	96.2%	95.8%	99.8%	98.7%	97.8%	97.3%
43	96.2%	96.4%	99.8%	98.7%	97.9%	97.6%
44	96.2%	96.5%	99.8%	98.8%	98.0%	97.7%
45	96.2%	97.0%	99.8%	98.8%	98.2%	97.9%
46	96.2%	97.1%	99.8%	98.8%	98.3%	98.0%
47	96.2%	97.5%	99.8%	98.9%	98.5%	98.2%
48	96.2%	98.4%	99.8%	99.0%	98.7%	98.7%
49	96.2%	98.5%	99.8%	99.0%	98.7%	98.7%
50	96.2%	98.6%	99.8%	99.0%	98.8%	98.8%
60	96.2%	99.1%	100.0%	99.4%	99.2%	99.2%
70	97.1%	99.7%	100.0%	100.0%	99.7%	99.7%
80	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

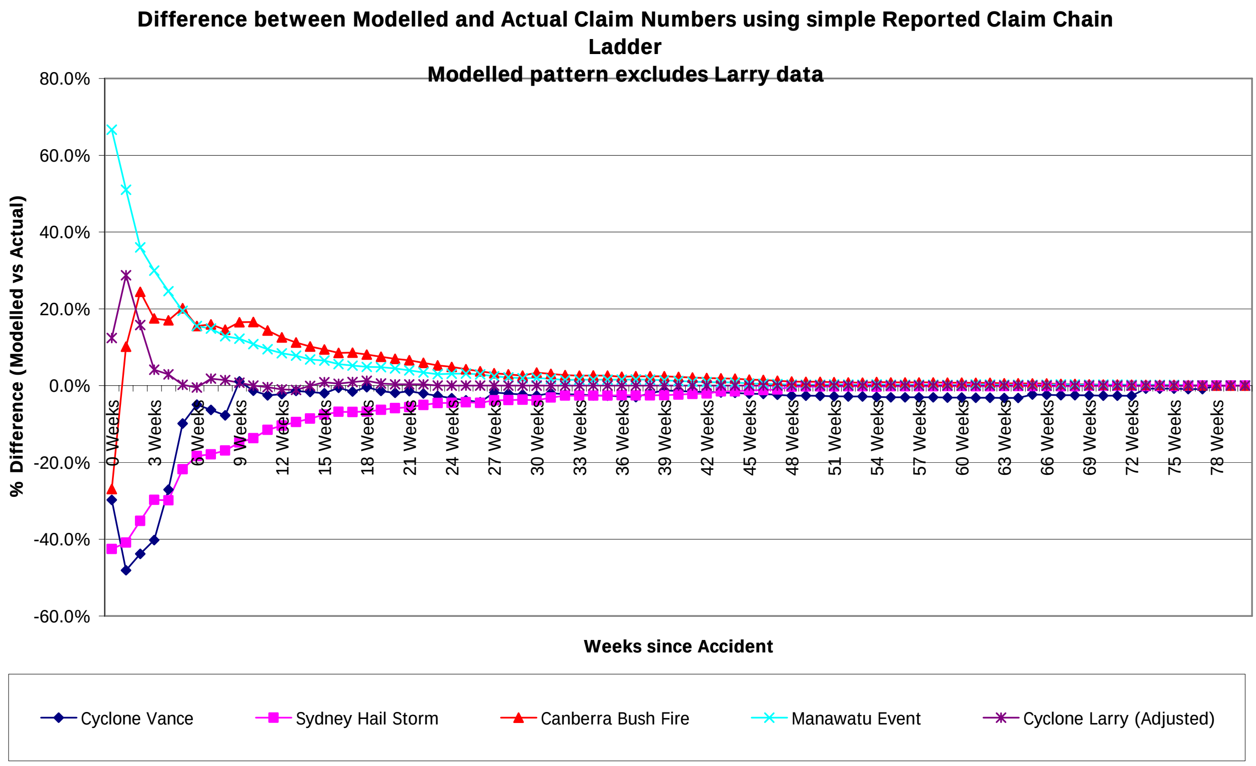
A1.1.2 Weekly Development Factors for Reported Claims

Development Week	Cyclone Vance	Sydney Hail Storm	Canberra Bush Fire	Manawatu Event	Cyclone Larry (Adjusted)	Average (Excl Larry)	Smoothed	Cumulative Smoothed
0 to 1 Week	126.7%	176.2%	258.3%	155.3%	196.3%	171.4%	171.4%	487.1%
1 to 2 Weeks	142.1%	143.9%	148.4%	118.3%	118.1%	131.3%	131.3%	284.2%
2 to 3 Weeks	125.9%	128.3%	111.7%	113.0%	106.4%	118.3%	118.3%	216.4%
3 to 4 Weeks	135.3%	110.9%	110.5%	106.4%	109.7%	109.4%	111.0%	182.9%
4 to 5 Weeks	134.8%	121.6%	112.0%	104.6%	106.1%	113.0%	109.0%	164.8%
5 to 6 Weeks	112.9%	111.7%	102.8%	103.5%	106.2%	107.0%	107.0%	151.2%
6 to 7 Weeks	101.4%	103.5%	103.4%	102.4%	105.4%	103.0%	103.0%	141.3%
7 to 8 Weeks	101.4%	104.2%	101.8%	101.2%	102.6%	102.6%	103.0%	137.2%
8 to 9 Weeks	112.5%	105.2%	104.4%	102.0%	101.9%	104.1%	102.6%	133.2%
9 to 10 Weeks	100.0%	103.8%	102.5%	101.2%	101.7%	102.5%	102.5%	129.8%
10 to 11 Weeks	101.2%	105.1%	100.5%	101.3%	102.1%	102.8%	102.5%	126.7%
11 to 12 Weeks	102.4%	103.4%	100.5%	101.1%	101.5%	102.1%	102.1%	123.6%
12 to 13 Weeks	102.4%	102.6%	100.3%	100.9%	101.4%	101.6%	101.5%	121.1%
13 to 14 Weeks	101.2%	102.5%	100.5%	100.6%	102.5%	101.5%	101.5%	119.3%
14 to 15 Weeks	101.1%	102.7%	100.8%	101.2%	102.5%	101.8%	101.5%	117.5%
15 to 16 Weeks	103.4%	102.7%	101.1%	101.0%	101.5%	101.9%	101.9%	115.8%
16 to 17 Weeks	100.0%	101.0%	101.0%	100.7%	101.4%	100.8%	101.0%	113.6%
17 to 18 Weeks	102.2%	101.1%	100.5%	100.6%	101.3%	100.9%	101.0%	112.5%
18 to 19 Weeks	100.0%	101.5%	100.5%	101.0%	100.3%	101.1%	101.0%	111.4%
19 to 20 Weeks	100.0%	101.0%	100.0%	100.2%	100.3%	100.6%	100.6%	110.3%
20 to 21 Weeks	101.1%	100.9%	100.3%	100.1%	100.6%	100.5%	100.6%	109.7%
21 to 22 Weeks	100.0%	101.2%	100.0%	100.1%	100.6%	100.6%	100.6%	109.0%
22 to 23 Weeks	100.0%	101.2%	100.0%	100.2%	100.3%	100.6%	100.6%	108.4%
23 to 24 Weeks	100.0%	100.7%	100.3%	100.7%	100.6%	100.6%	100.6%	107.7%
24 to 25 Weeks	100.0%	100.8%	100.0%	100.6%	100.6%	100.6%	100.6%	107.0%
25 to 26 Weeks	100.0%	100.3%	100.0%	100.3%	100.5%	100.2%	100.5%	106.4%
26 to 27 Weeks	103.2%	101.2%	100.0%	100.0%	100.5%	100.7%	100.5%	105.9%
27 to 28 Weeks	100.0%	100.4%	100.0%	100.0%	100.3%	100.2%	100.3%	105.3%
28 to 29 Weeks	100.0%	100.4%	100.0%	100.1%	100.3%	100.2%	100.3%	105.0%
29 to 30 Weeks	100.0%	100.1%	101.0%	100.3%	100.3%	100.3%	100.3%	104.7%
30 to 31 Weeks	101.0%	101.1%	100.0%	100.1%	100.3%	100.6%	100.3%	104.4%
31 to 32 Weeks	100.0%	100.8%	100.0%	100.0%	100.3%	100.4%	100.3%	104.1%
32 to 33 Weeks	100.0%	100.1%	100.0%	100.2%	100.1%	100.1%	100.1%	103.8%
33 to 34 Weeks	100.0%	100.2%	100.3%	100.2%	100.2%	100.2%	100.2%	103.6%
34 to 35 Weeks	100.0%	100.1%	100.0%	100.1%	100.1%	100.1%	100.1%	103.4%
35 to 36 Weeks	100.0%	100.3%	100.0%	100.2%	100.2%	100.2%	100.2%	103.4%
36 to 37 Weeks	100.0%	100.1%	100.3%	100.2%	100.1%	100.1%	100.1%	103.1%
37 to 38 Weeks	101.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	103.0%
38 to 39 Weeks	101.0%	100.3%	100.3%	100.0%	100.2%	100.2%	100.2%	102.9%
39 to 40 Weeks	100.0%	100.3%	100.0%	100.0%	100.2%	100.2%	100.2%	102.7%
40 to 41 Weeks	100.0%	100.3%	100.0%	100.0%	100.2%	100.2%	100.2%	102.5%
41 to 42 Weeks	100.0%	100.2%	100.0%	100.0%	100.1%	100.1%	100.1%	102.4%
42 to 43 Weeks	100.0%	100.7%	100.0%	100.0%	100.1%	100.3%	100.1%	102.3%
43 to 44 Weeks	100.0%	100.1%	100.0%	100.1%	100.1%	100.1%	100.1%	102.2%
44 to 45 Weeks	100.0%	100.5%	100.0%	100.0%	100.2%	100.2%	100.2%	102.1%
45 to 46 Weeks	100.0%	100.1%	100.0%	100.0%	100.1%	100.1%	100.1%	101.8%
46 to 47 Weeks	100.0%	100.4%	100.0%	100.1%	100.2%	100.2%	100.2%	101.7%
47 to 48 Weeks	100.0%	100.9%	100.0%	100.1%	100.2%	100.5%	100.2%	101.5%
48 to 49 Weeks	100.0%	100.1%	100.0%	100.0%	100.0%	100.0%	100.0%	101.3%
49 to 50 Weeks	100.0%	100.1%	100.0%	100.0%	100.0%	100.0%	100.0%	101.3%
50 to 51 Weeks	100.0%	100.1%	100.0%	100.2%	100.1%	100.1%	100.1%	101.2%
51 to 60 Weeks	100.0%	100.5%	100.3%	100.2%	100.3%	100.3%	100.3%	101.1%
61 to 70 Weeks	101.0%	100.6%	100.0%	100.6%	100.5%	100.5%	100.5%	100.8%
71 to 80 Weeks	103.0%	100.3%	100.0%	100.0%	100.3%	100.3%	100.3%	100.3%
Over 80 Weeks	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

A1.1.3 Graph of Cumulative Proportion of Reported Claims



A1.1.4 Graph of Variability in Accuracy of Predicted Ultimate Claim Numbers using Simple Chain Ladder Model by Week



A1.2 Incurred Cost Chain Ladder Patterns

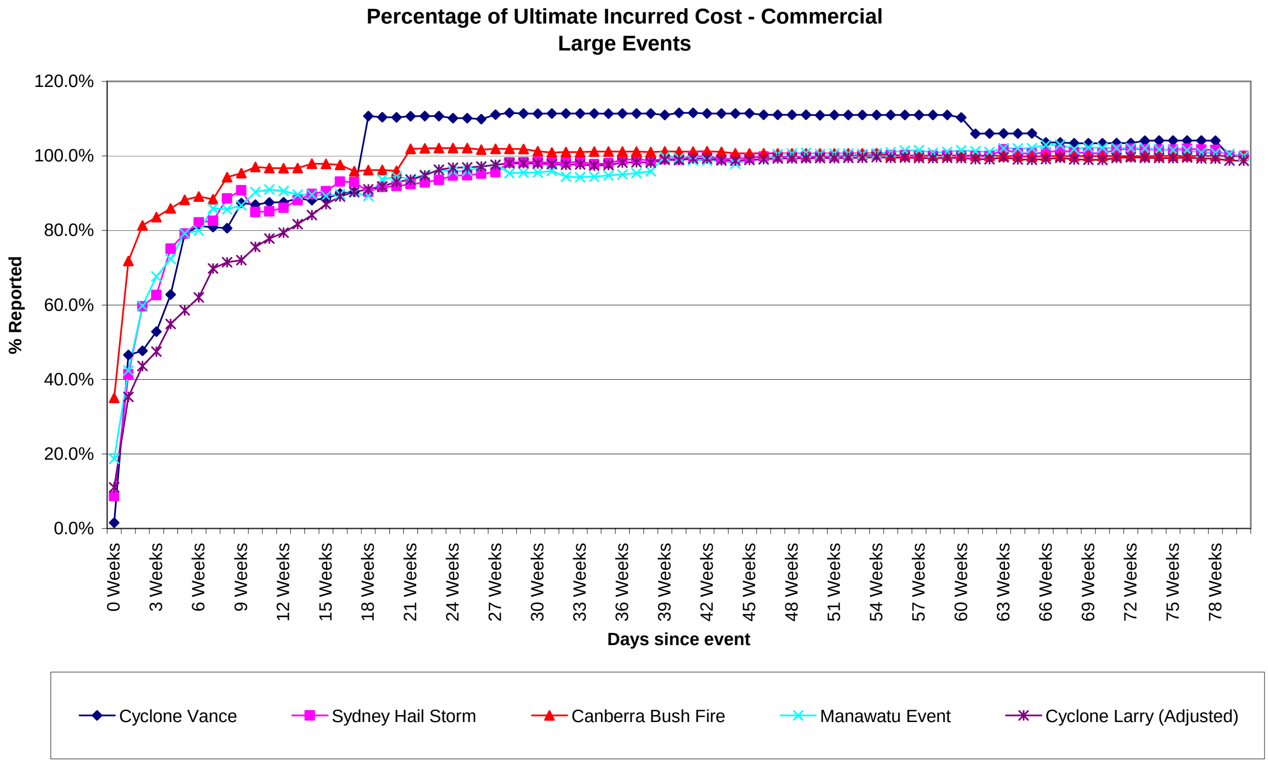
A1.2.1 Cumulative Known Proportion of Ultimate Incurred Cost by Development Week

Development Week	Cyclone Vance	Sydney Hail Storm	Canberra Bush Fire	Manawatu Event	Cyclone Larry (Adjusted)	Average (Excl Larry)
0	1.5%	8.7%	35.0%	18.7%	11.2%	16.1%
1	46.6%	41.4%	71.8%	42.4%	35.8%	48.9%
2	47.7%	59.6%	81.3%	59.8%	44.1%	64.1%
3	52.8%	62.7%	83.6%	67.6%	48.1%	67.9%
4	62.7%	75.1%	85.9%	72.3%	55.6%	76.6%
5	79.1%	79.2%	88.2%	79.1%	59.3%	81.3%
6	81.2%	82.1%	89.1%	79.9%	62.8%	83.4%
7	80.9%	82.6%	88.3%	85.9%	70.7%	84.4%
8	80.6%	88.6%	94.3%	85.7%	72.4%	89.1%
9	87.3%	90.7%	95.4%	86.7%	73.0%	91.0%
10	86.9%	84.9%	97.0%	90.3%	76.6%	88.7%
11	87.5%	85.1%	96.8%	91.0%	78.8%	88.9%
12	87.6%	86.1%	96.7%	90.6%	80.5%	89.3%
13	88.5%	88.1%	96.7%	89.6%	82.8%	90.4%
14	88.1%	89.8%	97.9%	89.5%	85.3%	91.6%
15	88.7%	90.6%	97.9%	89.3%	88.2%	92.0%
16	89.9%	93.1%	97.6%	89.8%	90.3%	93.5%
17	90.4%	93.0%	95.9%	90.1%	91.5%	93.1%
18	110.7%	90.3%	96.2%	89.3%	92.2%	92.6%
19	110.4%	91.7%	96.2%	93.8%	93.0%	94.0%
20	110.3%	91.9%	95.9%	94.4%	94.3%	94.2%
21	110.6%	92.4%	101.9%	93.8%	94.9%	95.7%
22	110.7%	92.9%	102.0%	95.0%	96.0%	96.2%
23	110.7%	93.6%	102.1%	96.2%	97.6%	96.8%
24	110.1%	94.7%	102.1%	95.9%	98.1%	97.4%
25	110.1%	94.8%	102.1%	96.0%	98.2%	97.5%
26	109.9%	95.2%	101.6%	97.0%	98.5%	97.7%
27	111.1%	95.6%	101.9%	97.7%	98.9%	98.2%
28	111.5%	98.2%	101.9%	95.4%	99.3%	99.3%
29	111.4%	98.3%	101.8%	95.5%	99.3%	99.4%
30	111.3%	98.4%	101.3%	95.5%	99.3%	99.3%
31	111.4%	98.1%	100.9%	96.0%	99.1%	99.1%
32	111.4%	98.2%	101.1%	94.4%	98.9%	99.0%
33	111.4%	98.4%	101.1%	94.3%	99.0%	99.0%
34	111.4%	97.8%	101.1%	94.4%	98.7%	98.7%
35	111.3%	98.0%	101.1%	94.8%	98.9%	98.9%
36	111.3%	99.0%	101.1%	95.1%	99.5%	99.5%
37	111.4%	99.1%	101.1%	95.4%	99.6%	99.6%
38	111.4%	98.8%	101.1%	95.9%	99.5%	99.5%
39	111.0%	99.2%	101.2%	99.8%	100.3%	100.3%
40	111.5%	99.0%	101.1%	99.5%	100.2%	100.2%
41	111.5%	99.9%	101.1%	98.8%	100.6%	100.6%
42	111.4%	99.9%	101.3%	98.7%	100.6%	100.6%
43	111.4%	99.2%	101.1%	98.8%	100.2%	100.2%
44	111.4%	99.3%	100.7%	97.9%	100.0%	100.0%
45	111.4%	99.4%	100.7%	98.9%	100.2%	100.2%
46	111.0%	99.8%	100.7%	99.0%	100.4%	100.5%
47	111.0%	99.8%	100.7%	100.5%	100.7%	100.7%
48	111.0%	99.8%	100.7%	100.6%	100.7%	100.7%
49	111.0%	99.8%	100.7%	100.8%	100.7%	100.7%
50	110.9%	99.9%	100.7%	100.5%	100.7%	100.7%
60	110.3%	100.0%	100.0%	101.5%	100.8%	100.8%
70	103.4%	100.7%	100.0%	102.2%	100.2%	100.9%
80	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

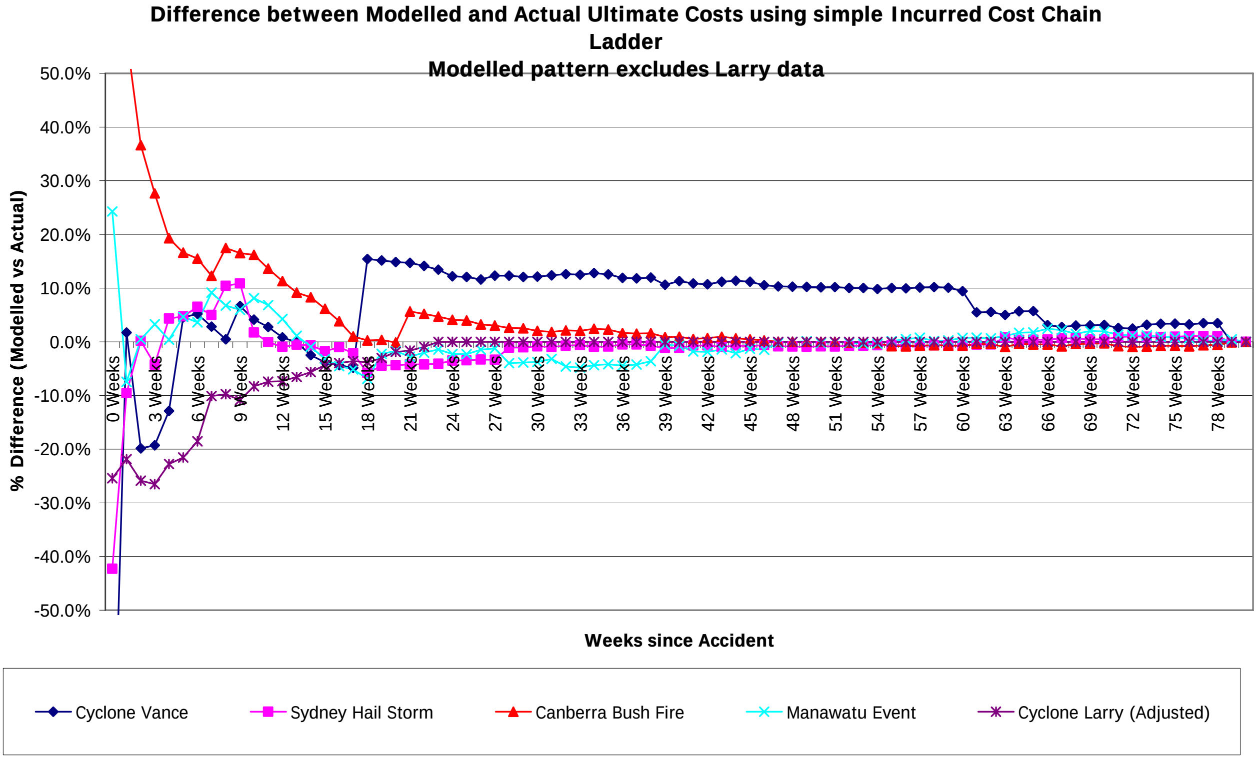
A1.2.2 Weekly Development Factors for Incurred Costs

Development Week	Cyclone Vance	Sydney Hail Storm	Canberra Bush Fire	Manawatu Event	Cyclone Larry (Adjusted)	Average (Excl Larry)	Smoothed	Cumulative Smoothed
0 to 1 Week	3029.7%	478.0%	205.0%	227.1%	319.5%	304.9%	304.9%	665.9%
1 to 2 Weeks	102.5%	144.0%	113.2%	141.1%	123.4%	131.0%	130.0%	218.4%
2 to 3 Weeks	110.7%	105.1%	102.8%	113.1%	109.0%	105.8%	110.0%	168.0%
3 to 4 Weeks	118.7%	119.9%	102.8%	107.0%	115.6%	112.9%	110.0%	152.7%
4 to 5 Weeks	126.0%	105.4%	102.6%	109.5%	106.7%	106.1%	105.0%	138.9%
5 to 6 Weeks	102.7%	103.7%	101.0%	101.0%	105.9%	102.6%	102.0%	132.2%
6 to 7 Weeks	99.7%	100.6%	99.2%	107.4%	112.5%	101.2%	102.0%	129.6%
7 to 8 Weeks	99.7%	107.3%	106.7%	99.8%	102.4%	105.6%	102.0%	127.1%
8 to 9 Weeks	108.3%	102.4%	101.2%	101.2%	100.7%	102.2%	102.0%	124.6%
9 to 10 Weeks	99.6%	93.6%	101.7%	104.1%	104.9%	97.4%	102.0%	122.2%
10 to 11 Weeks	100.6%	100.2%	99.7%	100.8%	103.0%	100.2%	102.0%	119.8%
11 to 12 Weeks	100.1%	101.1%	99.9%	99.5%	102.1%	100.5%	102.0%	117.4%
12 to 13 Weeks	101.1%	102.4%	100.0%	98.9%	102.9%	101.2%	102.0%	115.1%
13 to 14 Weeks	99.6%	101.9%	101.2%	100.0%	103.0%	101.3%	102.0%	112.9%
14 to 15 Weeks	100.6%	100.9%	100.0%	99.7%	103.4%	100.4%	102.0%	110.7%
15 to 16 Weeks	101.4%	102.8%	99.8%	100.6%	102.4%	101.6%	102.0%	108.5%
16 to 17 Weeks	100.5%	99.9%	98.3%	100.4%	101.4%	99.6%	101.0%	106.4%
17 to 18 Weeks	122.5%	97.2%	100.3%	99.1%	100.8%	99.4%	101.0%	105.3%
18 to 19 Weeks	99.7%	101.5%	100.1%	105.0%	100.8%	101.6%	100.0%	104.3%
19 to 20 Weeks	99.9%	100.3%	99.7%	100.7%	101.4%	100.2%	100.2%	104.3%
20 to 21 Weeks	100.3%	100.5%	106.2%	99.3%	100.6%	101.7%	100.4%	104.1%
21 to 22 Weeks	100.0%	100.5%	100.1%	101.3%	101.2%	100.5%	100.5%	103.7%
22 to 23 Weeks	100.0%	100.8%	100.2%	101.2%	101.6%	100.6%	100.6%	103.2%
23 to 24 Weeks	99.5%	101.2%	100.0%	99.7%	100.6%	100.6%	100.6%	102.5%
24 to 25 Weeks	100.0%	100.2%	100.0%	100.1%	100.1%	100.1%	100.1%	101.9%
25 to 26 Weeks	99.8%	100.4%	99.5%	101.1%	100.2%	100.2%	100.2%	101.8%
26 to 27 Weeks	101.1%	100.4%	100.3%	100.7%	100.5%	100.5%	100.5%	101.6%
27 to 28 Weeks	100.4%	102.8%	100.0%	97.7%	100.4%	101.2%	100.4%	101.1%
28 to 29 Weeks	99.8%	100.1%	100.0%	100.2%	100.0%	100.0%	100.0%	100.7%
29 to 30 Weeks	100.0%	100.1%	99.5%	100.0%	99.9%	99.9%	99.9%	100.7%
30 to 31 Weeks	100.0%	99.7%	99.7%	100.4%	99.8%	99.8%	99.8%	100.7%
31 to 32 Weeks	100.0%	100.1%	100.1%	98.4%	99.8%	99.8%	99.8%	100.9%
32 to 33 Weeks	100.0%	100.2%	100.0%	99.9%	100.1%	100.1%	100.1%	101.1%
33 to 34 Weeks	100.0%	99.4%	100.1%	100.1%	99.7%	99.7%	99.7%	101.0%
34 to 35 Weeks	99.9%	100.2%	100.0%	100.4%	100.2%	100.2%	100.2%	101.3%
35 to 36 Weeks	100.0%	101.0%	100.0%	100.3%	100.6%	100.6%	100.6%	101.1%
36 to 37 Weeks	100.0%	100.1%	100.0%	100.3%	100.1%	100.1%	100.1%	100.5%
37 to 38 Weeks	100.0%	99.6%	99.9%	100.5%	99.9%	99.9%	99.9%	100.4%
38 to 39 Weeks	99.7%	100.4%	100.1%	104.1%	100.8%	100.8%	100.8%	100.5%
39 to 40 Weeks	100.5%	99.9%	99.9%	99.7%	99.9%	99.9%	99.9%	99.7%
40 to 41 Weeks	100.0%	100.9%	100.0%	99.3%	100.4%	100.4%	100.4%	99.8%
41 to 42 Weeks	99.8%	100.0%	100.1%	99.9%	100.0%	100.0%	100.0%	99.4%
42 to 43 Weeks	100.0%	99.3%	99.8%	100.1%	99.6%	99.6%	99.6%	99.4%
43 to 44 Weeks	100.0%	100.2%	99.6%	99.1%	99.9%	99.9%	99.9%	99.8%
44 to 45 Weeks	100.1%	100.1%	100.0%	101.0%	100.2%	100.2%	100.2%	100.0%
45 to 46 Weeks	99.6%	100.4%	100.0%	100.0%	100.2%	100.2%	100.2%	99.8%
46 to 47 Weeks	100.0%	100.0%	100.0%	101.5%	100.2%	100.2%	100.2%	99.6%
47 to 48 Weeks	100.0%	100.0%	100.0%	100.2%	100.0%	100.0%	100.0%	99.3%
48 to 49 Weeks	100.0%	100.0%	100.0%	100.2%	100.0%	100.0%	100.0%	99.3%
49 to 50 Weeks	99.9%	100.1%	100.0%	99.7%	100.0%	100.0%	100.0%	99.3%
50 to 51 Weeks	100.0%	100.0%	100.0%	100.1%	100.0%	100.0%	100.0%	99.3%
51 to 60 Weeks	99.4%	100.2%	99.4%	100.9%	100.1%	100.1%	100.1%	99.3%
61 to 70 Weeks	93.7%	100.7%	99.9%	100.6%	99.5%	100.1%	99.5%	99.2%
71 to 80 Weeks	96.7%	99.3%	100.0%	97.9%	99.8%	99.1%	99.8%	99.8%
Over 80 Weeks	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

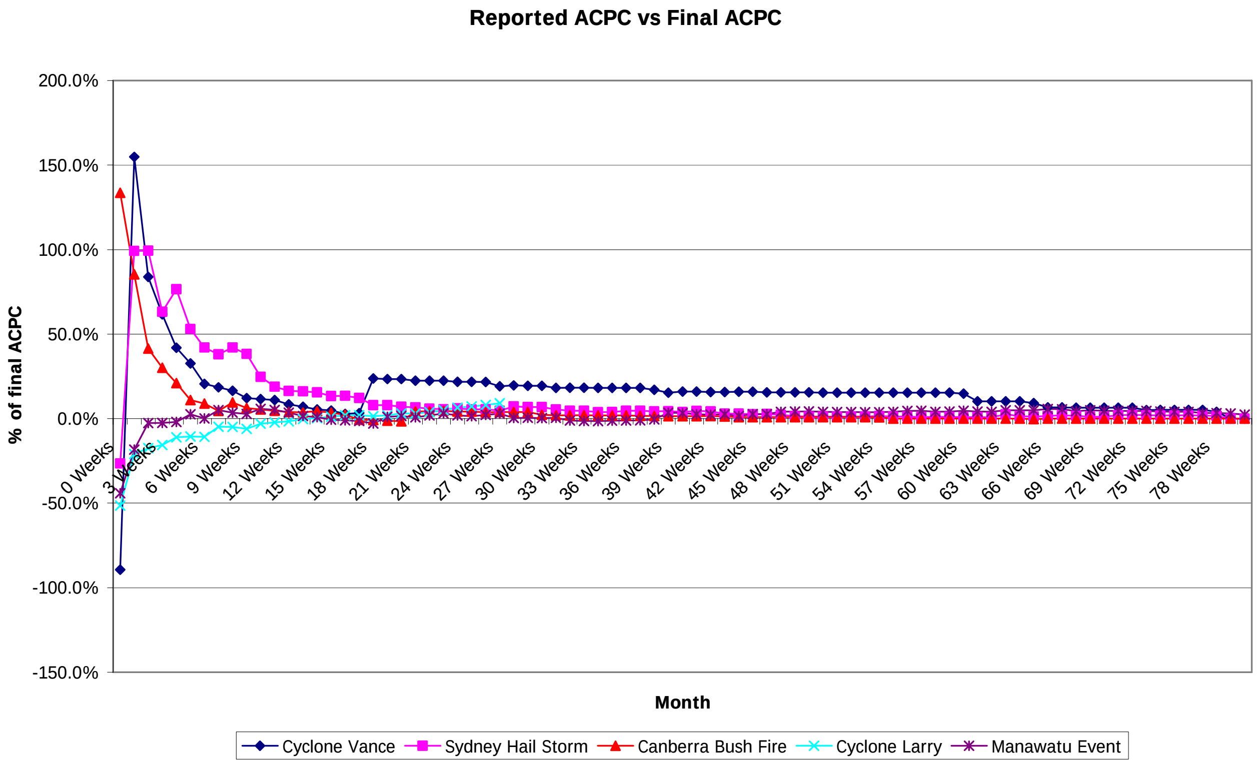
A1.2.3 Graph of Cumulative Proportion of Ultimate Costs by Development Week



A1.2.4 Graph of Variability in Accuracy of Predicted Ultimate Incurred Cost using Simple Chain Ladder Model by Week



A1.3.1 Reported Average Cost per Claim as a Proportion of Ultimate Average Cost per Claim by Development Week



A1.3.2 Claim Size Band Monitoring Tool

Claim Band	Reported							Ultimate			
	# Claims	% of Claims Reported	Average Cost per Claim	Total Cost to Date	# Closed	% Closed		Selected % of Claims Reported	# Claims	Adopted ACPC	Total Cost
Zero	100	8.2%	-20	-2,000	100	100.0%		20.00%	600	-20	-12,000
Less than $100	120	9.9%	56	6,720	12	10.0%		5.00%	150	56	8,400
$100 to $1,000	200	16.5%	650	130,000	20	10.0%		10.00%	300	650	195,000
$1,000 to $5,000	400	32.9%	4,000	1,600,000	40	10.0%		32.00%	960	4,000	3,840,000
$5,000 to $10,000	320	26.4%	7,320	2,342,400	32	10.0%		25.00%	750	7,320	5,490,000
$10,000 to $20,000	60	4.9%	14,950	897,000	6	10.0%		5.00%	150	14,950	2,242,500
$20,000 to $50,000	10	0.8%	36,100	361,000	1	10.0%		2.30%	69	36,100	2,490,900
$50,000 to $100,000	2	0.2%	74,500	149,000	1	50.0%		0.50%	15	74,500	1,117,500
$100,000 to $250,000	1	0.1%	125,000	125,000	0	0.0%		0.10%	3	125,000	375,000
$250,000 to $500,000	0	0.0%	0	0	0	0.0%		0.00%	0	0	0
Over $500,000	1	0.1%	800,000	800,000	0	0.0%		0.10%	3	800,000	2,400,000
Total	1,214	100.0%	5,279	6,409,120	212	17.5%		100.00%	3,000	6,049	18,147,300

- This table could be used in conjunction with other tools and actuarial models to help assess the size of a catastrophe event
- In the “Ultimate” Section the Total Number of Claims (3,000) might come from your Reported Claim Chain Ladder Model

Appendix 2

Walk through a potential cyclone hitting Tauranga region. Model is for Commercial Property Losses only

Step 1: Assessment of Magnitude and Location of Event

Grade 4 Cyclone heading for Bay of Plenty, in particular Tauranga

First Notification of Potential Event. Probably followed closely by a request for information on potential losses

Step 2: Identification of High Level Areas Affected and Creation of Exposure Dataset for all Live Exposures

Possible Cresta Zones Affected	# of Risks	Sum Insured	Average Sum Insured
Bay of Plenty	1,000	1,100,000,000	1,100,000
Waikato	1,500	1,800,000,000	1,200,000

After High Level Regions are identified a dataset of all potentially affected exposures is created

Step 3: Isolation of potentially affected Risks (can we narrow our criteria into Epicentre/Second Tier/Outskirt/No Damage)

Cresta	Town Key	# of Risks	Sum Insured	Average Sum Insured	Potential Effect
Bay of Plenty	Tauranga	500	700,000,000	1,400,000	Epicentre
	Rotorua	300	300,000,000	1,000,000	Second Tier
	Other	200	100,000,000	500,000	Outskirt
Waikato	Hamilton	1,000	1,300,000,000	1,300,000	None
	Matamata	200	200,000,000	1,000,000	Outskirt
	Other	300	300,000,000	1,000,000	None

After collecting information on event specifics (course/epicentre, magnitude, etc) the dataset is drilled into to split exposures into regions that can be classified as either Epicentre (Heavily Effected), Second Tier (Moderately Effected) or Outskirt (Minimally Effected)

Step 4: Selection of Damage Ratio Assumptions (need damage ratio and claim frequency assumptions for each region by effect group if possible)
Possibly think about top 5 events (by estimated annual cost - combination of likelihood and size)

Event 1: Bay of Plenty Cyclone (Grade 5)

Disaster Ratio Assumptions for Top 5 events (by freq or severity) could be prepared in advance and modified to fit event

Peril Type	Region	Average SI for Region	Region Loss	Individual Loss Size	Proportion of Exposure	Average Damage Ratio	Claim Frequency	Implied ACPC
Cyclone	Bay of Plenty	1,100,000	Outskirt	No Claim	60%	0.0%	0.0%	
				0-10% of SI	32%	4.0%	100.0%	44,000
				10-30% of SI	7%	19.0%	100.0%	209,000
				30-100% of SI	1%	65.0%	100.0%	715,000
				Adopted	**100%**	**3.3%**	**40.0%**	89,650
			Second Tier	No Claim	40%	0.0%	0.0%	
				0-10% of SI	30%	4.0%	100.0%	44,000
				10-30% of SI	25%	19.0%	100.0%	209,000
				30-100% of SI	5%	65.0%	100.0%	715,000
				Adopted	**100%**	**9.2%**	**60.0%**	168,667
			Epicentre	No Claim	5%	0.0%	0.0%	
				0-10% of SI	10%	4.0%	100.0%	44,000
				10-30% of SI	35%	19.0%	100.0%	209,000
				30-100% of SI	50%	65.0%	100.0%	715,000
					100%	**39.6%**	**95.0%**	457,947

Individual Loss Size Bands allow a relatively rough assessment of potential damage ratios and claim frequencies

These assumptions can be formed by looking prior events, talking to reinsurers or by getting claims assessors views from the region

Average Damage Ratio and Claim Frequency assumptions can then be selected and applied to identified exposures

Event 1: Bay of Plenty Cyclone (Grade 4)

Peril Type	Region	Average SI for Region	Region Loss	Individual Loss Size	Proportion of Exposure	Average Damage Ratio	Claim Frequency	Implied ACPC
Cyclone	Northland	1,100,000	Outskirt	No Claim	70%	0.0%	0.0%	
				0-10% of SI	22%	4.0%	100.0%	44,000
				10-30% of SI	7%	19.0%	100.0%	209,000
				30-100% of SI	1%	65.0%	100.0%	715,000
				Adopted	**100%**	**2.9%**	**30.0%**	104,867
			Second Tier	No Claim	40%	0.0%	0.0%	
				0-10% of SI	33%	4.0%	100.0%	44,000
				10-30% of SI	23%	19.0%	100.0%	209,000
				30-100% of SI	4%	65.0%	100.0%	715,000
				Adopted	**100%**	**8.3%**	**60.0%**	151,983
			Epicentre	No Claim	5%	0.0%	0.0%	
				0-10% of SI	10%	4.0%	100.0%	44,000
				10-30% of SI	40%	19.0%	100.0%	209,000
				30-100% of SI	45%	65.0%	100.0%	715,000
				Adopted	**100%**	**37.3%**	**95.0%**	431,316

Event 3: Other Cyclone

May have default events for everything not covered by above

Damage Ratio and Claim Frequency taken from above

When Applied to Live Risk Count and Sum Insured will give an estimate of claim numbers and cost

Step 5: Application of Damage Ratio Assumptions

Cresta	Town Key	# of Risks	Sum Insured	Average Sum Insured	Potential Effect	Damage Ratio	Claim Frequency	# Claims	Cost	ACPC
Bay of Plenty	Tauranga	500	700,000,000	1,400,000	Epicentre	37.3%	95.0%	475	260,750,000	548,947
	Rotorua	300	300,000,000	1,000,000	Second Tier	8.3%	60.0%	180	24,870,000	138,167
	Other	200	100,000,000	500,000	Outskirt	2.9%	30.0%	60	2,860,000	47,667
Waikato	Hamilton	1,000	1,300,000,000	1,300,000	None	0.0%	0.0%	0	0	
	Matamata	200	200,000,000	1,000,000	Outskirt	2.9%	30.0%	60	5,720,000	95,333
	Other	300	300,000,000	1,000,000	None	0.0%	0.0%	0	0	
Total		2,500	2,900,000,000	1,160,000		10.1%	31.0%	775	**294,200,000**	379,613

Initial Estimate of Total Cost

Step 6: Sensitivity Analysis of Assumptions

Stepping through what if scenarios for different mixes of individual losses, effects of post event inflation and possibility for over/under stated exposure

Sensitivity Analysis is critical for understanding how variable your estimate may be. It can also let you quantify some risks like "what if exposures are understated by 10%"

Step 7: Prepare and Present Findings (possibly section on key things that should be addressed in initial report - like potential variability/range)

Preparation of report and presentations important as need to illustrate level of confidence from beginning, getting feedback from claims team etc, may be useful
Keep report independent and objective. May have section on Claims teams views, etc but findings should be your view with reference back to others view