Inquiry into recent trends and preparedness for extreme weather events

Introduction

Statistics are very useful tools providing they are used carefully and the underlying data is not limited so that it conceals important trends. The International Panel on Climate Change uses temperature and climatic data compiled since 1850. However if it had used data compiled since 1750 its conclusions would have been quite different. This is because from around 1785 to 1840 there was a period of extreme weather across the globe. This period was known as a "little ice-age" and it coincided with a multi-decadal period of low sunspot activity on the sun. The name for these periods of extreme weather was given because of the very cold winters in some countries of the Northern hemisphere. In many countries the extremely cold winters did not occur every year because sometimes they had mild winters and even very wet winters. Sometimes all three extremes occurred in the one winter. In some places summers were unusually hot. Sometimes there were times of extreme rainfall and other times of little or no rainfall leading to crop failures. However on other occasions there were extended periods of relatively mild conditions.

Although the climatic extremes of periods known as little ice-ages were well documented for the Northern hemisphere, there is only sparse documentation of the extreme weather in the Southern hemisphere during the last of these periods and actuarial records of the cost consequences of such extremes do not exist. As the first European colony in Australia commenced at the beginning of the last little ice-age so Australia's history of that time is relevant. It is important to understand what weather conditions were like in Australia at that time so as to be able to predict the conditions over the next few decades and the consequences of climate change.

This submission concentrates on the very recent trends in extreme weather events. It provides a perspective on what will occur in the next few decades and suggests policy options to enable adaptation to the extremes that will occur and mitigation of the most serious of the secondary effects of these extremes.

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Summary

The tide of extreme weather events is rising rapidly. Some might even exaggerate by calling it a coming tsunami of extreme weather events. Whatever it is called there will be many times more extreme weather events in the next few decades than occurred on average in the 20th century. At this stage actuarial records, like the IPCC records, do not include data on the last period of extreme weather that was similar to what has just commenced. Therefore this tide of extreme weather events that is occurring around the world still only appears as an inconsequential wave on the actuarial beach of experience.

The Australian government's role should be to encourage and facilitate adaptation to this changed climate reality. It should fortify Australia's defences against the secondary effects of the incoming tide of extreme weather events. This is much smarter than pretending, Canute-like, that it can stop the tide. Even if it could stop the tide it will discover that the tide will have already gone out by the time any such actions to prevent it could have had any effect. So does it really matter whether the weather extremes now being experienced across the world are due to anthropogenic induced climate change or Nature? It is much more important to act on the immediate threats and risks posed by extreme weather rather than to act on what may or may not happen in the decades much later in this century.

The consequences of continuing extreme weather events significantly concern the UN Food and Agriculture Organisation (FAO). The Government of Australia should be just as concerned. There are severe risks to Australia of the secondary effects of the growing tide of extreme weather events. These risks should be recognised now and acted upon immediately. Some suggested responses to the risks posed by extreme weather are detailed in the final section of this submission.

Extreme Weather in a Solar Grand Minimum

Just before Christmas 2012, the UK MET office quietly downgraded its forecasts for global temperatures to relatively flat for the next five years. This means that there will have been no global warming for nearly 2 decades. At about the same time the world-wide astrophysics community named the new solar grand minimum, which is said to have commenced in early 2008. The new grand minimum is to be called the Eddy Minimum after Mr John A. (Jack) Eddy (1931-2009), who named the Maunder Minimum in a landmark scientific paper of that name, published in 1979. The Maunder Minimum is generally regarded as the coldest, most miserable period of the so-called mini ice-ages. It apparently had the most extreme weather of the previous millennium. Habibullo I. Abdussamatov, the lead scientist of the Russian/Ukrainian section of the International Space Station, believes that the Eddy Minimum will be as deep as the Maunder Minimum but many other astrophysicists and solar physicists believe it will be more like the last grand minimum known as the Dalton Minimum (officially 1790-1830). Since the Dalton Minimum commenced around the time of European settlement of Australia this submission will look at the experience of that part of Australia's history to provide some idea of the likely extreme weather events likely to be experienced in future decades. However this inquiry should not just concern itself with the effects of extreme weather in Australia but the consequential risks to Australia of extreme weather events occurring right across the globe.

Although the periods of past solar grand minimums coincided with what was called mini ice-ages, these periods were only called that because parts of the Northern Hemisphere suffered very cold winters during those times. The countries that suffered a very cold winter one year didn't necessarily have a similar winter the next. Some winters in some countries were mild, some were wet and some were freezing. Sometimes a mixture of all three occurred in the one winter. Often in parts of Europe there would be frosts through to late May and then within days it would get hot and remain so until September or October. France recorded many droughts and heat waves as did England and they both recorded prolonged very wet periods with disastrous flooding. Pulling together weather records from many sources these periods of solar grand minimums were also characterised by floods in parts of Asia failed or delayed monsoons, droughts and heat waves. Probably one of the most authoritative works on past weather records was written by James A. Marusek, a retired US Navy nuclear physicist and engineer. This record is entitled "A Chronological Listing of Early Weather Events". Many other records exist, including several on Australia's experience during the Dalton Minimum.

There were 4 of these grand minimum events recorded in the last millennium. They varied in length from 40 years (the Dalton Minimum[1]) to 105 years (the Maunder Minimum - around 1610-1715[2]) and their start dates were spaced apart from 160 years to 200 years. The start of the Eddy Minimum will probably be regarded as early 2008 and so will be 218 years after the commencement of the grand minimum that preceded it. However some consider that it began in late 2004 when the sunspot activity of solar cycle 23 significantly diminished.

The Weather Extremes in Australia's Early History

The first of Australia's extreme weather events of the Dalton Minimum was recorded by the officers on the ships of the first fleet. Snow to ground level was seen as they made their way up the coast of Tasmania in the height of summer (in early January 1788) and at that time there were severe storms that impacted the fleet.

"Chilly temperatures as cold as England in December were recorded close to Christmas 1787.
The Fleet was forced to slow down New Year's Day when they encountered the strongest winds of the journey losing one man overboard and injuring the cattle on board. In the first week of January 1788, the Fleet sails past the southeast corner of Van Diemen's Land (Tasmania, Australia), into a violent thunderstorm and observe small patches of snow along the coastline during the height of summer.
Sailing north up the coast of New South Wales against strong headwinds, many ships of the Fleet and its cargo of precious seedlings, were damaged by sudden squall of wind and very high seas in a severe storm on 10 January 1788. The squall was strong enough to split the mainsail on one ship and another ship lost its main yard carried away in the slings.

[1] Officially the Dalton minimum occurred between 1790 and 1830 but some texts suggest it ended in 1840 but the differences in opinion may be due to the increasing magnification of telescopes. Some suggest that it really commenced in 1784, when the sunspot activity of the preceding solar cycle 4 reduced significantly.
[2] The Maunder Minimum commenced in 1610 according to a recent recalibration of solar activity in the early 17th Century. However many references give its start date as 1645.

Between 24 and 26 January 1788, a strong wind and huge seas buffeted ships sailing out of Botany Bay to the more suitable location of Port Jackson, where on 26 January 1788, a Union Jack flag, was planted to celebrate the beginning of European settlement in Australia[3]*."*

The new settlers experienced a drought for most of 1789 through to early 1791 but the heat wave of January/February 1791 must have been extraordinary.

"*No rain is said to have fallen at Sydney, Australia between June to November 1790 and all the grass was dried up… On 27 December 1790, the temperature in Sydney, Australia reached 102° F in the shade. Then on 10 and 11 January 1791, the temperature in Sydney reached 105° F…In January and February 1791, there were several weeks of excessive heat, hot winds, myriads of flying foxes and birds dropped dead from trees and everything burnt up, streams of water supplying Sydney nearly dried up. The heat continued into February. On 10 and 11 February 1791 the temperature at Sydney, Australia, stood in the shade at 105° F, the country around Rose Hill and Parramatta was on fire for many miles. The heat was so excessive at Parramatta, made worse by the bush fires, that immense numbers of the large fox-bats were seen to drop from the trees into the water, and many dropped dead on the wing. At Sydney about the harbor in many places the ground was found covered with small birds, some dead, others gasping for water. The wind was northwest, and burned up everything before it. Persons whose business obliged them to go out declared that it was impossible to turn the face for five minutes to the wind*[4]*."*

According to Watkin Tench, the captain of the marines, the temperature reached 109° F (42.8° C) on December 29 1790. This was hotter than Tuesday January 8th, 2013. It is not known how hot it was in the rest of Australia in late 1790 and early 1791 but given the protracted nature of the heat wave experienced in Sydney it seems likely that it was extremely hot across much of the interior of Australia. The early Australian settlers experienced many other periods of extreme heat as they established European settlement.

Watkin Tench, also noted in his first voyage up the Nepean River in 1789, that there was driftwood 30 feet up the trees along-side the river in one gorge. But as the early settlers discovered floods could be a great deal higher than that.

"*In March 1799, there was a major flood at Hawkesbury/Nepean Valley in New South Wales, Australia. The water level was recorded at 50 feet (15.25 meters) above the water mark at Windsor. The whole village at that site was washed away. Because this was the colony's major farming centre, the flood caused great shortages and hardship*[5]*."*

Then for much of the rest of 1799 there was a severe drought in the colony. But in March 1800 the Hawkesbury again flooded. This time:-

"The water level was recorded at 40 feet (12.2 meters) above the water mark at Windsor. Again, crops and the whole village were washed away. After this flood, the settlement was moved to the current location of the city of Windsor[5]*".*

This was fortunate as the flood of March 1806 reached 48 feet at that location and the August flood of that year reached 47 feet. The March 1806 flood destroyed much of the food and crops and caused starvation throughout the colony. The Hawkesbury floods continued. The following Hawkesbury River flood heights were recorded from 1799-1820.

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[3] Joëlle Gergis, Philip Brohan and Rob Allan: The weather of the First Fleet voyage to Botany Bay, 1787–1788

[4] J. H. Heaton, Australian Dictionary of Dates and Men of the Times containing History of Australiasia from 1542 to May 1879, Sydney, 1879

[5] The Hawkesbury Historical Society

Hawkesbury River Floods	
1799 -1820	
Date	Height
Mar/1799	50'
Mar/1800	40'
Mar/1806	48'
May/1809	48'
Aug/1809	48'
June/1816	45.5'
Feb 1817	46'
Feb 1819	46'
June 1819	46'

Heat waves, droughts, floods and storms (including hailstorms with hail the size of cricket balls) were characteristic of those first 40 years of Australia's European settlement. One severe hailstorm in 1814 is said to have smashed every pane of glass in the colony and wrecked all the gardens.

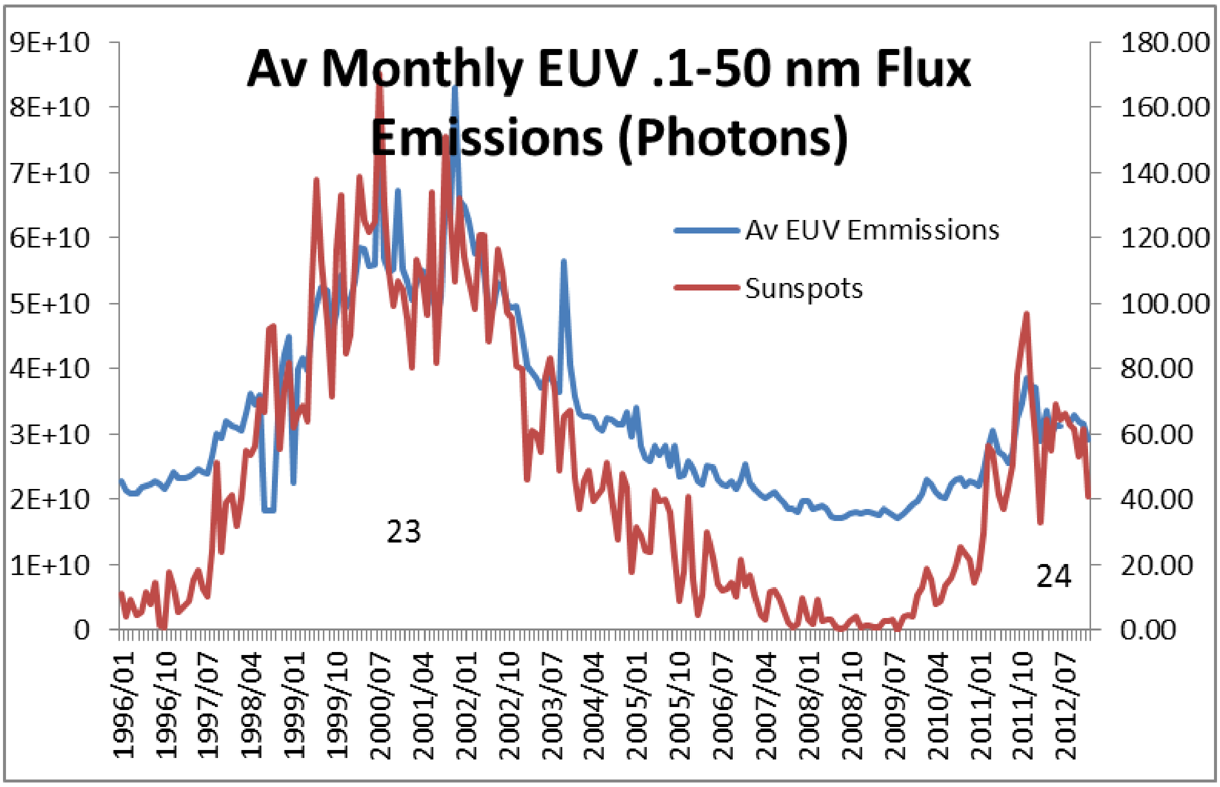
The whole period of the Dalton Grand Minimum was exceptionally difficult because often floods or droughts, late or early frosts and unexpected and often prolonged heatwaves caused losses of crops. In Asia, sometimes monsoons either failed altogether or were very weak. But also the opposite happened and sometimes there was great flooding in parts of Asia. For example in 1800 there were great floods in China and again in 1820 along the Yangtze. But in 1811, 15 million are estimated to have died from famine in China. In India and Pakistan there were often floods or droughts due to very heavy or very light monsoons. For example 1790/92 (drought), 1802/07 (drought), 1811 (Chennai floods), 1814 (Bengal floods) and 1816 (delayed monsoon, then floods causing a cholera epidemic) and 1820 (Pakistan floods).

It wasn't always cold during the Dalton Minimum. For example in 1799 China recorded one of its 20 warmest years on record in over 300 years from 1600. Many parts of the US and Europe recorded record temperatures in summer – but then some also had record low temperatures in winter. For example in Moscow in March 1809 the mercury in thermometers froze (Mercury freezes at -39 °C). Lack of food, and the consequent increasing prices of it, was a contributing cause of the revolutions and wars of this period.

The Physics Behind Grand Minimum Weather Extremes

The attached paper details the physics that cause solar grand minimums, the extreme weather events that are associated with them and discusses the causes of the increased major seismic activity (great earthquakes and VE6+ volcanic eruptions) that seem to accompany them. Benjamin Franklin is given the credit for first suggesting the connection between extreme differences in solar activity and seismic activity and it is only recently that scientists have been able to prove this and explain part of the physics that are behind the connection. Japanese scientists seem to be at the forefront in this – presumably because Japan is a country that is very much at risk from seismic events.

As many of the Environment and Communications References Committee may not have the time to read the detailed attachment, this submission will briefly indicate how the sun does affect the climate. The sun is a gigantic ball of plasma approximately 1.4 million kilometres in diameter. Climate scientists often state that the total solar irradiance of the sun does not vary enough to affect the climate on Earth. This statement is almost correct. The visible light that is provided by the sun does not vary by very much. Also the long wave-length (infra-red emissions) of the sun do not vary by much either[6]. But the very short wavelength emissions do vary significantly, particularly those in the ultra-violet range and shorter wavelengths. The extreme and far ultra-violet emissions, vary by 300%-400% during a normal solar cycle of around 11 years. As scientists are now observing the total emissions of the shortest wavelengths over a whole solar cycle can also be significantly supressed. This is happening in solar cycle 24 – the current solar cycle. As it happens the sun's magnetic field strength also varies very significantly over a normal solar cycle and seems significantly suppressed so far in the current solar cycle. The following graph details short wave emissions data obtained from the Space Sciences Centre of the University of Southern California. It obtained data from the Solar and Heliospheric Observatory (SOHO satellite) that was launched in December 2 1995. The monthly data is the average of the recorded daily average data. The sunspot data was obtained from the Solar Influences Data Analysis Centre (SIDC) which is attached to the Royal Observatory of Belgium and the world-wide recognised standard for measuring sunspot activity.



So far both the sunspot numbers and the EUV emissions are somewhat less in solar cycle 24 than they were to this stage in solar cycle 23. But solar cycles 22 and 21 had higher sunspot activity than solar cycle 23. So is it a coincidence that global warming seemed to stop just after the time solar cycle 23 commenced in1996?

Sometimes the EUV emissions appear to be less than what you would otherwise expect from observing the sunspot numbers and sometimes these emissions are more than what you would otherwise expect. Primarily this is because each sunspot is different. NASA records 7 different types of sunspots. The first are alpha spots which only have one magnetic pole. When looked at with a UV filter they do not appear to emit as much ultra-violet light as parts of the sun's surface that are not covered by a sunspot. The second are beta spots and they emit much more UV light than their surroundings. Other types of sunspots are known as gamma and delta sunspots as well as mixtures

[6] The sun's size can change by around 1% between very prolonged strong sunspot activity and grand minimums when there is very little sunspot activity. This can explain some of variation in infra-red radiation from the sun. Also sunspots themselves are hotter than surrounding areas so emit more infra-red radiation.

of the four main types. These other types are comparatively rare, and more complex than the alpha and beta spots. Also some sunspots are very large and others relatively small. SIDC attempts to allow for their size in its count but it does not record levels of magnetic strength or UV emissions of each sunspot. Although the sunspot record kept by SIDC goes back to 1749 the series is not completely comparable over time because of changes in technology. A satellite based telescope can see very much more detail than the very small hand held telescopes that were used in the 18th and early 19th centuries. Also there have been some changes in how the data is interpreted.

A solar physicist in Australia is keeping a record of the current solar cycle 24's sunspot activity using methods that approximate to those used at the end of the 18th Century. This enables a comparison between the activity of the first solar cycle (no. 5) of the Dalton Minimum and the first solar cycle of the Eddy Minimum. At this stage the sunspot activity of the current cycle is slightly undercutting the sunspot activity of solar cycle 5[7].

How do the ultra-short wave length emissions of the sun affect the atmosphere? These emissions create much of the ionosphere and cause the thermosphere to be expanded during the day as well as being part of its heat source. They provide the energy required to form ozone from oxygen and nitrogen oxides. So the ultra-short wave length emissions of the sun provide the energy to maintain the balance of ozone, oxygen, nitrogen and nitrogen oxides from the upper stratosphere through to the thermosphere. As a result of the low levels of these emissions there have been some changes in these parts of the atmosphere.

Madhulika (Lika) Guhathakurta, PhD who is the Lead Program Scientist of the Living With a Star Program of the Heliophysics Division, Science Mission Directorate, NASA Headquarters[8] made some observations in his presentation to the United Nations Committee On the Peaceful Uses of Outer Space (UNCOPUOS) meeting in Vienna, Austria on February 10, 2011. He stated in relation to the then current extreme solar minimum:

"Since the dawn of the space age (this has been the):

- *Longest period with no Sunspots,*
- *Lowest solar X-ray flux (and)*
- *The Ionosphere Has Collapsed,*
- *Space Junk Is Accumulating,*
- *Radiation Belts are Charged with Killer Electrons,*
- *A Drop in Solar Irradiance affects Earth Temperatures,*
- *The Sun's Magnetic Field is in a Strange State*
- *Cosmic Rays have Hit A Space Age High"*

He also commented that then "*the night-time ionosphere was only 260 miles (433 km) above Earth's surface, a sharp decrease from the usual value of ~400 miles (667 km). The ionosphere is also 100 degrees cooler than expected."* So the then lack of sunspot activity had reduced the depth of the night time atmosphere by 35% and made its highest portion 100 deg cooler! Doesn't this suggest that the sun might be influencing the weather just a little?

[7] http://www.landscheidt.info/?q=node/50 - Geoff Sharp.
[8] Space Weather Super Storm http://www.oosa.unvienna.org/pdf/pres/stsc2011/tech-14.pdf

The huge (VE7) eruption of the Indonesian Mt Tambora volcano in April 1815 caused the following winter in the northern hemisphere to extend pretty well right through the next summer. This eruption ejected some 150 cubic kilometres of material into the atmosphere. As a result many crops failed and starvation resulted in many countries. The Tambora eruption is regarded as a once in a millennium event and there isn't any records of any VE7 or greater eruptions during the Maunder Minimum. However there does seem to have been an enormous amount of volcanic activity that time. There was a very large eruption just before the Sporer Minimum (1460-1550). It was probably the Kuwae volcano in Vanuatu. Researchers believe that was also a VE7 eruption although it probably was not as big as the Tambora eruption.

An indication of the recent change in seismic activity can be gauged by the increase in the frequency of great earthquakes since 2004. Great earthquakes have a magnitude of 8 or more and the frequency of these since 2004 has been roughly seven times the frequency of these earthquakes in the second half of the 20th Century. There however doesn't seem to be a similar change in the frequency of lesser earthquakes. So far this also does not appear as a significant wave on the actuarial beach of limited experience.

Solar Influence on Weather Extremes

The new grand minimum is enabling independent scientists across the globe to understand the processes by which the prolonged reduced levels of ultra-short wave length emissions change the weather patterns. The science is difficult but in very simple terms the changes in the depth of the atmosphere and temperature of the upper atmosphere plus the associated changes in level of ozone in the middle of the atmosphere cause the jet streams to change shape and course. There have been several papers produced by the IPCC that linked, during the decades of the late 20th Century, the gradual progression of the jet streams towards the poles to warming caused by increases in carbon dioxide in the atmosphere. But in recent years although the carbon dioxide levels have continued to increase the jet streams have become very much more erratic, loopy and are generally migrating much closer to the equator. These jet stream changes allow frigid air to move closer to the equator in winter time. But which countries are affected depends on the location of the loops in the jet streams at the time. The loops in the jet streams (known as Rossby waves) seem to also be moving more slowly and are often locking into position for extended periods.

Jet streams are known to be a principle driver of weather and particularly extreme weather events. For example it was a "locked" jet stream that was said to be responsible for the massive floods in Pakistan in 2010 and the heat wave in the Russian grain belts at the same time. It was the position of the jet streams that caused the blocking high pressure system that in turn caused Hurricane Sandy to move towards the US instead blowing itself out in the Atlantic.

Risks and Required Responses

Australia and the whole world will experience a significantly increased level of extreme weather events for at least the next 40 years. From time to time there is a risk that these events will impact food supplies and as the UN Food and Agriculture Organisation has already indicated world-wide shortages of some grains will develop in 2013. This will cause rapid increases in food prices. There is a risk that rapidly increasing prices of staple foods will create political instability in some countries.

For example rapidly rising prices of bread in the Middle East as a result of the Russian crop failures in 2010 and the then attempts to convert crops to ethanol were a catalyst for the start of the Arab Spring uprisings.

World grain stocks are currently believed to be around 10 - 12 weeks' of total world consumption. Al Gore has recently stated his concern of the consequences of a massive above ground volcanic event during the Eddy Minimum (fortunately 70% of volcanoes are under the ocean). If this happened then world grain stocks will quickly become fully depleted and there will be mass starvation in poorer drought stricken countries leading to massive political instability. When there is little or no food that is available to import then the prices of what limited grain that is available will multiply and inflation rates will increase significantly causing dislocations in many economies and in world trade.

The UN Food and Agriculture Organisation stated in October 2012 that the droughts and floods in various grain growing regions in the last two years have already reduced grain stocks to the lowest levels since 1974. With just a continuation of the current level of extreme weather events it warned of massive political unrest if prices rise and grain stocks continue to fall. A new report released in the Guardian Newspaper on January 17, 2013 suggests that with the continuing levels of extreme weather events the problem has become acute. Already, India has increased is grain stocks by 300% above normal levels and other countries will probably follow suit over the coming year or two. Therefore it would be prudent for Australia to also significantly increase the amount of grain it grows and to use the increased crops to increase its reserves of grain stocks whenever it can do so without dislocating its export markets unnecessarily. This means Australia should develop new grain storage facilities and stockpile much more grain than it currently does. Governments may have to provide financial assistance for this.

For the next few decades Australia should adopt a much tighter policy on overseas ownership of its productive cropping land and adopt policies to ensure that productive farmland is not exploited for any minerals and gas beneath. Finally, because of the potential risk for multi-country political instability Australia should increase its defence budget. It is imperative that Australia immediately purchase modern reliable attack submarines and Australia needs much better air security than it currently has.

Australia should also quickly adopt climate change adaptation strategies. These would include, for example, improvements in building codes so properties are less at risk of storm and tempest, removing sediment in river systems that would impede their flow and cause additional flooding in extreme wet weather events, investment in dams and water storages to harness more water from extreme wet weather events to utilise during very dry periods and investment in water storage and distribution systems that minimise the losses due to evaporation.

Australia should also adopt appropriate risk mitigation strategies. Impediments to taking out private insurance should be removed. This means that stamp duties and fire service levies on insurance policies should be removed. The revenue forgone should be raised by state governments as property taxes. This would ensure that all property owners pay these levies rather than just those who insure their properties. Private health insurance should be more encouraged in Australia as Australia's public hospital system will have to bear the brunt of the trauma caused by extreme weather events. This will eventually mean that more elective services will have to be shifted from the public to the private sector.

The coming decades of extreme weather events must be met with continuous improvement in the forecasting of the event consequences and the social, government and NGO responses to such events. Australians are unlikely to accept either poor forecasting or poor responses because of lack of preparation by governments and NGOs. If poor forecasting and/or poor responses cause significant mortality in Australia there will be an increased risk of major political repercussions.