From:
To: Flood Inquiry
Subject: NSW Northern Rivers Flood Submission
Date: Tuesday, 10 May 2022 11:54:24 AM
Attachments: Climate Change Paper 2021-1.doc
Aboriginals & Climate Change Small.10-19.doc

To Whom It May Concern,

On the northern rivers of NSW - Sea Level has been lower & higher than now, CO2 in the atmosphere has been lower & higher than now and Air Temperatures have been lower & higher than now.
In 1989 I was a joint conference co-ordinator & proceedings editor for the first conference in Australia to address climate change. The two day conference at Port Macquarie was sponsored by the Institution of Engineers Australia and over 100 delegates attended. The key note speaker was Professor Bruce Thom, Chair of the NSW Coastal Council. Also the CEO of the Insurance Council of Australia also was a key note speaker.
For the last 33 years I have taken a keen interest in natural and man made climate change. The recent 1 in 500 year floods on the northern rivers has let to this submission. You may get some valuable material from the two attached papers which may be suitable for background material.

Dr.
Retired Environmental Scientist (74 year old) e-mail
Ballina NSW 2478

The Facts About Natural and Human Impacts on Climate Change

About the Author

Dr. is a retired Environmental Scientist. He has consulted to various State & Federal governments in Australia and to the United Nations overseas. In 1989 he was joint conference co-organizer and co-editor of proceeding for the first conference on Climate Change in Australia. The conference was sponsored by the Institution of Engineers, Australia. He has lived in rural NSW for over 55 years experiencing the impact of seasonal climate change on agriculture and natural eco-systems. He is the author of 60 scientific papers with 26 peer reviewed. He has been listed in Who's Who in the World on several occasions.

Greenhouse Gases

Greenhouse gasses in the atmosphere comprise:-

TABLE I

Table I Sourced from United Nations – Intergovernmental Panel on Climate Change (IPCC).

Greenhouse gas	Chemical formula	Global warming potential, 100 year time horizon	Atmospheric lifetime (years)
Carbon Dioxide	CO2	1	100*
Methane	CH4	25	12
Nitrous Oxide	N2	265	121
Chlorofluorocarbon-12(CFC-12)	CC12F2	10,200	100
Hydrofluorocarbon-23(HFC-23)	CHF3	12,400	222
Sulfur Hexafluoride	SF6	23,500	3,200
Nitrogen Trifluoride	NF3	16,100	500

*No single lifetime can be given for carbon dioxide because it moves throughout the earth system at different rates. Some CO2 will be absorbed very quickly, while some will remain in the atmosphere for thousands of years.

The above table shows the relative concentrations of major greenhouse gases. Some gases (like CO2) are made both naturally and by manmade processes, while others (like hydrofluorocarbons) are only the result of human industrial activity.

Methane gas on the other hand can escape from the earth's surface naturally however some can escape from gas extraction operations if infrastructure is not maintained. It should be noted that large urban cities like Sydney emit Methane to the atmosphere up to

18 times above the ambient fresh air concentration of 1.8 parts per million by volume (ppmv). (9)

Climate change has been occurring naturally since the year dot, driven by solar and oceanic variables which we cannot control.

Carbon dioxide is quite stable in the Earth's atmosphere, but individual carbon dioxide molecules are in near constant flux from different sources, such as the surface oceans, land surfaces, and the atmosphere.

If atmospheric gases did not exist in the atmosphere the average temperature on earth would be minus 18 degree C (Centigrade) rather than plus 15 degree C at present.

The United States Oceanic and Atmospheric Administration state that the global temperature in 2019 was 0.98 degree C warmer than the average temperature for 1951 to 1980. The data was drawn from 20,000 weather stations around the world both on land and sea. (10)

Australia's land area has warmed 1.4 degree C since 1910.

In 2020 Australia was listed at 14th in the world for emitting CO2 behind heavy weights, such as China, US, India, Russia, Japan to name a few.

Most climate scientists do not incorporate past natural temperature variations into their modelling. Human induced CO2 emissions account for only a small fraction of our post-industrial temperature change. The 2021 IPCC report has again failed to incorporate pre-industrial data into their modelling. However the 2022 IPCC report now acknowledges natural gas processes on Earth.

Australia has gone through climate change for thousands of years. Droughts since the late 1800's have been recorded as:-

- 1895-1903 The Federation Drought
- 1937-1947 World War II Drought
- 1958-1968 Drought
- 1982-1983 Drought
- 1997-2009 Millennium Drought

The earth's climate has always changed with cycles of warming and cooling long before humans appeared on Earth. Numerous overlapping cycles range from 140 million years to 11.1 years.

Solar activity drives climate change:-

- 1850-1940 warmer
- 1940-1976 cooler
- 1976-1998 warmer and
- Post 1998 cooler?

The carbon cycle does not drive climate, it piggy backs on the water cycle. Over geological time, there is no observed relationship between global climate and atmospheric CO2. However the IPCC modelling report of 2021 say's we will be impacted by a rise of CO2 in the atmosphere?

CO2 in the atmosphere is only 0.001% of the total CO2 held in the oceans, surface rocks, air, soil and life forms.

During global warming and high CO2 levels in the atmosphere, history has shown humans have adapted, prospered and life lengthened.

CO2 is an essential input into food production. An increase in CO2 both enhances plant growth and aids the efficiency of water use by plants. Many glasshouses around the world run at up to 1,000 ppmv CO2, so as to achieve maximum output of produce. An increase of this level increases photosynthesis of plants by about 50%. At 560 ppmv one can expect up to 70% more vegetables and fruit. (3)

The surface of the earth is more than 71% water and the water cycle drives climate change on earth. The oceans contain about 22 times more heat than the atmosphere and the southern hemisphere oceans store between 75% - 98% of that heat. There has been numerous oscillations of the Western Antarctic ice sheet over 40,000 years, periodically linked to the Earth's orbital obliquity occurred during this period. This has caused sea level to rise especially in the southern hemisphere. If again and as in the past, the West Antarctic ice sheet melts we can expect large sea level rises in parts of the southern hemisphere by the end of the 21st century. (1)

There is an exchange of latent heat and dissolved CO2 between the oceans and the atmosphere. Our ocean currents transfer large amounts of heat around the world. Warm currents provide a warm atmosphere and land surface temperatures to many countries which would otherwise be cold. If ocean currents change, the surface of the land mass will be affected.

Currently CO2 levels in the atmosphere are at their lowest in thousands of years. The current level is 385 ppmv up from 325 ppmv 35 years ago. In the warmer Pleistocene sub-period CO2 was 25% higher than now at 481 ppmv. Aboriginal had abundance of food resources and some tribes/clans/hordes settled in one location for considerable time. (11) The Murray Basin (SW of NSW), coastal & other areas provided fresh water, diversity of flora, animals & fish/eels for consumption. Because of the abundance of food many Tribes occupied the Murray Basin and that is why the Willandra Lakes Region was World Heritage Listed by the United Nations.

To learn more on this issue you must read my paper titled **"Australian Aboriginals and Their Survival Throughout Natural Climate Change".** (11)

In the Holocene warming period the Budj Bim Aboriginals established a village of up to 700 people and lived in some 300 basalt stone houses. The village supported an aquaculture system dating back 6,600 years. The area was United Nations Educational, Scientific and Cultural Organization (UNESCO) World Heritage listed in 2019. (13) The listing of this Cultural Landscape is on a par with the Great Barrier Reef and the Opera House.

During Medieval warming 720-1100 years ago the global temperature was a few degrees higher than today and we had no CO2 emitting industries.

In Greenland 1,000 years ago the warm climate allowed the growing of grain crops and sheep and cattle grazing. Will this happen again soon?

Historically CO2 in the atmosphere does not come from industry but the fluctuations in CO2 resulting from solar activity, cosmic rays and orbital and terrestrial processes. Therefore climate change cannot be attributed solely to humans. Clouds can reflect 60% of the Sun's radiation and therefore influence atmospheric temperatures on earth.

The IPCC 2021 report talks about a rise in sea level. However off the east coast of Australia sea level has risen 130 meters over the last 14,000 years and in the past has been 5-7 meters higher than at present. The Gulf of Carpentaria changed from a Hugh inland lake to a shallow sea. In the past main land Australia was joined to Papua New Guinea and Tasmania. (11)

The United Kindown's highest scientific authority, The Royal Society has questioned the 2017 IPCC report regarding climate change. The Royal Society makes it clear that climate change is real and emissions from human activities are at least partly responsible, however there are no impacts from natural processes documented, in the report which show their contribute to climate change. The Royal Society says the IPCC modelling on atmospheric clouds and their impact on reflecting sun's heat back to earth is lacking. They also say the impact of any climate change around the world will not be uniform. This is supported by past world climate change events. (7)

NASA and the US National Oceanic & Atmospheric Administration support the Royal Society view that clouds are reflecting the sun's heat back onto the earth. Since 2005 they report a doubling of heat in the atmosphere. The oceans absorb about 90% of that heat. However it is difficult to measure how much humans have contributed to the cyclical variations in climate over time. (10)

The Thermohaline circulation cycle of the Earth's oceans (the conveyor belt system) appears to be slowing. Transport of oxygenated ocean waters is helping to ventilate the oceans. The oceans draw CO2 out of the atmosphere and the conveyer belt system moves the currents around the world. If the Gulf Steam slows or changes direction this may bring colder conditions to Northern Europe.

Understanding climate change is complex because of the dynamics of a multi-dimensional system at play worldwide.

Conclusions

Civilizations in the past have survived throughout natural climate changes and will into the future by adapting to human climate change influences.

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AUSTRALIAN ABORIGINALS AND THEIR SURVIVAL THROUGHOUT NATURAL CLIMATE CHANGE

About the Author

Dr. is a retired Environmental Scientist. For over 55 years he has worked in rural New South Wales (NSW) Australia. He has consulted to various State & Federal governments in Australia and to the United Nations overseas. He is the author of a book dealing with rehabilitation of disturbed landforms. He is the author of 60 scientific papers with 30 peer reviewed and published in conference proceedings in Australia and overseas. He has been listed in Who's Who in the World on several occasions. During his 55 years in the bush he has seen aboriginal stone tools including grinding tools, axes and cutting implements. He has seen axe factories, culturally modified trees, ceremonial bora rings, and aboriginal middens and hearth sites from the arid inland to the coast. He has seen fish traps, fossilized bones and carved waterholes in rock outcrops.

Acknowledgements

My daughter , archaeologists and teacher for her critical review of many drafts.

Introduction

In the ancient continent of Australia, Aboriginals have adapted to natural climate change as have the ecosystems in which they have lived. Aboriginals have lived through warm & cool climates for over 65,000 years. There were 121 Aboriginal tribes in Australia and all with their own dialect. Each tribe has many clans and hordes. The Aboriginals lived together with Australian megafauna for over 20,000 years.

The surface of the earth is more than 70% water and the water cycle drives climate change on earth. The oceans contain about 22 times more heat than the atmosphere and the southern hemisphere oceans store between 75%-95% of that heat (8). There is an exchange of latent heat and dissolved Carbon Dioxide (C02) between the oceans and the atmosphere. Ocean currents transfer large amounts of heat around the world. Warm currents provide warm atmospheric and land temperatures to countries which would otherwise be cold.

Currently C02 levels in the atmosphere are at their lowest in thousands of years. The current level is 385 parts per million by volume (ppmv) up from 325 ppmv 35 years ago (8). C02 is an essential input into food production. An increase in C02, both enhances plant growth and aids the efficiency of water use by plants. Many glasshouses around the world run at up to 1,000 ppmv C02, so as to achieve maximum output of produce. An increase of this level increases photosynthesis of a plant by about 50%. At 560 ppmv one can expect up to 70% more vegetable and fruit production (4). Please note the level of methane and other greenhouse gases in the atmosphere historically and at present have not been discussed in this paper.

In the warmer Pleistocene sub-period when atmospheric C02 was 25% higher (481 ppmv) than now, the aboriginals had abundance of food and centralized their hunting and gathering activities. They even lived a semi-nomadic life as they were not required to travel long distances for food. The Murray Basin, coastal and other areas provided an abundance of fresh water, diversity of flora, animals and fish/eels for consumption. However during cooler periods aboriginal populations were forced to travel further for water and food. This bought neighboring aboriginal tribes into conflict. Similar historical conflicts occurred in Europe in cooler times over tens of thousands of years (8).

In Australian Geographic the CSIRO reported that the world's oldest astronomers may have been the Australian Aboriginals. Ancient stone structures found in Victoria suggest they were used for astronomical purposes and they await heritage listing. Different Aboriginal tribes used the southern sky constellations to integrate their understanding of the stars with knowledge of the land and seasons.

Earth's Early History

This paper traces natural change on earth and how humans and particularly aboriginals have evolved from the Last Interglacial period to the present. To do this in a logical sequence the paper has been divided according to Figure 1. Overlapping of text from one period to another has occurred in parts. Not all of the Earth's periods of development have been discussed equally. However key aspects of the paper are presented for the reader's knowledge.

Period	When it Occurred
Last Interglacial	110/116,000-130,000bn
Pleistocene ice age	110,000-14,700bn
Bolling	14,700-13,900bn
Older Dryas	13,900-13,600bn
Allerod	13,600-12,900bn
Younger Dryas	12,900-11,600bn
Holocene Warming (a)	11,600-8,500bn
Egyptian Cooling	8,500-8,000bn
Holocene warming (b)	8,000-5,600bn
Akkadian Cooling	5,600-3500bn
Minoan Warming	3,500-3,200bn
Bronze Age Cooling	3,200-2500bn
Roman Warming	500BC-535AD
Dark Ages	535AD-900AD
Medieval Warming	900AD-1,300AD
Little Ice Age	1,300AD-1,850AD
Modern Warming	1,850AD- now

Figure 1: Shows the geological stages of Earth's development.
bn = years before now.

Last Interglacial Period

Humans today are thought to have evolved from *Homo sapiens* from East Africa about 130,000 years ago or earlier and spread globally. Some authorities think modern humans evolved concurrently on many continents on earth. The planet then was about 2-6ºC warmer and sea level 4-6 meters higher than at present. In Western Australia the sea level was 3.0 meters higher. Evidence suggests the temperature peaked at > 5ºC higher around 115,000 years ago (8).

Pleistocene Ice Age

The last glacial period started about 116,000 years ago and peaked some 20,000 years ago. Atmospheric temperature and sea level fell resulting in a shift of plants, animals and the movement of *Homo sapiens*. It is known that sea level was 130 meters lower than at present. During this period evidence shows humans migrated from Asia via the Bering Straits to North America (8).

The eruption of Mt.Toba in Indonesia about 74,000 years ago saw forests and grasslands over lower latitudes impacted. Humans then were hunters & gathers and were put under stress or died. It has been suggested the human population more than halved as a result of Mt. Toba. The eruption forced human migration to Europe, India, Asia and Australia (8). The Mt. Toba mega-bang caused a prolonged nuclear winter and released ash in a huge plume that spread throughout Asia and deposited a 1-3 meter blanket of ash. For six years winter reigned on Earth, and the thousand years that followed were colder on average than previous glacial maximum.

So did our first aboriginals enter Australia's north at this time or had the aboriginal population evolved already on the continent? Did the aboriginals (*Homo sapiens*) evolved from *Homo erectus* who first

ventured out of Africa around 1.8 million years ago? Others suggest two species of *Homo sapiens* evolved at similar times in the northern and southern parts of Australia, based on their physical features. Others suggest these physical features were the product of their environment.

The Yolngu tribe at Nhulunbuy (Gove) have existed for over 65,000 years (7). Also in the Medieval Warming period (900AD – 1300AD) we know that Macassan people of Indonesia were trading and intermarrying with northern Australian aboriginals. At Mount Borradaile in the Northern Territory, aboriginal have existed for over 65,000 years and their rock art is recognized as the most stunning rock galleries in the world (7). We also know that Aboriginals were sophisticated stone tool-makers: no other culture had stone axes for another 20,000 years. At Jabiru within Kakadu National Park a stone axe was dated at 65,000 years old and was surrounded by stone flakes and stone spear tips.

Evidence from Lancefield Swamp Fossil Site which is 80,000-50,000 years old in the Macedon Ranges, about 70 kilometers north of Melbourne indicates aboriginals inhabited the area about 50,000 years ago (9). Similarly Mungo National Park, north east of Mildura, contains remains of earlier humans to inhabit the Park and are dated at more than 60,000 years old (7). Carbon dating suggests human bones could be 68,000 years old (15). That is why in 1981 the Park was World Heritage Listed. During this time macro fauna would have been a protein source for aboriginals. Aboriginal use of **fire-stick farming** as a tool to assist in herding animals and/or encourages animals to fresh green pick is well documented. Aboriginal may well have caused the extinction of macro fauna in regional areas but drought has played a hand. In the late Pleistocene era there was a more rapid extinction of macro fauna especially in south east Australia after severe drought (9).

In other parts of the world the rapid extinction of macro fauna occurred at different times. Except in America during the Younger Dryas period where extinction was sudden.

Murray Basin

The Murray Basin extends across 300,000 square kilometers of NSW, Victoria and South Australia. At times the Murray Basin (Murravian Gulf) was a vast sea and part of the southern ocean. During this time periodic sea level fluctuations occurred. Former fossilized ancient shorelines of the Basin run over a distance of 400-500 km in a northwest to southeast direction. Parts of the ancient shoreline are 450 kilometers from the current coastline (14). In this period sea level is known to have fluctuated at least 40 meters and C02 levels were 481ppmv, which is 25% higher than now (8).

Research shows that the Murray Basin was home to aboriginals for over 65,000 years. It is known that a 4,000 year warm period occurred between 32,000 – 28,000 years ago and favored the growth of the aboriginal population.

Heavy mineral sands minerals have been dated at 7 million years old along ancient coastal beaches in the Murray Basin at Ginkgo and Snapper mines, west of Pooncarie. These deposits are 450-500km from the current coastline. The author not far from Pooncarie has found ancient aboriginal midden sites on the Darling River floodplain. Ancient river fish traps have been found further north on the Darling River and in Victoria. Other undiscovered fish traps are out there to be found.

The climate change experienced in the Murray Basin particularly during the early and middle Pleistocene and the late Quaternary, played a major role is shaping the Basin's landforms. Numerous oscillations of the Western Antarctic ice sheet over 40,000 year, periodicity linked to the Earth's orbital obliquity occurred during this period and caused the Basin's sea level changes (14). However from the Late Quaternary the climate became dry which caused Lakes to shrink e.g., Lake Bungunnia. Some lakes became saline on the surfaces and some with saline groundwater discharged. Other former lakes have been infilled with aeolian sand movement from west to east. Recently some researchers suggest the Western Antarctic ice sheet may collapse and sea level could rise by up to one meter by the end of 21st Century (2)

Historic archeological sites in the Murray Basin potentially run into the thousands. Many are of low research value but others are of moderate to high value. The existence of the Willandra Lakes Region World Heritage Area supports the importance of this part of the Murray Basin. The moderate and high value sites include the Box Creek distributary of the Lachlan River, areas around Muckee Lake, Tin Tin Lake, Pitarpunga Lake and areas of relict lake fringes and depressions e.g., Lake Mungo (6).

The Riverine Plain forms the eastern part of the Murray Basin and aboriginals occupied the area. The plain is relatively flat and acts as an alluvial floodplain for the west flowing Murray, Murrumbidgee and Lachlan Rivers (14). In the past aboriginals have occupied these areas around freshwater lakes, some of which were up to several kilometers wide. Settlements were often on the western shorelines of the lakes, because the high western foreshore offered protection from the westerly winds. They also occupied sites along ancient stream channels. Because of the abundance of fish, fauna, flora and freshwater during warmer times the aboriginals became semi nomadic hunters and gathers only when food was scarce. They did not live in massive settlements or leave infrastructures for us to discover during this period. **However aboriginal villages occur later in the history of Australia**. The opposite occurred in Europe where we can gather evidence from archaeological sites because of their village infrastructure.

In dryer times as discussed in the previous paragraphs, saw aboriginals travel further for food. To the east of the Riverine Plain they established temporary water holes on rock outcrops. Holes were carved into the rock surfaces and water collected after rainfall. They then moved into these dry areas knowing they had water to survive on after rain. The rock outcrops also were used as lookout stations for hunting. When they left these areas the carved water holes were covered with timber and bark so animals could not gain access. The author has seen these elevated carved water holes.

Bolling

The end of the late Interglacial period around 14,000 years ago saw a rapid warming and sea level rose 130 meters (8). Plants, fish, animals and humans thrived and further migration occurred. Sea level rise saw the Torrens and Bass Straits filled with sea water. The Gulf of Carpentaria changed from a huge inland lake to a shallow sea and coastal lowlands around Australia were inundated (8). Ancient aboriginal sites can be found on lowlands well inland from the current coastline. Many of these sites are on private lands. Aboriginal axe factories, stone tools, ceremonial bora rings, culturally modified tree and hearth sites exist in these areas (12). The aboriginals have adapted to their changing environment.

Older Dryas

The Older Dryas covers a period of around 300 years and little is recorded in the literature which I have reviewed.

Allerod

The Allerod lasted about 700 years but we know this was a warm period and humans are recorded as migrating from Asia to North America. We can assume aboriginals multiplied and migrated within Australia during this warmer period.

Younger Dryas

The Younger Dryas was a period of rapid cooling in less than 100 years driven by changes to ocean currents (as discussed earlier). Summers and winters were estimated to have been 4ºC and 28ºC cooler than today, respectively.

At about 11,600 years ago saw the end of the Younger Dryas with atmospheric temperature increasing by 7ºC over about 15 years (8). This was a time on earth when some other hunter & gather populations built villages and some authors suggested that these large centralized populations led to the regional extinction of mega fauna from 12,000-11,000 years ago (8).

Holocene Warming (a)
This was a time of prosperity and migration occurred in Europe. About 10,000 years ago the population on earth was estimated at about 5 million, because of the warmer climate. Evidence exists of increased upslope tree cover and increased agricultural practices. In Europe this was a time of prosperity and migration. The aboriginal population increased and spread to less populated areas within Australia during this warmer period.

Australia's Wurdi Young Stonehenge site is located 45 kilometers west of Melbourne near Rothwell, Victoria. Geologists and experts estimate the site is around 11,000 years old. This makes the site older than the British Stonehenge and the Pyramids in Egypt.

In 1977 archaeologists surveyed 100 basalt boulders in roughly a 50 meters circle pattern. Boulders were from knee to waist height and were aligned in difference sizes and aligned so Aboriginals could track the winter and summer solstices. It is possible this site is the world's first observatory for observing activity of the sky. The site is awaiting listing on our National Heritage list.

If one Googles "Australian Stonehenge Structures" other sites will appear. This is further evidence of how advanced our Australian Aboriginal were compared to other civilizations.

Egyptian Cooling
Evidence exists of sea level 3 meters lower than now. Populations moved to lower altitudes. Anatolian highland people moved to the Black Sea in central Europe which covered an area of 160,000 square kilometers. The basin then contained fertile plains and two large freshwater lake. The ancient world described the basin as the bread basket of Europe. However, the North Anatolian Fault moved and sea water filled the Black Sea basin from the Marmara Sea via the Bosphorus passage. The Black Sea was filled in two years. Evidence of preserved submerged wooden villages have been discovered in the basin (8). Many of you would have sailed on the Black Sea as tourists.

Holocene Warming (b)
Between 7,000- 4,000 years ago sea level was 2 meters higher than now and it stayed at that level for about 3,000 years. The atmospheric temperature around 6,000 years ago was 6ºC higher than now (8). Evidence suggest that sea level rise was not global but regional, because areas of Florida and Bahamas suggest a sea level rise of 17 meters between 8,500-6,500 years ago and 6.5 meters between 7,600-7,200 years ago (8).

In Australia aboriginal archaeological sites can be found in the Holocene dunes and estuaries well back from the current coastline. Food was plentiful during this period and populations would have been semi-nomadic using shelters and caves for longer periods. Many caves hold evidence of long duration occupation (12).

In the SW of Victoria evidence exists of aboriginal villages comprising low profile stone building which would have accommodated a family. Three hundred basalt stone houses existed measuring about 3 meters in diameter by 1.0 meters high and roofed with wood, bark and reeds. One village is estimated to comprise up to 700 people. To sustain this village structure food resources would have to be plentiful. Stone tools in one village has been dated at 3,500 years ago. It appears climate change may have played a part in changing some aboriginal people to a village community. Between Lake Condah and Conhad Swamp aboriginal people undertook hydraulic engineering earthworks to ensure a reliable source of aquatic food. This area known as the Budj Bim Cultural Landscape was declared a United Nations Educational, Scientific and Cultural Organization (UNESCO) World Heritage site on the 6th July 2019. The site is an aquaculture system started over 6,600 years ago. It is the oldest aquaculture network in the world and is composed of engineered channels, ponds and weirs, running for 35km.where water levels were manipulated to encourage eels to swim into holding ponds for fattening. This allowed the Gunditjmara Aboriginal people to remain in one place. (16)

Akkadian Cooling
Little is known of this period which spanned 2,100 years
Minoan Warming
Like above little is recorded for this 300 year period but we know it was warmer than today and consequently life on earth advanced.

Bronze Age Cooling
This period spanned 3,200-2,500 years and at 2,500 years ago the earth's population was estimated at 100-150 million (8).

Roman Warming
After the cool Bronze Age atmospheric temperature rose 2ºC higher than today. Global population increased and agriculture advanced to feed them. Some alpine passes in Europe and Asia were free of snow which permitted people movement to unpopulated areas at around 2,500-1,700 years ago (8).

In this period, the Roman's tried to re-build the old port of Ephesus in Turkey, which many of you may have visited as tourists. The Roman's failed to re-build the port and today it lies 24 kilometers from the coast and 5 meters above current sea level (8).

Dark Ages
This 365 year period was extremely cold, with crop failure, disease, war, depopulation and migration of people. The Mayans civilization collapsed in this period.

Medieval Warming
Medieval Warming was a short period of 400 year. The atmospheric temperature was warmer than today. The temperature in Greenland was 6ºC warmer at 1,000AD. Agricultural cropping increased, village life expanded, large infrastructures were built and ocean exploration increased.

Little Ice Age
Four cold periods were recorded in the Little Ice Age. However in Greenland ice core records show only two very cold periods around 150AD and 1850AD (8).

Modern Warming
This period covers from 1850 to now. We currently live in an Interglacial Period with variable climate. Warming trends exist, driven by solar activity, cosmic ray intensity, earth's orbit, terrestrial processes and cloud cover. It is interesting that a change of just 1% in the Earth's cloud cover can significantly influence our climate (8).

Warmer sub-periods occurred in 1850-1940 and 1976-1998 and cooling sub-periods existed in 1940-1976 and 1998 - now (8). However given recent droughts and bushfires in Australia the end of the cooling sub-period may have to be reviewed.

United Kingdom Meteorological Office has confirmed average global atmospheric temperature since 1998 are falling despite atmospheric CO2 increasing (11).

Others suggest the West Antarctic ice sheet may collapse and sea level could rise by up to one meter by the end of the 21st century as a result of an increase in atmospheric C02 content (2).

NASA reported that Antarctic sea ice has increased in 1979 to 1999 (5). This has been confirmed by satellite altimeter echoes between1992-2003 which showed the ice sheet has grown. Technically this is sufficient to lower sea level by 0.08mm per year (5).

Other authors estimate sea level will rise 5cm. by 2100AD, from the melting of icecaps and alpine valley glaciers (8).

Other research scientists say 80% of global temperature over the last 150 years comes from solar activity but this can vary from continent to continent (8).

Again more authors have shown that for the entire 1900's sea level change was 1.74mm ± 0.16mm per year.

So who do we believe about sea level change?

Conclusion

For thousands of years aboriginals in Australia have been adapting to natural climate change. They have lived through warm and cool periods, through sea level rise and fall and through changes in the level of carbon dioxide in the atmosphere. We can learn from aboriginals and from older global civilizations on earth. But are we prepared to adapt to climate change whether natural or from human causes?

Today's population is just under eight billion people and will grow to over nine billion by 2050. The majority of this population increase will occur in developing countries. People in these countries will demand goods and services which developed nations enjoy. Currently fossil fuels supply 80% of the world's energy needs to meet the production of goods and services. However by the end of 2022 it is estimated fossil fuel energy will account for 70% of the world's energy needs with wind and solar supplying 10%. Carbon Dioxide will increase in the atmosphere because of a population increase and therefore the world must adapt, just like Australian Aboriginal's have in the past.

I have shown that an increase in carbon dioxide in the atmosphere is not as bad as some people make out. Carbon dioxide is a key input for food production and an increase in carbon dioxide can enhance food yields and improve natural ecosystems.

However there are differences among researchers around the world over sea level change. This paper show's that the sea level has changed throughout the geological stages of the earth's development. However if we accept a rise in sea level will occur in the near future, are we be prepared to adapt to this change?
Are we as prepared to:-

- Change our urban planning strategies.
- Change our building codes.
- To assist others financially who may be effected and/or
- Uplift our homes and move to safer areas, as aboriginals have done in the past.

There are many more impacts from a future rise in sea level which can be sourced from other publications. In 1989 the author was joint organizer and editor of proceedings of the first conferences in Australia to address climate change/greenhouse. The conference was sponsored by the Institution of Engineers, Australia (13).

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