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CAT 360

Catastrophe Risk from Every Perspective

The ACE Report is a periodic publication distributed to policy holders and other interested parties as a service by ACE. Its purpose is to address insurance concerns worldwide, as well as present timely information on current developments in liability issues surrounding directors and officers.

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Editors

Sophia Zhang
sophia.zhang@acegroup.com

Randall Law
randall.law@acegroup.com

ACE Tempest Re
ACE Building
17 Woodbourne Avenue
Hamilton HM08
Bermuda

441 292-2603 tel
441 295-2888 fax
acetempetre@acegroup.com
www.acetempestre.com

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Weather Variability Down Under

Australia has been at the brunt of widespread flooding, intense cyclones, hail storms and bushfires in the past 12 months. Sophia Zhang considers whether this activity is linked to broader climatic cycles.

The Queensland flooding this past year has drawn attention to catastrophe exposures in Australia. While flooding regularly occurs in Queensland, the intensity of the recent flooding was the state's worst since the 1974 Brisbane flood (triggered by Tropical Cyclone Wanda). Is global warming to blame, or are there other climate factors at play causing this extreme weather?

In discussions over the cause of the 2010/2011 Queensland floods, La Niña is often referred to by meteorologists and other weather experts. It is thought a strong La Niña created one of the wettest summers on record in eastern Australia, bringing together a confluence of weather systems and water logged conditions which led to widespread flooding. The La Niña also contributed to the intensity of Category 5 Cyclone Yasi, which made landfall on the Queensland coast on 3 February and was one of the strongest storms to hit Australia since records began. Strong winds emanating from Yasi are also blamed for stoking wildfires in Western Australia.

This article discusses the variability in Australia weather, in particular the ENSO (El Niño/La Niña-Southern Oscillation) and how it affects weather events such as floods, droughts, hail storms, bushfires, the East Coast Low and tropical cyclone activity. It looks at the impact of ENSO on weather events in Australia, discusses whether a decadal variability exists and whether it is possible to identify a trend in the weather events.

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ENSO's impact on Australian weather

ENSO is characterized by irregular two-to-seven year oscillations in the equatorial Pacific sea surface temperatures. It affects weather globally with the positive phase of ENSO called El Niño and the negative phase called La Niña. ENSO is the most important climate oscillation that affects Australia. The following table summarizes the effects of ENSO on different weather events while the sections below discuss how it affects each individual weather phenomena.

	El Niño	La Niña
Tropical Cyclone	-	+
Flood	-	+
Drought	+	-
Hail	- (slight)	+ (slight)
Bushfire	+	-
East Coast Lows Note 1	-	+

Legend
- = Decrease
+ = Increase
- = Slight Decrease
+ = Slight Increase

Note 1 Especially for storms with significant rainfall

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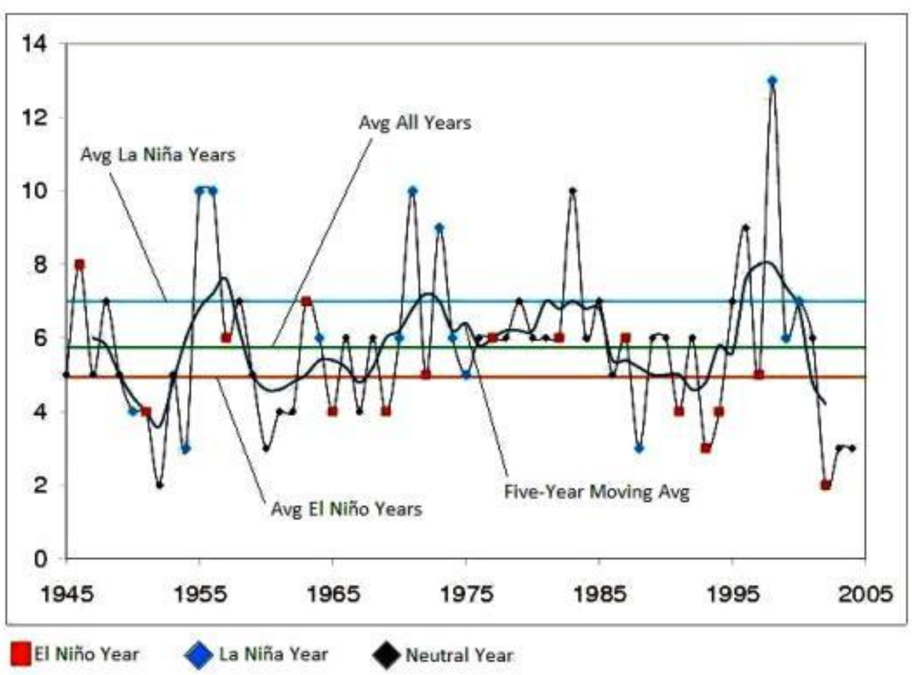
Tropical Cyclone

The average tropical cyclone landfall frequency is about 5.8 times per year. In El Niño years, the average landfall frequency drops to 4.9 while it increases to 7.0 in La Niña years. The following graph shows the annual tropical cyclone landfalls. While this graph shows a slight upward trend in annual cyclone landfall frequency, a longer term view from the late 1800s shows an inconclusive trend over the entire period of time.

Annual Tropical Cyclone Landfall Frequency - 1945 to 2004



Major Tropical Cyclones Tracy (1974), Joan (1975), Olivia (1996) and Larry (2006) occurred during La Niña periods, while Ingrid occurred during an El Niño period.

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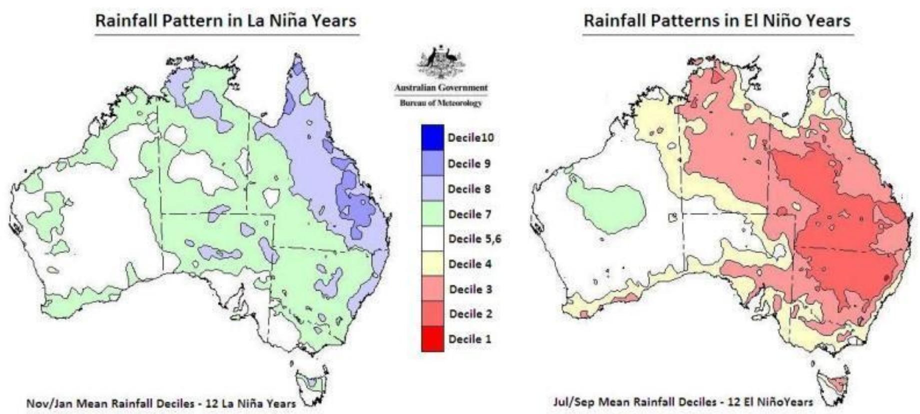
Flood and Drought

El Niño decreases the chance of flood and increases the chance of drought while La Niña has the opposite effect. The most affected region is the east coast of Australia. The following graphs show rainfall patterns in La Niña and El Niño years and compare them to the average for the Southern Hemisphere summer (November to January). The shades of blue represent wetter than the average rainfall while the shades of red represent drier than the average rainfall.

In La Niña years, the entire east coast of Queensland is wetter than average. The 1974 Brisbane Flood occurred in a La Niña year as did the multiple floods in Central Queensland and Victoria during the 1988-1989 La Niña. By contrast, El Niño causes droughts to occur in Queensland and New South Wales with the dry conditions mostly occurring during the winter period July to September. Both the 2002-2003 and 1982-1983 El Niño events had a very strong impact in Australia, causing widespread drought.



Rainfall patterns in ENSO years. Shades of "Blue" represent wetter than average rainfall. Shades of "Red" represent drier than average rainfall.

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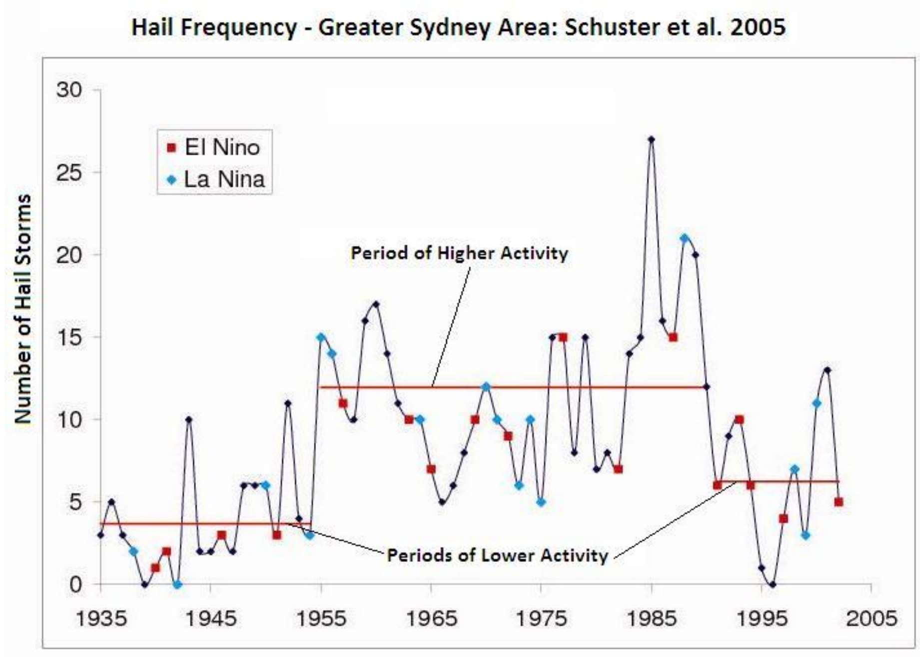
Hail

Hail frequency in La Niña years is slightly higher than El Niño years. However, there are neutral years in which severe damage has occurred. The following graph shows the hail storm frequency in the Sydney area. The red dots are the El Niño years and blue dots are the La Niña years. There are periods of high and low activity. However, there is only a weak relationship between ENSO and hail storm frequency, and hail damage is largely localized. Widespread hail damage like the 1999 Sydney hailstorm (costing AUD1.7bn in insured losses), which affected a large area along the east coast of New South Wales, is rare.

It can also be observed that the frequency of storms is not indicative of the hail damage. For example, while 1990 and 1999 were the two most damaging years in terms of hail losses, the frequency during those years was close to or below average. While it appears there is a higher average frequency from 1955 to 1990, there does not appear to be a particular climate signal that would be associated with the increased frequency.



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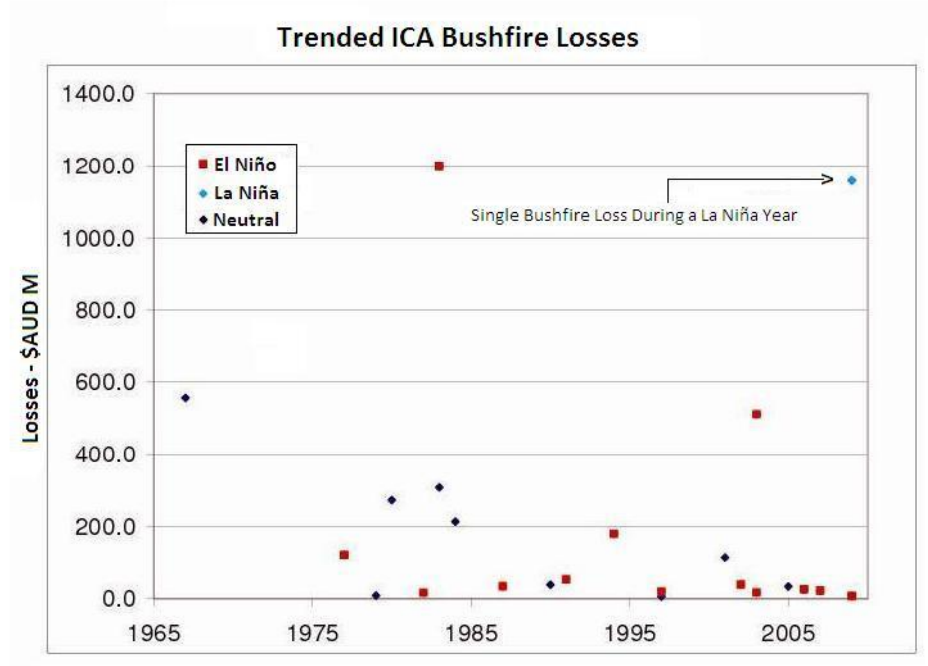
Bushfire

There is a strong association between bushfires - or wildfires - and ENSO with many of the bushfires occurring during El Niño years, including the Ash Wednesday fires in Victoria in 1983. The graph below plots the trended Insurance Council of Australia (ICA) bushfire damage. The red dots are El Niño years and the blue dots are La Niña years.

In the 1982-1983 El Niño event, below-average rainfall patterns were established in April 1982 and continued almost unabated up to and including February 1983 when southern Australia experienced heat-wave conditions and bushfires that culminated in the Ash Wednesday disaster. The insured loss from this event was AUD1.2bn (trended).

There was only one exception to the usual La Niña trend of low bushfire losses that remains in recent memory. In 2009, a weak La Niña event occurred during the period August 2008 to April 2009. While La Niña years are normally wet across the entire eastern region of Australia, January to February 2009 was very dry across much of southern Australia. This, coupled with two extreme heat-waves during the same period, contributed to the Black Saturday bushfires. The insured loss from this event is close to AUD1.2bn.



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East Coast Low

East Coast Lows (ECLs) are intense low pressure systems which occur several times each year off the eastern Australian coast. The system, which has closed cyclonic circulation at the surface, can intensify very rapidly forming gale-force winds and heavy flooding. Overall an average of 22 East Coast Low events occur each year - but not all of them cause damage. Events with significant rainfall happen around seven times a year. An ECL in 2007 is blamed for causing the Hunter Valley Storm/Flood, which led to AUD1.6bn in insured losses.

In 1997, scientists Hopkins and Holland studied the effects of ENSO on the East Coast Low. They found a preference for ECLs to form during years transitioning between negative and positive Southern Oscillation Index. The 2007 Hunter Valley Storm/Flood falls into this category. An El Nino event was established during May 2006 to April 2007 and by June 2007 it was transitioning to weak La Niña, which is when the storm and floods occurred. A La Niña event tends to draw convection closer to eastern Australia and provides abundant moisture to the ECLs, thus increasing the chance of intense rainfall and flooding. The frequency of ECLs is slightly lower in El Nino years.

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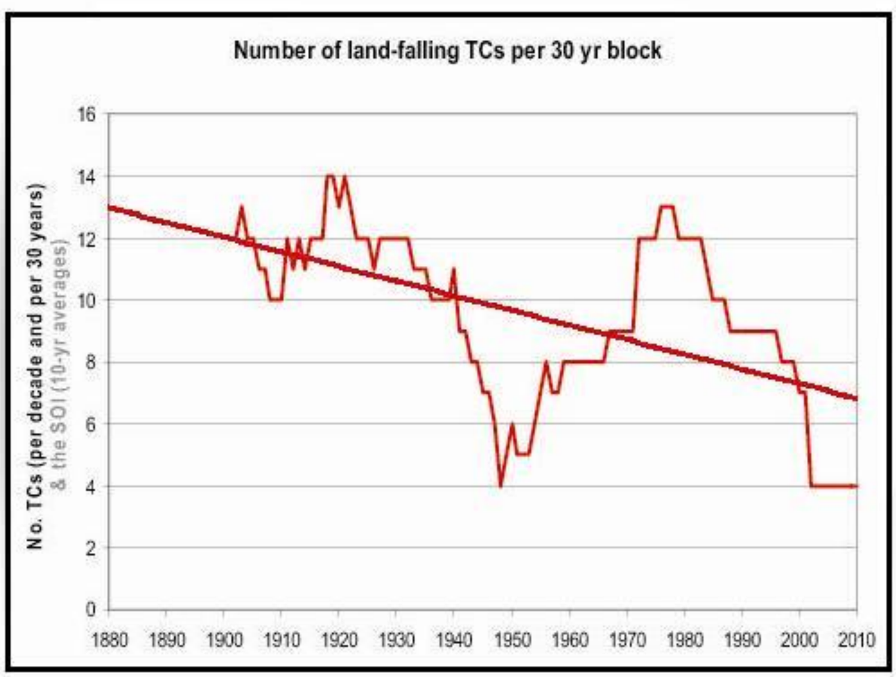
Trends and Decadal Variabilities

We have seen that there is strong evidence that supports Decadal Variability for the natural perils that affect Australia. However, the trend is mostly inconclusive. The following table summarizes whether trends or decadal variabilities are observed for each of the discussed weather phenomena.

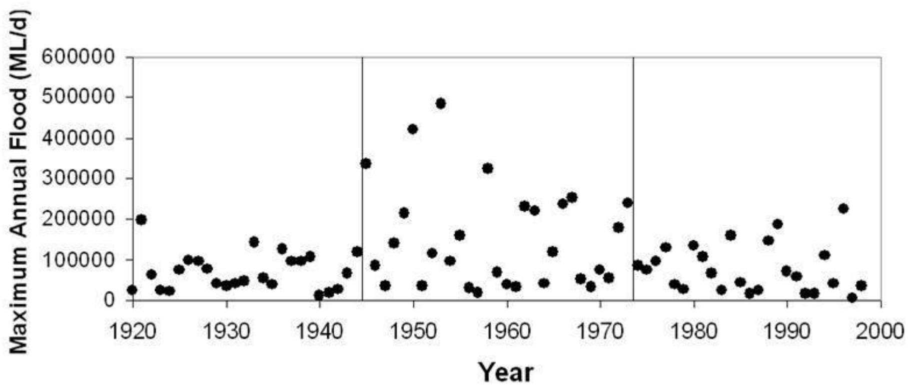
	Decadal Variability	Trend
Tropical Cyclone	Yes	Inconclusive
Flood	Yes	Inconclusive
Drought	Yes	Inconclusive
Hail	Yes	No
Bushfire	N/A	Yes
East Coast Lows	Yes	No

Recently, a group of Australian scientists extended the tropical cyclone landfall data to 1880 and studied the multi-decadal variability of tropical cyclone landfall. They found a period of heightened activity, lasting 20 to 30 years, followed by quieter periods. Perhaps surprisingly given some very intense tropical cyclones in recent years, they believe we are currently in a period of low activity with the last active period ending in the late 1990s (having begun in the 1970s). It is postulated that this variability is related to decadal variability in ENSO and the longer-term Inter-decadal Pacific Oscillation (IPO). However, the predictability of the inter-decadal changes of climate signals is low.

In addition, the scientists found that the incidence of land-falling tropical cyclones has been steadily trending downwards over the past 130 years. However, other studies dispute this, finding either no trend or even a positive trend in intense tropical cyclones and for this reason the trend of tropical cyclone activity is inconclusive. The difference in findings can be put down to the quality and the length of the data sets used. For example, some people use data sets going back to 1880 while others use post-1950 data.



The graph below illustrating flood data from 1920 to 2000 is from a study by scientists at University of Newcastle. It clearly shows a multi-decadal shift occurring with a sudden shift representing the change from a low to high flood risk period. The period between the mid-1940s and mid-1970s has higher flood risk than the period that came before and the period that followed. Unfortunately, the study is based on data captured before 2000 and it is therefore not clear whether there has been a shift back to a high flood risk period since 2000, keeping in mind that 2002-2003 was one the worst droughts in Australian history. The multi-decadal variability of flood and drought is again linked to IPO.



There is little study on the decadal variability of hail activity; however a visual inspection of the hail chart in section 1.3 suggests there is decadal variability every 20-30 years. However, given that the two most damaging hail events happened during quiet periods of activity this trend is not decisive. After removing the artificial trend introduced by the modern reporting process the conclusion must be that there is no obvious trend in the data linking hail activity to a multi-decadal cycle, at least not for the urban Sydney region.

As for ECLs, there are currently no observed clear trends that can be separated out from the decadal variability. A Commonwealth Scientific and Industrial Research Organization study on ECLs off the Victoria coast found there would be no appreciable change to the frequency of ECLs in a warmer environment but that rainfall from these systems is likely to increase with climate change.

In summary, many of Australia's weather events have a multi-decadal variability that is linked to inter-decadal changes of climate signals such as IPO. Long-term predictability of IPO is an area of ongoing study, which is needed to understand the current phase and to decipher whether there has been any phase change. For annual forecasts emphasis should be focused on the likely stage of the ENSO, which is the most important climate signal affecting Australia in the short term. A lead time of three to four months gives a fairly reliable forecast although special attention is needed in the spring when ENSO tends to change its phase from El Niño to La Niña or La Niña to El Niño.

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