

# **SUBMISSION REGARDING THE MANAGEMENT AND PREDICTION OF MAJOR FLOODS IN EASTERN NSW**

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*Date of submission: 7 April 2022*

This submission relates to the NSW Independent Flood Inquiry, Terms of Reference, Item 2:

*2. And to make recommendations arising from the Inquiry as considered appropriate, including on:*

- a. safety of all emergency service personnel and community first responders;*
- b. preparation and planning for future flood threats and risks;*
- c. use of flood gauges and other warning structures and/or strategies for improved flood prediction;*

We submit evidence that the probability of major floods on the Hawkesbury-Nepean rivers is strongly influenced by two patterns determined from observational data since 1790:

- a) An approximately 85-year cycle of alternating flood-dominant and drought dominant time-spans of about 42 years each, the most recent drought dominant phase having ended in 2020 and the subsequent flood dominant phase having started in 2021.
- b) Individual floods are strongly associated with La Nina climate conditions. La Ninas have until recently been regarded as not predictable more than about two seasons (~6 months) ahead, but recent studies demonstrate a method to predict these three years (and perhaps a decade) ahead).

These two patterns provide (a) a long-range tool to assist in managing the rehabilitation from the floods of 2021-22, and in predicting the decades having higher risk of major floods in the future; and (b) predicting individual years with probable La Nina events three (possibly 10) years ahead.

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# 1. THE 85-YEAR CYCLE OF FLOODS IN THE HAWKESBURY-NEPEAN

1.1 Historical evidence shows a clear periodicity in major floods at Windsor Bridge (Hawkesbury River) since 1790. Thus there were four major floods 1790-1818; seven between 1857-1904; six between 1949-1990; and two since 2021. By contrast, there was only one major flood in the three intervening intervals 1821-1856; 1901-1948; 1991-2020; see Fig. 1. The cycle of approximate 42-year time spans containing major floods followed by similar time-spans marked by rare floods is documented by Infrastructure NSW<sup>1</sup>.

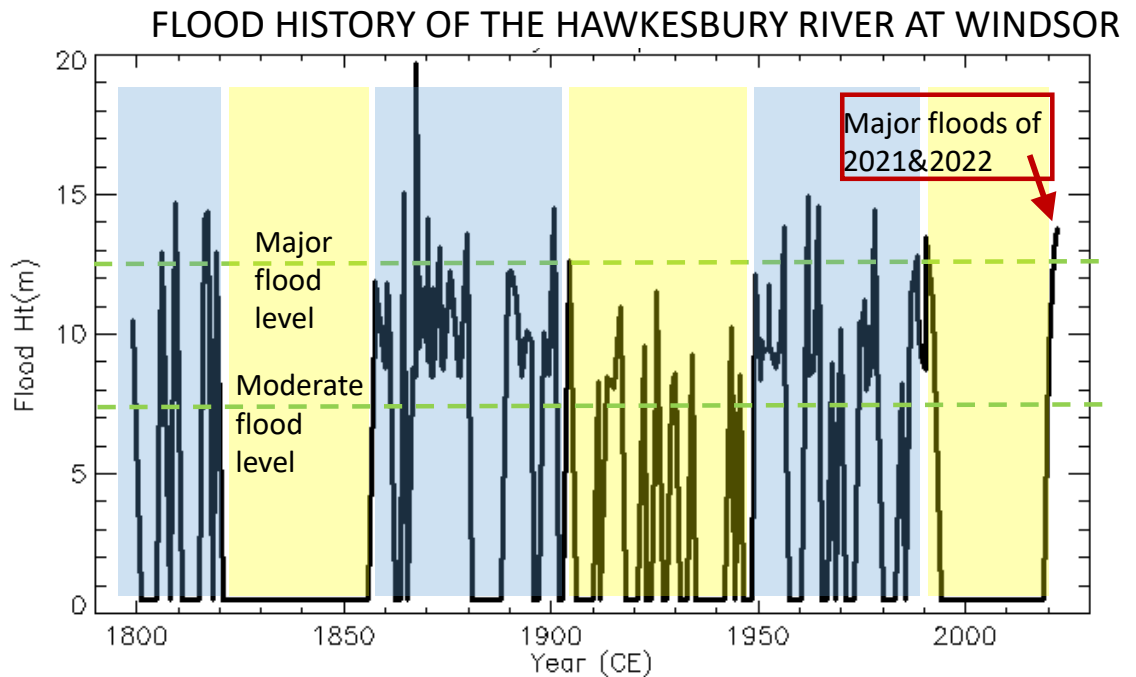


Fig. 1. The flood levels recorded for the Hawkesbury River, NSW, at the Windsor Bridge. Times date from the start of European settlement (1799). The dashed green lines are the levels classified as major and moderate floods. Background colors: blue = flood-dominated, yellow = drought-dominated time-spans. The drought-dominated time-span 1991-2020 is bracketed by moderate floods in 1992 and 2020. Flood levels and classification of flood-dominated, drought-dominated time-spans supplied by Infrastructure NSW.

1.2 Detailed records of the water depth at Lake George (NSW) indicate that this repeating sequence of flood-dominated and drought-dominated time-spans was widespread on the NSW coast and not a statistical fluctuation restricted to the Sydney basin.

1.3 Based on these records we submit that there is a significant probability that the 2021 and 2022 major floods **may be the onset of a 40 year time-span marked by multiple major floods similar to those of 1857-1900; and 1949-1990<sup>2</sup>.**

1.4 Note in particular that the historical evidence shows that the great flood of 1867 peaked at 19.7 meters at Windsor, **5.7 m above the floods of 2021 and 2022 (Fig. 1). This would have devastating consequences for a much larger region than that affected by the 2021-22 floods.**

- 1.5 World-wide studies have repeatedly shown that there is an 86 year cycle in atmospheric properties and rainfall. For example
- An 86 year periodicity in the floods on the River Nile 622-1470<sup>3</sup>
  - Floods on the Brahmaputra River, Bangladesh<sup>4</sup>
  - <sup>14</sup>C records from tree rings worldwide dating back 3000 years
  - Ice-core records from the Arctic and Antarctic dating back 60,000 years and beyond
  - The scientific literature calls this 86 year cycle the Gleissberg cycle, and it is clear that it is a permanent worldwide phenomenon. References to further scientific papers in the top international journals can be supplied if required.

## **2. PREDICTION OF LA NINA CLIMATE EVENTS**

- 2.1 Arrival of the 2020-21 La Nina<sup>a</sup> climate event provided affirmation of a falsifiable hypothesis first published by US scientists Leamon and McIntosh in 2017, reporting results of a NASA-funded study. They showed that La Nina events are associated with solar-magnetic activity and are predictable from monitoring that solar activity using satellite and ground-based technology<sup>5</sup>.
- 2.2 The Leamon and McIntosh method successfully hindcast four la Nina events prior to 2020 and predicted the 2020-21 event<sup>6</sup> (which also became a double event, repeated in 2021-22).
- 2.3 During the flood-dominated time-span 1950-89 the Oceanic Nino Index (ONI) shows 12 La Ninas of which five (or 42%) coincided with major floods of the Hawkesbury. Another two major floods occurred but not associated with a La Nina.
- 2.4 During the drought-dominated time-span 1990-2019 the ONI shows eight La Ninas but no major or moderate floods.
- 2.5 The next two La Ninas forecast by Leamon and McIntosh are for 2027-28 and 2032-2033. (Dates are subject to ongoing monitoring of solar magnetic changes over next 5 years).

## **3. OUTLOOK FOR FUTURE DECADES**

- 3.1 The Gleissberg 85-year cycle analysed in flood records gives a best estimate of 2032 for commencement of the next flood-dominated time-span. However observation of the 2020-21 and 2021-22 Hawksbury floods suggests the flood-dominated span may have commenced early. Historically there have been moderate floods which have occurred during drought-dominated time-spans. An alternative interpretation which will be tested by observation over the next decade is that the 85-year cycle has been advanced by climate change.
- 3.2 When the next flood-dominated time-span commences the probability of a major flood resulting from a pair of La Nina events is about 65%.
- 3.3 When the next flood-dominated time-span commences, the historical record indicates we should expect multiple major floods with a return time of six to eight years.

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<sup>a</sup> For the purposes of this discussion we use a simple definition of a La Nina event as being defined by an Oceanic Nino Index value lower than -0.5.

#### 4. RECOMMENDATIONS

- (1) That the inquiry should recognise the historical evidence that the floods on the Hawkesbury-Nepean occur in groups over 4 decade intervals; that the next one may have commenced already with the major floods of 2021-22; and the fact that there has been an historical flood event (1867) peaking 5.7 metres above those of 2021-22.**
- (2) That remediation actions for the 2021-22 floods should take into consideration that the next 40 years is expected to be a flood dominant interval**
- (3) That remediation action and future policy should recognise the historical fact that a future flood at Windsor could peak 5.7 m above the level reached in 2021-22.**
- (4) That A major study should be initiated, possibly in conjunction with University of Maryland (Leamon) and NCAR (McIntosh) to maximize use of the Gleissberg 85-year cycle and La Nina predictions in analysis and management of flood risk on the Hawkesbury River. This project could be extended to include similar studies for other flood-prone districts of eastern NSW (eg Lismore and the Northern Rivers).**

#### THE AUTHORS

Michael Asten is a Professor of geophysics, now retired after 23 years in School of Earth Atmosphere and Environment, Monash University, Melbourne. Prior to that he was a Senior Principal Geophysicist in BHP with 18 years experience in world-wide programs of research and practice of methods for the search for new mineral resources. He is a past-President of the Australian SEG, and served a recent three-year term as the Australian Geoscience Council representative on the Australian Academy of Sciences UNCOVER Committee. He has published 214 scientific papers and has various research awards from the Australian SEG, BHP and CSIRO for innovations in electromagnetic, airborne gravity gradient and passive seismic methods in applied geophysics. Using time-series analysis methods from past work he has also been researching for nine years the role of natural cycles in centennial and millennial global climate change; this work has been subject of seven papers at international conferences, the latest being the American Geophysical Union in (virtual) San Francisco, December 2021. He served as an invited Expert Reviewer of the 2021 IPCC Climate Change 6<sup>th</sup> Assessment Report WGI.

Ken McCracken, AO, FAA, has a long history of providing practical advice to governments (Australia, USA, India) and industry (Space, IT, Mining) based on cutting-edge science and technology He was the principal investigator for radiation instruments on six NASA Pioneer and Explorer satellites in 1960-70; Advisor to NASA on astronaut radiation protection. 1964-67; Designer and founding Chief of the CSIRO Division of Mineral Physics 1970-1982 with personal contributions to the geophysical and Remote Sensing research therein; Director of the CSIRO Office of Space Science and Application and member of the Australian Space Board 1985-92; Principal of Jellore Technologies 1990-2015 (geophysical consultation); Research Fellow at University of Maryland (space and solar physics 2001-12) and the International Space Science Institute 2005-2018 (Switzerland- solar and atmospheric studies using 150,000 year ice cores.) He has 4100 citations in international journals.

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<sup>1</sup> Infrastructure NSW, Hawkesbury-Nepean Valley Regional Flood Study July 2019 -Overview, [https://www.infrastructure.nsw.gov.au/media/2162/ec\\_insw\\_hawkesbury-nepean\\_fss-document\\_web.pdf](https://www.infrastructure.nsw.gov.au/media/2162/ec_insw_hawkesbury-nepean_fss-document_web.pdf) .([https://www.infrastructure.nsw.gov.au/media/2162/ec\\_insw\\_hawkesbury-nepean\\_fss-document\\_web.pdf](https://www.infrastructure.nsw.gov.au/media/2162/ec_insw_hawkesbury-nepean_fss-document_web.pdf))

<sup>2</sup> Asten, MW and McCracken, KG, 2021, Time-series analysis of extreme rainfall and flood events in two water catchments of Eastern New South Wales shows an indicative link to Gleissberg 87 yr cycles, Abstract ID#: 850985, AGU 2021, New Orleans.

The interactive poster is viewable at

[agu2021.fallmeeting-agu.ipostersessions.com/Default.aspx?s=15-EC-92-A3-1D-16-E6-E7-17-CF-0F-06-DE-01-7E-3E](https://agu2021.fallmeeting-agu.ipostersessions.com/Default.aspx?s=15-EC-92-A3-1D-16-E6-E7-17-CF-0F-06-DE-01-7E-3E)

(click on the various windows to enlarge segments of the iposter)

A downloadable pdf of the full content of the poster is available at

[doi.org/10.1002/essoar.10510770.1](https://doi.org/10.1002/essoar.10510770.1)

<sup>3</sup> Ruzmaikin A, Feynman J, Yung YL, 2006, Is solar variability reflected in the Nile River? Journal of Geophysical Research, Vol. 111, D21114, doi:10.1029/2006JD007462

<sup>4</sup> Asten, MW and McCracken, KG, 2022, Discharge and flood cycles of the Brahmaputra River past present and future; implications for possible global mechanisms, Paper EGU22-8090 , European Geophysical Union, Vienna, May 2022.

<sup>5</sup> Leamon, McIntosh and Marsh, 2020, Termination of Solar Cycles and Correlated Tropospheric Variability, ArXiv:1812.02692v2 [astro-ph.SR] 4Feb 2020

<sup>6</sup> Leamon, R. J., McIntosh, S. W., & Marsh, D. R., 2021, Termination of solar cycles and correlated tropospheric variability. Earth and Space Science, 8, e2020EA001223. <https://doi.org/10.1029/2020EA001223>

HOME / LETTERS



# Floods have always come in clusters, so don't interpret this as climate change

By  
12:00AM JULY 7, 2022 • NO COMMENTS

The trauma of people in the flooded Hawkesbury-Nepean Valley of western Sydney is deeply distressing, but suggestions that the traumas are related to climate change-related extreme events are misplaced. Yes, there have been four floods in the past two years, but examination of the records at Windsor show eight similar flood groupings since 1790, beginning with 1816-19 (three major floods in 33 months). The most striking example was 1864-1900 during which 32 major and moderate floods occurred over 36 years, including the horrific record flood of 1867 that crested at a height 5m above the flood of this year. The most recent example of flood grouping prior to 2020 was 1988-92 which saw six major and moderate floods in less than four years.

We were lulled into a false sense of security by the 28-year flood-free span of time from 1992 to 2020, during which huge areas of residential development occurred in flood-prone areas. A deeper analysis of the flood cycles both here and in Bangladesh shows a significant 80-year cyclic pattern, where the drought-dominant phase is ending and a likely 40-year span of flood-dominant times is commencing. The cycle is not a local phenomenon, nor is it related to climate change, but we must recognise it and be prepared to spend billions of dollars in management, mitigation and probably population shift in the affected areas.

*Michael Asten, retired professor of geophysics, Hawthorn, Vic*

Well done, PM

Anthony Albanese has ensured Australia has been on the world stage at one of the most difficult and threatening strategic times for a century. He has patched up our relationship with France (which conned us in the first place, but that's another issue). He has ensured we are seen to be allied with NATO. He has strengthened our relationship with our near Asian neighbours. He has added our voice and

I didn't vote Labor, but I support Albanese's trips absolutely. Apart from distracting rescue services with tokenistic tours of our flood disasters, what can he do to help? Certainly his criticism of Scott Morrison has come back to haunt him (as it should), but that does not justify the opposition ignoring the correct prioritisation he has made by ensuring Australia is in the minds of the most powerful world leaders.