Queensland Flood in 2010-11: Will This Type of Flood Occur Soon?

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Abstract

During 2010-2011 Australia experienced one of the biggest flood events in Australia's history. Six major rain events affected large parts of the eastern states of Australia during this period. From December 2010 to January 2011, Queensland, Western Australia, Victoria and New South Wales experienced widespread flooding. There was extensive damage to both public and private properties, towns were evacuated and 37 lives were lost, 35 of those in Queensland. Three quarters of Queensland was declared a disaster zone, an area greater than France and Germany combined, and the total cost to the Australian economy has been estimated at more than $30 billion. The large scale of events, the number of lives lost and the scale of the damage incurred prompted numerous inquiries and review processes. The Queensland government convened a Commission of Inquiry to investigate the issues and consequences from the flood and to work towards learning lessons from the flooding to reduce the future vulnerability of the community to this type of disaster. To manage flood, minimise the risk, impact and damage due to flood, it is important to understand the cause of such flood and, frequency of occurrence. This paper presents the possible causes of such flood, possibility of its occurrence, insurance issues associated with flood, outcome of the 2010-11 floods commission of inquiry and the relation of global warming and climate change.

Keywords: Flood, flood insurance, cause of flood, chance of occurrence, impact of climate change.

1. INTRODUCTION

Flooding is the most common environmental hazard worldwide. It is part of the natural water cycle or a "Hydrologic Cycle". Floods occur when the amount of water flowing from a catchment exceeds the capacity of its drains, creeks and rivers. This process begins with rainfall, but is affected by many other factors. In Australia, high rainfall variability heavily influences flooding. Floods can also be caused by other factors including tsunamis, large tides, storm surges etc. In the last 35 years of the 20th century, seventy-seven (77) floods were recorded in Australia; eight major floods were recorded in the 19th century and six in the first decade of the 21st century (OQCS 2016). While Australia is described as the driest inhabited continent on Earth, right now it might seem hard to believe. Dangerous floods have occurred in every Australian state over the last 150 years. An Australian flood of 2010–11 principally affected three eastern states of Australia and was one of the worst in the country's history. Queensland (Figure 1), in the north, was hit hardest, but the widespread flooding of a scale not seen since the mid-1970s began in December 2010 spread southward to inundate portions of the neighboring states of New South Wales and Victoria by early 2011 (Murray 2015). This flood at the state of Queensland is known as Queensland 2010-11 floods. Flood affected much of central and southern Queensland. Three-quarters of the areas of Queensland were declared disaster zones, 35-people were killed, over 200,000 people were affected by it (Wikipedia 2016a). In Australia, floods are the most expensive type of natural disaster. Until recently, the costliest year for floods in Australia was 1974, when floods affecting New South Wales, Victoria and Queensland resulted in a total cost of $2.9 billion (OQCS 2016).

Figure 1. Location of Queensland and Brisbane (van den Honert and McAneney 2011)

2. CAUSE OF QUEENSLAND 2010-11 FLOODS

Australian flood records extend back as far as the 1840's, only a few years after European settlement of the area in 1824 (Figure 2) (van den Honert and McAneney 2011). The 2010/2011 floods occurred after a prolonged period of drought, in quick succession, compounded intermittently by three major storm events and cyclones.

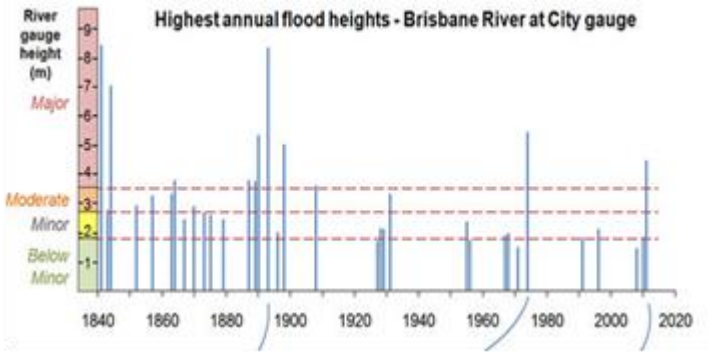

Figure 2. Highest annual flood heights at the Brisbane City gauge, 1840-2011 (van den Honert and McAneney 2011)

The 2010-11 Queensland floods were a series of floods in Australia which began in December 2010 and ended in January 2011. The record-breaking rainfall during the 2010–11 La Niña (BOM 2016e) (La Niña is an unusual weather pattern, which brings wet weather to eastern Australia often associated with extreme rainfall and widespread flooding) led to widespread flooding in many regions of Australia including severe flooding in southeast Queensland. The second half of 2010 and early 2011 was characterized by one of the four strongest La Niña events since 1900 (Figure 3). Figure 4 shows total rainfall across Australia for November 2010 to January 2011. Some gauge stations at north and west of Brisbane exceeded 1,200 mm rain. December 2010 was the wettest on record, with 107 places getting their highest rainfalls ever. Significant number of locations in Queensland experienced greater than 1 in 100-year rainfall. The state average rainfall level was 404.7mm compare to maximum 369mm in 1975. 2010 was the state's wettest spring since 1900 (Wikipedia 2016a) and the Australia's third wettest year (NASA 2011).

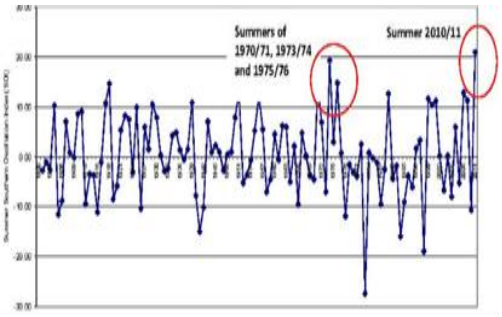

Figure 3. Average summer (October to March) Southern Oscillation Index (SOI), 1900/01 to 2010/11 (BOM 2011d)

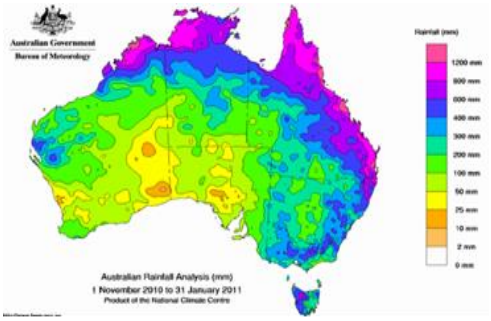

Figure 4. Total rainfall for the period November 2010–January 2011 (BOM 2011b)

Flooding started across parts of the state in early December 2010. These floods were caused by heavy rain from tropical cyclone "Tasha" that joined with a trough during a La Niña event. Australia. The 2010 La Niña was the strongest since 1973 (Wikipedia 2016a). Excessive rainfall caused rivers in southern Queensland reached record water levels including Brisbane and Bremer Rivers and caused flooding (BOM 2016f). Very intense localised rainfall caused severe flash flooding through the Toowoomba city (BOM 2011c). Heavy to very intense rainfall caused rapid creek rises and extreme flash flooding in the Lockyer Valley (BOM 2010a). Heavy rainfall caused very high water level at Wivenhoe and Somerset Dams that caused release of water from the dams resulting downstream flood. This flood was termed a "dam release flood" by hydrologists appointed by the Insurance Council of Australia. They suggest that a release of water from the Wivenhoe Dam was a principal cause of flooding at downstream of the dam (ICA Hydrology Panel 2011). Commission of Inquiry into the 2010–11 Queensland floods final report states that 59% of the downstream flooding was caused by water releases from the dam (Wikipedia 2016b).

3. NATURE, MAGNITUDE AND EXTENT OF QUEENSLAND 2010-11 FLOOD

The 2010-2011 floods across Queensland (the floods) were unprecedented in magnitude, scale and scope and in terms of extent, impact and severity, was amongst the most significant in Australia's recorded history. The January 2011 flood event can be categorized as a large to rare event by the Institution of Engineers Australia (Engineers Australia) national guidelines for the estimation of design flood characteristics (AR&R). The flood level classifications adopted by the Bureau of Metrology also define the Event as a major flood (SEQ Water 2011). Research published in Geophysical Research Letters has estimated that 2010-11 summer rainfall played a major role in average global sea levels dropping by seven millimeters (SCD 2015). Many places, including Condamine and Chinchilla were inundated by flood waters on multiple occasions (Hubert 2011). The most extreme flooding occurred in Central and South Queensland, particularly in the Fitzroy River and Condamine-Balonne River systems.

The extent and magnitude of the floods in Queensland were unprecedented in many places. As an illustration, this series of flood events yielded the filling of Lake Eyre for the third year in succession, a rare event. Further the floods contributed to the filling of the water reserves across the State, that is, both the surface reservoirs and the aquifers. Additionally, the river outflows into the Pacific Ocean constituted a series of freshwater turbid plumes that impacted the Great Barrier Reef. The floods in Queensland encompassed both large-scale floods and some flash flooding, including a deadly event in Toowoomba and the Lockyer Valley on 10 Jan. 2011. In 2011 (Hubert 2011), The Queensland flooding was Australia's largest natural disaster in recent memory. With a ballpark estimate of US$ 15.9 billion in total damages and economic losses (with a public reconstruction cost of approximately US$7.2 billion), this is also one of the major international disasters of the last decade. The government and private sector have mobilized an estimated US$ 11.8 billion, representing 75 percent of the estimated damage and losses which is already above the 45 percent average of disaster coverage in

developed economies (The World Bank 2011). During these floods, approximately 3572 businesses were inundated. There were 5900 people evacuated from 3600 homes, approximately $4b in commercial losses across mining, agriculture and tourism sectors, and 19,000 km of roads were damaged. Three major ports were significantly affected. More than 28 per cent of the Queensland rail network was left twisted and displaced. An estimated 28,000 homes may need to be rebuilt while vast numbers of dwellings require extensive repairs (Harden Up 2016).

4. QUEENSLAND 2010-11 FLOOD INQUIRY

The 2010-11 wet seasons brought unprecedented rain and flooding to Queensland. The large scale of events, the number of lives lost and the scale of the damage incurred prompted numerous inquiries and review processes by different governments and organisations. On January 2011, the Queensland Floods Commission of Inquiry was established to examine the events leading to the floods, all aspects of the response and the subsequent aftermath, and to make recommendations about things that could be improved for the future (QFCI 2011).

The Commission's inquiries included considering over 700 written submissions, conducting 68 days of public hearings, taking evidence from 345 witnesses and convening community consultation sessions and meetings. The final report contains 177 recommendations directed at a broad range of matters related to the 2010/11 floods, including: floodplain management, planning and building issues, the performance of private insurers, the impact of floods on operational and abandoned mines, the emergency response to the floods and dam management (Queensland Government 2012). The Australian review of 2010-11 floods including Queensland Floods Commission of Inquiry reports varied greatly in their scope, but it virtually ignored the issue of climate change and its impact on flooding (Wenger et al. 2013).

5. QUEENSLAND 2010-11 FLOOD RELATED INSURANCE ISSUES

Following a natural disaster, the insurance industry plays a vital role in funding the rebuilding, repair or replacement of damaged homes, infrastructure and assets. While some insurers offer cover for riverine flood, many currently do not, something that many policy holders discovered only after the January 2011 floods (Johnston et al. 2011). Thus, whilst claims by insured victims of flash flooding in Toowoomba and the Lockyer Valley were generally settled by insurers, many residents along the Brisbane River had claims denied. Whilst the Insurance Council of Australia has put the proportion of denied claims at 15% (Trowbridge et al. 2011), the perceived lack of performance of private insurers in assisting the recovery from the flood has led to a community backlash. Many people were unaware that they were at risk of flood; others rejected flood insurance where offered because it was viewed as being prohibitively expensive (Johnston et al. 2011). The January 2011 floods have exposed the non-insurance or under-insurance of not just individual homeowners, they have also focused attention on the Queensland government's lack of insurance cover for its own infrastructure. At present self-insurance purchase by the State applies only to 25% of the reconstruction costs, with the Commonwealth covering the other 75% (van den Honert and McAneney 2011). Many insurers do not provide riverine flood insurance due to a lack of information on which to determine and price the risk. After Queensland 2010-11 floods, one of the biggest differences has been the rapid rollout of flood cover by insurers. In Queensland, 91.4 per cent of home and contents policies are now purchased with flood cover, compared with about 3 per cent in 2006 (FOS 2013). Nevertheless, a positive example of sensible land-use planning to arise out of the 2011 flooding occurred in the township of Grantham, where it is planned to relocate residential homes from the floodplain to higher ground outside the flood-zone (van den Honert and McAneney 2011).

6. WILL THIS TYPE OF FLOOD OCCUR SOON?

Understanding the chance of different sized floods occurring is important for managing flood risk. Floods occur in Queensland at irregular intervals. Six major floods occurred in Brisbane between 1885 and 1910, followed by more than 60 years without a major flood. Figure 2 also illustrates the sporadic nature of flooding, showing river levels at the Brisbane City gauging station since 1840 (OQCS 2016). Several factors are involved to predict whether flood event like Queensland 2010-11 floods will occur again or not. Firstly, we need to define an extreme event. Secondly, flow gauge record length is very short in Australia and this limits statistical analysis of the 'extremes'. Thirdly, climate is known to have varied at both decadal and centennial scales and this can also affect flood frequency predictions.

An extreme event (Based on IPCC definition, which is defined as equivalent to, or of greater than 90th quantile of the Australian Envelope Curve or AEC) can delineates the presently known upper limit of flood magnitude in Australia. The Queensland 2011 event lies below this upper limit in both the AEC and Global Envelope Curve (GEC) data sets suggesting that while large, events of higher magnitude can, and do, occur (The Big Flood 2016).

Brisbane Port-City gauge shows (Figure 2) extreme events in 1840s and 1890s are much larger than any flood events recorded since 1900. Most gauging stations in the region have very short record length (30-40 years). This is a limitation to use it to predict a rare event. Moreover, many gauging stations have not recorded an extreme event to guide the upper tail of the statistical distribution. Some gauging stations also do not have many extreme floods in their record. Based on 31 years of flood record at Lockyer Valley at the Spring Bluff gauge prior to the 2011 flood, the approximated 2011 flood peak is predicted to have an ARI of greater than 2000 years and with the inclusion of 2011 (32 years record), this reduced to 75 years and in 2016 with 36 years record the 2011 flood has a predicted recurrence interval of 90 years. This alone highlights the sensitivity of flood prediction to length of record of measured data. In addition, there exists decadal and centennial-scale climate variability. If short gauging records capture either a drought dominated or flood-dominated period, then these variations will bias predictions of flood frequency. Figure 7 shows that there are no clear trends in annual total Queensland rainfall over the 20th century. Rainfall varies from year to year and from decade to decade. La Niña is also associated with more heavy rainfall events. One of the key challenges is to extend the current gauging record length to better represent these climate fluctuations. One option is to use a Probabilistic Regional Envelope Curve (PREC) method (combine short record length gauging station with flood records from regions with similar characteristics) and then combined with traditional Flood Frequency analysis (FFA) on the combined longer record gauging data. Where available historical flood information (building mark, tree mark, newspaper) and history of past flood events stored within the floodplain sediments (named paleoflood record) can also be used. The inclusion of paleoflood records at-a-station can significantly decreases the uncertainty (90 % confidence Interval) for estimation of rare events in FFA (The Big Flood 2016). A review on coincident flooding in Queensland using joint probability and dependence methodologies done by the Queensland government for estimation of extreme flood did not specifically recommend applying this technique for estimation of extreme events (DoS 2012).

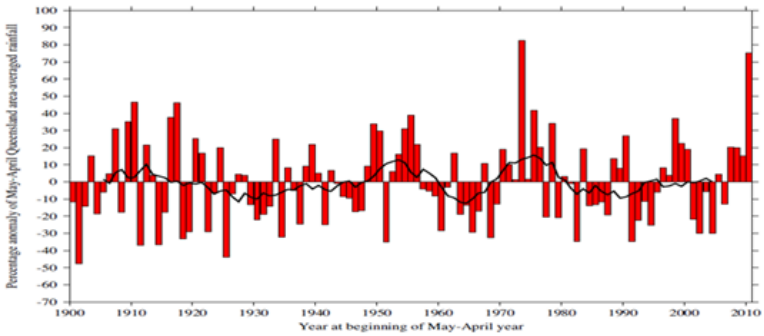

Figure 7: Queensland 100 years Rainfall (the red bars show the percentage deviation of each year's rainfall from the long term (1900-2010) average. The black line (11 year moving average) demonstrates decade-to-decade changes in rainfall) (DERM-QCCCE 2016)

7. CONCLUSIONS

Due to changing climate, the frequency and magnitude of floods in near future is expected to vary across Australia. As climate change will have notable impacts on the rainfall runoff process, thus hydrologic time series (e.g., flood data) can no longer be assumed to be stationary. A failure to take climate change into account can undermine the usefulness of the concept of return period, and can lead to underestimation / overestimation of design flood estimates (Wenger et al. 2013). Most climate models predict that the magnitude and frequency of storms and rainfall events will increase under a warmer 'greenhouse' climate (Nott et al. 1996). Because flood events are influenced by several factors, based on the current science it is difficult to confidently state that, overall, extreme flood events in Queensland will increase in intensity or frequency for climate change.

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