Submission to the Senate Committee Inquiry - Recent trends in and preparedness for extreme weather events

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Author Background

Stewart Franks is an Associate Professor of Environmental Engineering at the University of Newcastle and will take up the Foundation Chair of Environmental Engineering, University of Tasmania from 29th February 2013. He currently serves as the Australian National Representative to the International Association of Hydrological Sciences (IAHS) and is the current President of the International Commission on the Coupled Land-Atmosphere System (ICCLAS). He has published extensively on modelling the interactions of land surface hydrology and atmosphere for atmospheric and climate models, uncertainty estimation and on the non-stationarity of climate extremes in Australia (flood, drought and bushfire risk).

Comments on the terms of reference;

(a) recent trends on the frequency of extreme weather events, including but not limited to drought, bushfires, heatwaves, floods and storm surges;

On attribution by simple linear trend analysis

I write in large part to supplement the submission by Dr Anthony Kiem with whom I have published on the long-term variability of climate extremes in Eastern Australia. These papers have been published in the leading international peer-reviewed literature and document the variability of flood, drought and bushfire risk as a function of variability El Nino-Southern Oscillation (ENSO) processes and the multi-decadal (20-40 year) variability of the Pacific Decadal Oscillation/Interdecadal Pacific Oscillation (PDO/IPO).

Recent observed trends in the frequency of occurrence of extreme events can be very easily misconstrued a being due to anthropogenic factors. Numerous studies have sought to fit linear trends to relatively short observations (eg. 1950-present) which are then often interpreted as due to anthropogenic climate change (eg. Nicholls, 200; Cai et al, 2008). Given the clear multidecadal variability exhibited by climate extremes when analysed from >120 years observations and much longer paleo-reconstructions (>400 years), such analyses are not valid.

If one looks at the 1945-1998 trend in rainfall/annual maximum flood data for eastern Australia, a declining linear trend is observed to be statistically significant. However, if one performs the same analysis utilising the data from 1920-1975, a similarly significant trend is observed but one where the trend is increasing. Figure 1 demonstrates this simple observation utilising a typical record of annual maximum flood data from northern NSW. Consequently, simple trends observed over 50-60 year periods are actually a function of long-term variability in the known climate drivers of extremes in eastern Australia (figure 2), and yet are often speculatively attributed to anthropogenic factors.

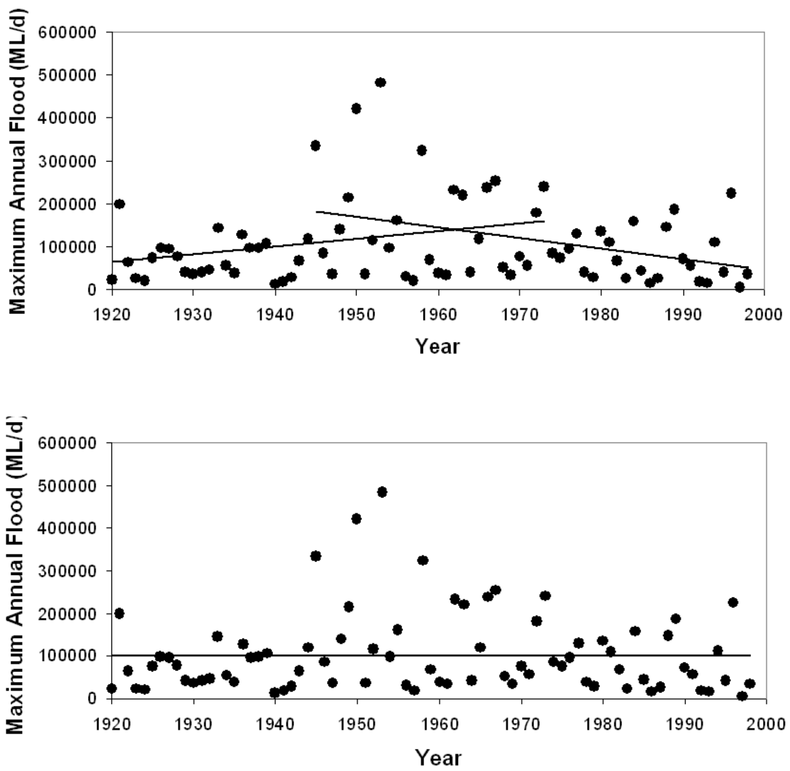

Figure 1: Annual maximum flood observations 1920-1998 (a) trend from 1920-1975 and 1945-1998, (b) trend from 1920-1998 after Franks (2013)

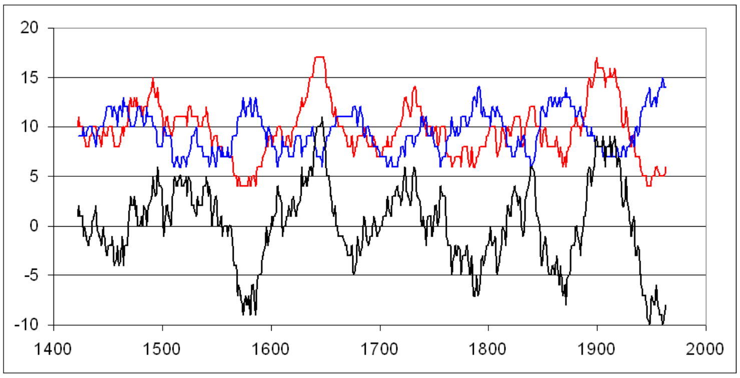

Figure 2: Frequency of occurrence of El Nino (red) and La Nina (blue) in 30 year window applied to 500+ year ENSO paleo-reconstruction. Black line indicates the number of El Nino minus the number of La Nina events, after Franks (2013). Note multi-decadal (20-40 year) variability of El Nino/La Nina dominance

Misunderstanding the physics of evaporation and the 'exacerbation' of drought in Australia

In 2002, an El Nino event led to widespread drought across eastern Australia and in particular in the Murray-Darling Basin. The drought led to many incorrect claims by leading Australian climate scientists who confused cause and effect with regard to the role that higher air temperatures played in 'exacerbating' the drought.

For example, several recent studies of the drought in the Murray–Darling basin (MDB) in Australia have linearly correlated maximum temperatures with rainfall and examined the residual temperature time series (e.g. Nicholls, 2004). The 2002 MDB drought had higher temperatures than expected from the fitted linear trend alone, which was interpreted as increased temperatures leading to increased evaporation and an exacerbation of the 2002 drought. Further studies proposed that increased temperatures are the cause of reduced inflows into the basin (Cai and Cowan, 2008) and that increased temperatures have led to decreased soil moisture in the MDB (Cai et al., 2009). These propositions would imply that increased evaporation is primarily a consequence of higher temperatures. However, in terms of physical mechanisms, it is the amount of evaporation that plays a major role in controlling the temperatures reached in the daytime, rather than vice versa.

When the solar radiation falls on a wet landsurface, much of the incoming energy is utilised in evapotranspiration leaving only a small portion available for the heating of the near surface atmosphere. Consequently, daytime maximum temperatures are moderated by the evapotranspiration. When solar radiation falls on a dry land surface, as occurs during a drought induced by deficient rainfall and hence soil moisture, evapotranspiration is limited. Consequently, a much greater portion of the incoming energy is utilised to heat the near surface atmosphere resulting in much higher maximum daytime temperatures (Lockart et al, 2012).

There continues to be a widespread misunderstanding in the Australian climate community that future hotter temperatures led to increased drought intensity. This has led, in part, to claims of a 'drying' of eastern Australia and attributed to anthropogenic climate change. As demonstrated above, this represents a confusion of cause and effect at the highest level of Australian climate science.

There is no empirical evidence that drought is more frequent, nor more intense than previous widespread droughts that have occurred across the Australian continent. Moreover, a recent study (Sheffield et al., 2012) has demonstrated little if any change in the occurrence of drought on a global basis over the last 60 years.

Mitigating the impacts of natural climate variability as a pre-requisite for coping with 'changes in climate'

It is clear that despite many claims to the contrary, there is little empirical evidence that hydro-climatic extremes (flood, drought or bushfire risk) are any worse today than they have been in the past. The observation that multi-decadal variability of ENSO and PDO/IPO has a dominant effect on eastern Australian climate risk means that simple short-term trends (eg. 1950-present) are unrepresentative of any fundamental change in the longer-term climate, and any claims of attribution to anthropogenic effects are invalid under such extreme natural variability.

Notwithstanding these observations, there is sufficient concern over future climate change to warrant increased mitigation of the impacts of extreme events, the reduction of vulnerability to their occurrence and the development of increased resilience to such events.

Whether future climate change is truly catastrophic or not, we are currently vulnerable to the occurrence of naturally climate variability and extremes. The development of mitigation strategies to cope with natural climate variability can therefore be seen as a necessary pre-requisite for coping with future climate change whether due to natural or anthropogenic causes.

I would argue that the dominant focus on carbon dioxide emissions and anthropogenic climate change has actually distracted public and political understanding and discussion of mitigation strategies that would provide tangible benefits to the Australian community irrespective of the cause of future climate extremes. For instance, improved resilience to flood events can be achieved through a range of 'hard' and 'soft' engineering solutions – improved infrastructure (dams, levees), flood diversion and flood warning schemes. Improved flood risk estimation that accounts for multi-decadal variations in flood risk should be used to better inform floodplain development guidelines. Drought resilience may be improved through more efficient irrigation and conveyance technologies, pro-active water restrictions and improved storage infrastructure. Bushfire risk may be mitigated by revisiting restrictive regulatory frameworks that hamper fuel load reduction programmes.

Given the long history of climate variability and associated extreme events in Australia, Australians have the most to gain through adopting a practical approach to mitigating such extremes and will consequently be better placed if and when future climate change occurs.

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