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Lies, lies . . . and wretched statisticians

John McAneney, Rob van den Honert and Stephen Yeo

Time series of economic or insured losses are generally characterized by large inter-annual variance to the degree that, in the parlance of physics and engineering, trying to find a small climate change contribution to a noisy signal poses a severe signal-to-noise challenge. In recognition of this problem, Ryan Crompton et al. (2011) suggest it more sensible to search for climate change signals in time series of hazard attributes -- tropical cyclone numbers, hailstone size or heights of floodwaters, etc.

With this in mind, here we briefly explore a long-term series of flood height observations from the Rarawai Sugar Mill on the Ba River in Fiji since 1892 (Stephen Yeo, 2015). The homogenized series of mean air temperatures measured at the Nadi airport (some 60 km distant from the Mill site) show warming of $\sim 0.18\text{C}/\text{decade}$ in line with most other Pacific Island stations.

What makes this Ba river flood data set so valuable is that it comprises measurements undertaken with one consistent and simple technology: ruler measurements of flood height above the Mill floor or surveyed heights that can in turn be referenced back to this datum.

In comparison the North Atlantic hurricane record, which, however important, is contaminated by changes in observation platforms - shipborne, aircraft and satellites - and even within the satellite era by improvements in coverage, resolution and signal processing operations. These characteristics inevitably complicate any attempt to identify a climate change signal in the data series.

Figure 1 (next page) shows flood heights above the Rarawai Mill floor (5.5 m above mean sea level). These constitute 'major floods' and exhibit no statistically significant changes in frequency over the time of observation. The remainder of this study will only consider the peak heights of the floods.

Figure 2 (next page) shows that in a statistical sense the peak height of the floods appear to be increasing. The slope of the regression line is positive and statistically significant at the 10% level (but not quite at the 5% level). While this trendline explains less than 10% of the variance, we might cautiously conclude that flood depths are gradually increasing in the long term and ascribe this increase to global warming or some other phenomena.

This Issue

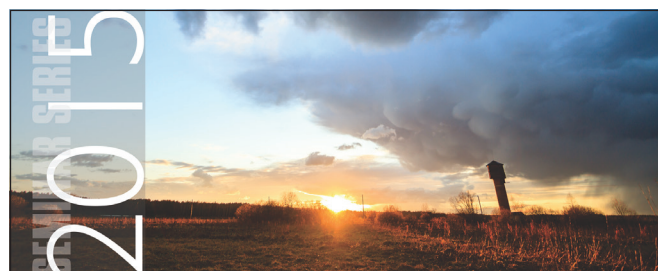
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Risk Frontiers' Seminar Series 2015 will be held on

Tuesday 27th October 2015

at the Museum of Sydney (cnr Bridge and Phillip Streets)
from 2.00pm until 4.30pm followed by light refreshments

- **Call this climate change?** *Ian Goodwin* (MU) will speak about large changes in wind and wave climates in the Pacific over the last millennium, how these facilitated the colonization of New Zealand and their implications for coastline stability.
- **Vignettes de recherche**
 - *Christina Magill* on updates to hail modelling using Reanalysis data
 - *Felipe Dimer de Oliveira* on FN curves and fat-tailed distributions
 - *Ryan Crompton* on using numerical modelling to recreate tropical cyclone windfields
- **Christchurch Earthquake - New Normal or Old Normal and Implications for Policy.** This year's selection for the Joyner Lecture, *Paul Somerville*, will speak to this topic.
- **Resilience: wot's that?** *Deanne Bird* on what happens when Operations Research meets Social Science.

Please note this date in your diary. Registrations will commence late September.

For a number of reasons, the heights of three of the four earliest data points (i.e. those before 1912) are considered to be of low accuracy. It may be debated whether or not these should be omitted from the dataset for further analysis, so as not to sully the otherwise subsequent and more accurate data points. Furthermore, extreme points (i.e. at either end of the x-range) have more of an influence on the slope of the regression. If these points were removed, what impact would this have on our conclusions?

Figure 3 displays the scatterplot and regression line calculated on the data since 1918.

The regression now is not significant, i.e. the slope of the trend line is not statistically significantly different from zero. The (reduced) dataset indicates that there is no significant increase in flood heights across time.

The above discussion illustrates that varying the starting point of a time series can lead to quite different conclusions about trends, even if the statistical analysis is consistent.

Let's consider another example: we might, as others have done more defensibly in the case of the North Atlantic hurricane data, begin our analysis in 1980, arguing perhaps that these more recent measurements are indubitably without error. We would then find a highly significant correlation (Figure 4).

Our conclusion might now be that flood heights (and the contributing rainfall) have no correlation until some threshold temperature is surpassed. This is plausible, but in this case unsupported by the annual rainfall measurements at the same site, which show no trend over a measurement period that goes back to 1910.

By way of one last example, and at the risk of being facetious, Figure 4 also shows that a similar series of points early last century show a similar rise in flood heights as does the most recent period. This of course comes back to the quasi-oscillatory character of the measured flood heights.

So in short, by judicious choice of start and end points, we are able to derive suitable statistics to defend almost any hypothesis we wish. We are only limited by our imaginations.

More seriously, these simple statistical tests show how difficult it is to confidently attribute trends in hazard attributes to global warming, or other phenomena, even when the data series is relatively long and uncontaminated by changes in technology. The problem is even more difficult when searching in economic or insurance loss data because of changing exposure and building vulnerability.

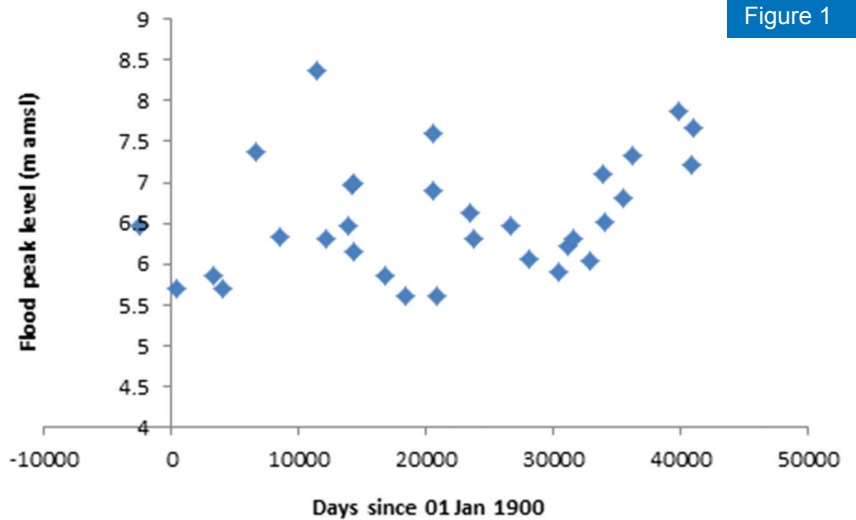


Figure 1

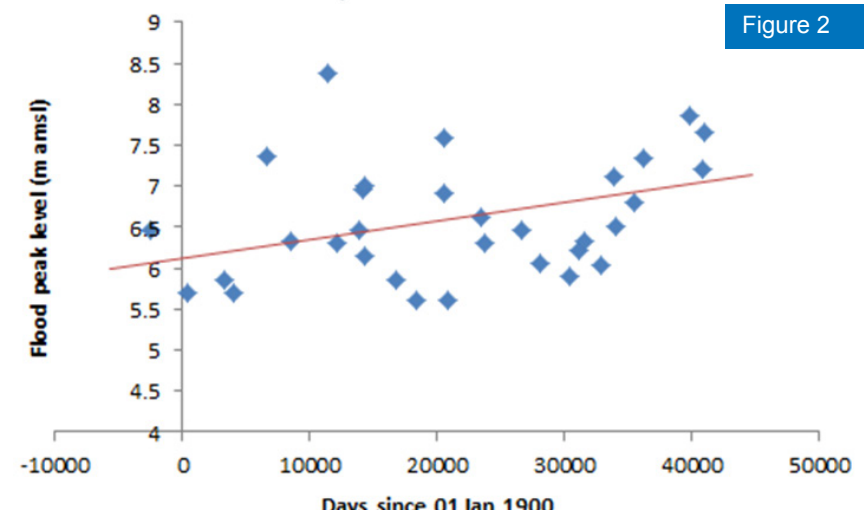


Figure 2

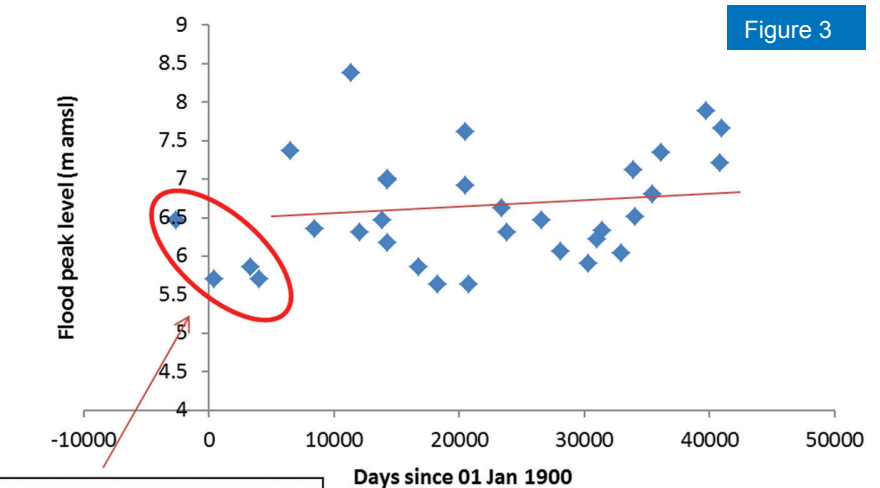


Figure 3

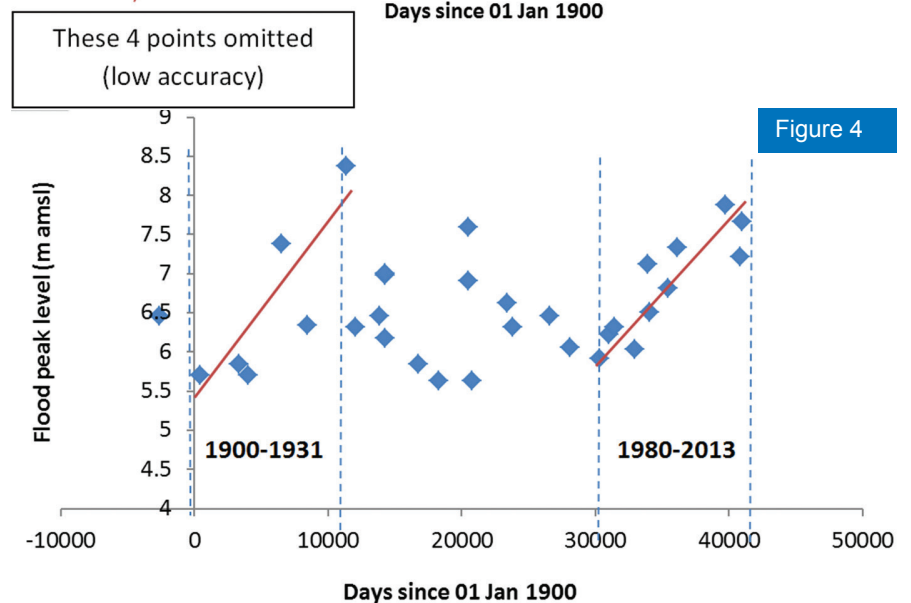


Figure 4

What is an Event?

By Colin Packham, Associate of Risk Frontiers

Introduction

As a reinsurance professional for almost 50 years, I have always been intrigued and fascinated by how the reinsurance market has adopted a simple mechanism – the “hours clause” – to enable it to reach agreement as to what constitutes an “event” for the purposes of recovering natural perils losses from catastrophe excess of loss treaties and other reinsurance contracts where such a definition is used.

Such is the efficacy of this practice that I can find no reference to any case law arising from the interpretation of this clause in the UK, the US or Australia or New Zealand. It is of course possible that some disputes may have been settled by arbitration.

Here I reflect on the history of the hours clause – as such definitions of loss occurrence are generally known – and on changes, additions and variations to it over the decades. Many of these changes were triggered by certain landmark events.

In the current era where catastrophe modelling companies and institutions such as Risk Frontiers have largely filled the space previously occupied by in-house catastrophe reinsurance underwriters, it is essential that critical features such as the precise terms of the chosen hours clause are mirrored in the modelled output.

The recent experience of the series of earthquakes in Christchurch has added additional focus to the need to be able to identify losses from one “event”.

The clause in its classic form as commonly seen in Australia:

Definition of Loss Occurrence (Hours Clause)

The words “loss occurrence” shall mean all individual losses arising out of and directly occasioned by one event.

However, the duration and extent of any loss occurrence so defined shall be limited to:

- (a) *72 consecutive hours as regards cyclone, hurricane, typhoon, windstorm, rainstorm, hailstorm and/or tornado*
- (b) *72 consecutive hours as regards earthquake, seaquake, tidal wave¹ and/or volcanic eruption*
- (c) *72 consecutive hours and within the limits of one City, Town or Village as regards riots, civil commotions and malicious damage*
- (d) *72 consecutive hours as regards any loss occurrence which includes individual loss or losses from any of the perils mentioned in (a), (b) and (c) above other than Bush Fires in Australia.*
- (e) *168 consecutive hours for any loss occurrence of whatsoever nature which does not include individual loss or losses from any of the perils mentioned in (a), (b) and (c) above*

and no individual loss from whatever insured peril which occurs outside these periods or areas shall be included in that loss occurrence.

In respect of Bush Fires in Australia, the words “loss occurrence” shall mean all individual losses arising during a period of 168 consecutive hours caused by fires originating in or spreading through trees and/or grassland.

The Reinsured may choose the date and time when any such period of consecutive hours commences and, if any event is of greater duration than the above periods, the Reinsured may divide that event into two or more loss occurrences, provided no two periods overlap and provided no period commences earlier than the date and time of the happening of the first recorded individual loss to the Reinsured in that event.

Brief History

Bob Kiln

R J (Bob) Kiln, a well-known leading Lloyd’s underwriter in the 60s, 70s and 80s, while not the first to introduce the hours clause into Catastrophe Excess of Loss treaties, can certainly be regarded as its father as he adapted and improved it to form a logical and sound definition of loss occurrence that is still recognisable today.

Hurricane Betsy 1965

Hurricane Betsy, which hit Louisiana was perhaps the first serious test of the pre-Kiln clause. At that time, the commonly found period was 48 hours for any one hurricane etc, and the phrase “provided no period commences earlier than the date and time of the happening of the first recorded individual loss to the Reinsured in that event” was yet to appear.

Kiln records that even though Betsy was of short duration, due to the extent of the damage which threatened to exhaust some insurers’ protections, certain companies interpreted the wording as allowing them to split the losses into two parts and thus make two recoveries.

It was not long afterwards that Kiln’s revision, known as LPO98a, was agreed and accepted by the market. This still forms the basis of the various versions in use today.

Australia

In Australia, while there have been certain landmark events that are etched in underwriters’ memories, few have tested the clause.

The realisation of the possibility of bushfires raging in different parts of the country at the same time led to the early introduction of the “Australian amendment” to the hours clause – 168 hours with no geographical limitation – as shown in the penultimate paragraph of the sample clause above. Some insurers went even further and negotiated an annual aggregate extension for bushfires.

The Ash Wednesday fires of 1983, that devastated parts of Victoria and South Australia with numerous separate outbreaks, provided a practical example of how this clause worked to the benefit of insurers.

Cyclone Tracy, which reduced large parts of Darwin to rubble 40 years ago, was a ‘short sharp shock’ and, as such, fell within the hours clauses in use at the time.

Similarly, the Newcastle Earthquake of 28 December 1989 did not test the clause, as there were no significant aftershocks.

Recent Events

In the current financial year, 2014/15, there has been an almost unprecedented series of ‘weather’ events.

For example, Suncorp has registered eight separate weather-related events in Eastern Australia, some of which impacted their Catastrophe XL program.²

It is likely that sooner or later there will be a situation where two major population centres are impacted by severe weather within

¹This is usually expressed as “tsunami” these days

a 72 hour period - for example, Brisbane and Sydney - with the consequent discussions as to whether the damage was caused by one "event".

APRA's LAGIC changes

Prudential Standard GPS 116 Capital Adequacy: Insurance Concentration Risk Charge effective 1 January 2013 introduced a number of changes intended to put a greater focus on repeated "weather" events such as have been experienced recently. Although the word "event" is not defined, insurers must determine the net loss arising from the occurrence of the greater of a) a single event, where that net loss is not less than the whole-of-portfolio annual net loss with a 0.5% (1 in 200 years) probability of occurrence (*the vertical requirement*), and b) with three times a 10% (1 in 10 years) probability of occurrence (H3), or four times a 16.7% (1 in 6 years) probability of occurrence (H4), whichever is the greater (*the horizontal requirement*).

This has led to insurers buying more aggregate reinsurance cover and/or more low-level Catastrophe layers with multiple reinstatements, known as "sideways cover", which will have proved its worth to insurers in the current financial year.

New Zealand

In New Zealand, the Canterbury (Christchurch) Earthquake series of 2010 and 2011 gave rise to some discussion as to whether events subsequent to the first shock were 'aftershocks' or should be treated as separate events. The market eventually agreed to regard the first (Darfield) event on 4 September 2010 as a separate loss occurrence to the second and subsequent shocks, including the Lyttelton event (22 February 2011), when the heaviest loss of life and damage took place, which is consistent with the wording of the hours clause.

The NZ Government funded Earthquake Commission (EQC) has its own special version of the hours clause in its Catastrophe excess of loss reinsurance program.

Reserve Bank of New Zealand

The RBNZ Solvency Standard for Non-life Insurance Business 2014 defines "Extreme Event" as "one or more events, including, for example, earthquake, flood or storm, that results in unexpected large or extreme losses as a result of claims on more than one insurance contract". This definition is required as part of the calculation of the Extreme Event Exposure to arrive at the Catastrophe Risk Capital Charge.

This will not necessarily produce the same result for insurers as the application of the hours clause in some instances.

Recent Developments

In recent times there have been radical changes made to the Hours Clause, principally in the London Market.

These include:

1. Extension of the time element for Storm from 72 hours to 120 hours, and, in some cases, 168 hours.
2. Extension of the time element for Flood "howsoever caused" from 168 hours to 504 hours.
3. Combined Windstorm and Flood events extended to 504 hours, and with the option to deem any one 'Loss Occurrence' to be the aggregate of all losses within the territorial scope of the contract.

4. Winter freeze also extended to 504 hours, and with the option to deem any one 'Loss Occurrence' to be the aggregate of all losses within the territorial scope of the contract.
5. Extension of coverage to include Fire as a direct consequence of any of the named perils.

The implications of these changes for reinsurers are:

- a) A widening of the definition of loss occurrence in terms of time. Windstorms often take several days (and more than 72 hours) in their life-cycle. European floods may take weeks to pass through river basins through a number of countries in Central and Western Europe (e.g. the Elbe and Danube floods in 2007). If the reinsurer is dependent upon Cat modelling that is aligned with perils that are not defined by time, then there may not be any issues. However, the application of these clauses to storm "events" that affect both the UK and Continental Europe would have adverse implications for reinsurers of Europe-wide programmes.
- b) The risk of reinstating cover. As "events" are extended in time, the likelihood of reinstating cover in the same "event" (where this is available) is reduced. However, the potential for a doubling of the loss occurrence limit still exists.
- c) Uncertainty of reinstatement. Where the reinsured has the option to decide to apply a single occurrence or an aggregation of occurrences, a considerable degree of uncertainty is introduced into the contract, thus making it more difficult for the reinsurer to determine its exposure.
- d) Increased exposure to attritional losses. As elements of historically well-defined "occurrence" coverage become aggregated over time, geography and perils, reinsurers will become more exposed to attritional losses which they may not have priced for, or expected to cover.
- e) Difficulty in matching retrocession coverage. It is much harder for reinsurers to align their retrocession protections if they are unsure as to how the reinsured will define the "event". The logical consequence will be for the reinsurers to reduce their exposure. Some reinsurers will seek to retain the contractual right to determine what constitutes an "event" in their retrocession contracts.
- f) One-sided options. Finally, if the reinsured has the option to define the loss occurrence following its happening, then reinsurers must be aware that that the revisions will always operate to the advantage of the buyer and the detriment of the seller. More and more, reinsureds are putting themselves in the best possible position.

Conclusion

Inevitably, the hours clause will continue to evolve and mutate.

In the current soft market, there are pressures on reinsurers to be ever more generous in what they will classify as falling within one "event", with the trend towards Catastrophe Excess of Loss treaties more and more taking the form of modified Aggregate Excess of Loss covers. This in turn has implications for how exposures are modelled.

Would Kiln turn in his grave?

For a more detailed review of the Hours Clause, in future you will be able to go to "What is an Event" at the Risk Frontiers website www.riskfrontiers.com and on LinkedIn (https://www.linkedin.com/company/risk-frontiers?trk=nav_account_sub_nav_company_admin)