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ONE SOLUTION TO WATER SUPPLY PROBLEMS

LIES HIDDEN IN THE ROCKS

THE LIKELIHOOD OF A GLOBAL DROUGHT IN 2009–2016

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Implementation of the reserve at the Berg River Dam and Supplement Scheme

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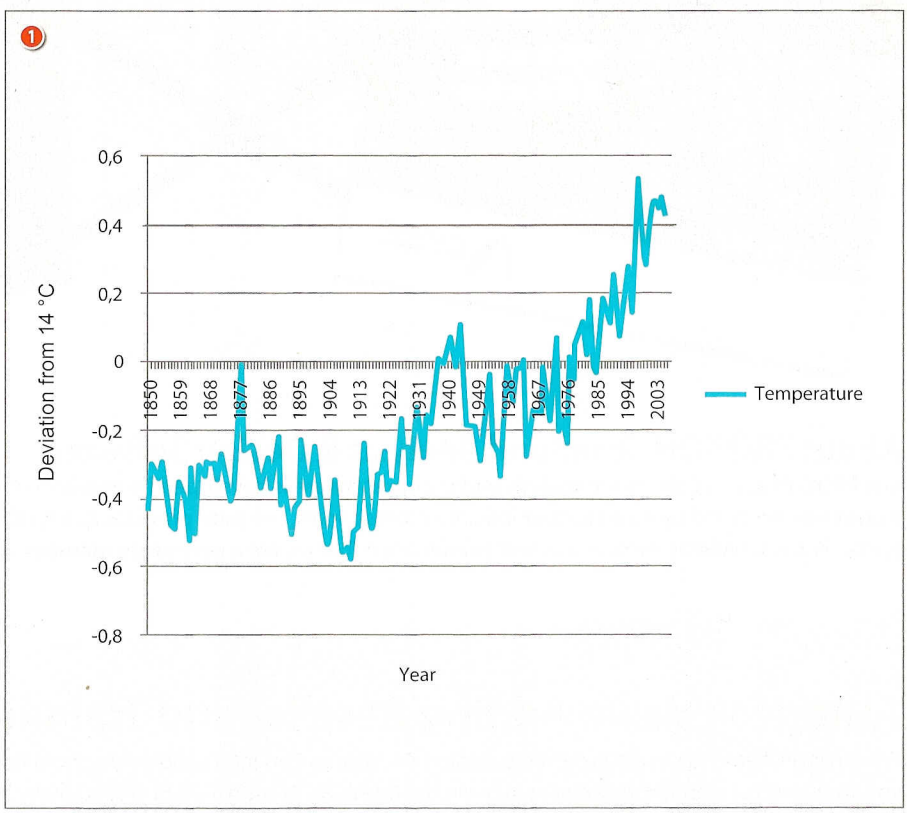
The likelihood of a global drought in 2009–2016

SOUTH AFRICA IS CURRENTLY experiencing a severe energy crisis that has widespread consequences on all sectors of our society. Blame is being levelled at the South African authorities for not heeding earlier warnings that shortages would develop if additional power stations were not built to meet the rapidly rising demand.

It takes between five and ten years to plan, design and construct large power stations. Coal-burning and nuclear power stations are the only option on the required scale. Restricting use through the imposition of electricity rationing appears to be the only immediate solution. This is likely to continue for at least the next five years. This is already having severe adverse effects on South Africa's economy.

There is the possibility of an equally severe event occurring before the



1 Surface air temperature data, 1850–2006

Abbreviations used:

IPCC – Intergovernmental Panel on Climate Change. This United Nations body was established in 1988 and produces five-yearly assessment reports. Its latest series of reports were published during 2007. A shortened synthesis report for decision-makers was distributed during the Bali Conference in November 2007. It is the reference used in these notes.

GGEs – Undesirable greenhouse gas emissions, principally carbon dioxide. It is claimed that these emissions from coal-burning power stations, transport and industrial activity are causing increases in global air temperatures. These in turn are predicted to cause a whole series of undesirable consequences including increases in floods, droughts and environmental damage.

energy crisis is resolved. This is the likelihood of the occurrence of severe drought sequences of a magnitude equal to that of the Great Depression drought of the 1930s. They are likely to commence within the next 12 months, reach their peak two or three years later, and continue through to 2016.

Consider the consequences. There will be shortages of cooling water for the inland coal-fired power stations for a start. This will exacerbate the energy crisis just at a time when things start improving. Then there will be all the other consequences for agriculture, rural communities and water supplies generally. Together with the present energy crisis it will be a national disaster of enormous consequences.

What is the likelihood of this occurring?

THE EARTH'S CLIMATE

The earth's climate is driven by the receipt and redistribution of solar energy. If global scale climatic changes are observed, the investigation into the most likely cause should begin with an examination of the concurrent variations in solar activity. The fundamental issue is the separation of the effects of human activities from natural variability.

Numerical quantifications of the natural variability of rainfall, river flow and open water surface evaporation (but not temperature) are the very essence of water resource analyses; flood magnitude/frequency analyses; and natural disaster mitigation studies. Those of us who are active in this field have a professional responsibility to assess and report on the effects of human activities on these processes should they be present.

The most important (critical) data set in climate change studies is the reconstructed global annual surface air temperatures since 1850. These are the foundations of the IPCC reports. This data set is not publically available despite its critical importance. I managed to obtain a copy. The annual sunspot data are from the website http://sidc.oma.be/DATA/yearssn.dat that I used for my earlier analyses. I now had two parallel sets of annual data from 1850 to 2006.

Table 1 Solar periodicity table

Period year	Periods							
1	1843	1867	1889	1913	1933	1954	1976	1996
2	1844	1868	1890	1914	1934	1955	1977	1997
3	1845	1869	1891	1915	1935	1956	1978	1998
4	1846	1870	1892	1916	1936	1957	1979	1999
5	1847	1871	1893	1917	1937	1958	1980	2000
6	1848	1872	1894	1918	1938	1959	1981	2001
7	1849	1873	1895	1919	1939	1960	1982	2002
8	1850	1874	1896	1920	1940	1961	1983	2003
9	1851	1875	1897	1921	1941	1962	1984	2004
10	1852	1876	1898	1922	1942	1963	1985	2005
11	1853	1877	1899	1923	1943	1964	1986	2006
12	1854	1878	1900	1924	1944	1965	1987	2007
13	1855	1879	1901	1925	1945	1966	1988	2008
14	1856	1880	1902	1926	1946	1967	1989	2009
15	1857	1881	1903	1927	1947	1968	1990	2010
16	1858	1882	1904	1928	1948	1969	1991	2011
17	1859	1883	1905	1929	1949	1970	1992	2012
18	1860	1884	1906	1930	1950	1971	1993	2013
19	1861	1885	1907	1931	1951	1972	1994	2014
20	1862	1886	1908	1932	1952	1973	1995	2015
21	1863	1887	1909		1953	1974		2016
22	1864	1888	1910			1975		
23	1865		1911					
24	1866		1912					

The first exercise was to plot the temperature data. The result is in figure 1. The temperatures are the deviations from 14 °C. This is almost identical to the temperature graph in figure SPM.1 in the IPCC's synthesis report distributed at Bali. The sharp upward trend since 1980 and the sustained high values during the past six years are also very clear. This is the graph that the IPCC relies on for evidence of human causality of global warming. The argument is that this graph is proof of a causal linkage between increasing GGEs and increasing global temperatures.

There are serious problems with this conclusion. Not only has there been no sustained increase in global temperatures since 1998, but during the past year global temperatures have shown a marked decrease. This is causing panic among the climate change fraternity.

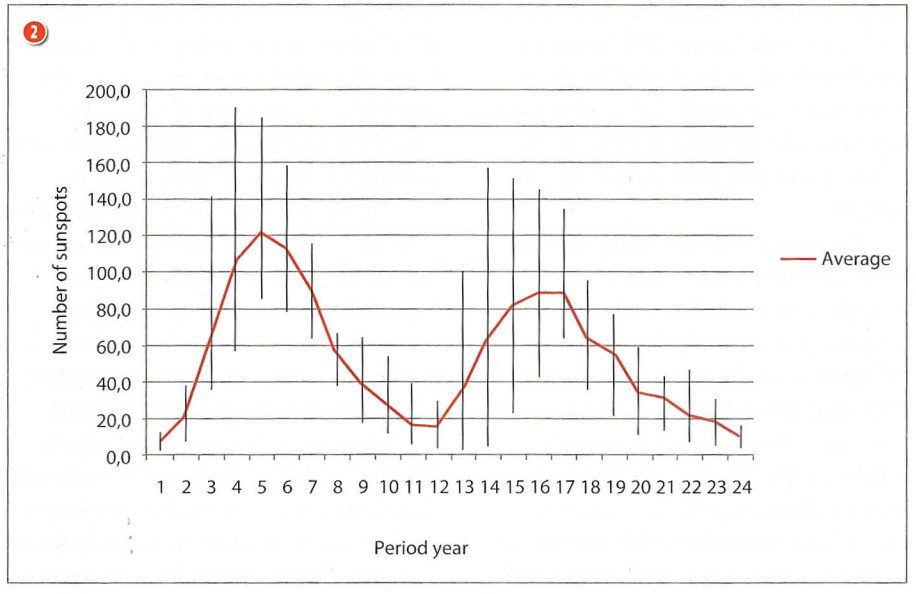
For reasons that remain a mystery, the IPCC failed to take the obvious next step. Could this increase be the consequence of a concurrent increase in solar activity? This is extremely important, as the solar linkage has to be eliminated before this temperature increase can be attributed to human activities.

It was a simple matter to produce Excel graphs that showed both the temperature and sunspot data and the corresponding linear trend lines. It is common practice in preliminary time series analyses to split the record into two parts and examine them separately. The year 1913 is the beginning of the first double sunspot cycle during the past century and a convenient point to split the data.

The two data sets were analysed. While during the period 1913 to 2006 both the sunspot numbers and the global temperatures showed increasing trends, during the earlier period 1850 to 1912 both the global temperatures and sunspot numbers decreased during this 62-year period.

Given the above information, it would be a very brave scientist who continues to claim that there is NO linkage between variations in global temperatures and corresponding variations in sunspot activity. Even more importantly, the IPCC scientists were negligent, bordering on irresponsible, not to carry out these simple analyses that go to the very core of climate change science, and need only a few

What then is an appropriate time unit for examining the relationship between variations in solar activity and global air temperatures? The obvious candidate is the length of the double sunspot cycle. In the analyses that follow, we are simply using a solar-related time unit. In principle this is a logical extension from a 24-hour day, to a 365-day year, to a 21-year solar period



2 Periodicity graph showing range of annual sunspot numbers
3 River flow prediction model

hours of effort using readily available computer software.

PREDICTABILITY

The cyclical and therefore predictable behaviour of sunspot activity is beyond all doubt. It has also been known for more than 100 years in South Africa that there is a synchronous linkage between sunspot numbers and South African rainfall and river flow. As explained in 'Linkages between solar activity, climate predictability and water resource development' (Alexander *et al* 2007) the alternating sunspot cycles are causally related to the acceleration and deceleration of the sun as it moves through galactic space.

SCALE DEPENDENCE

It was obvious from the analyses that a synchronous relationship exists between sunspot activity and global air

Table 2 Annual sunspot numbers

Period year	1843	1867	1889	1913	1933	1954	1976	1996	Lowest	Highest	Average
1	10,7	7,3	6,3	1,4	5,7	4,4	12,6	8,6	1,4	12,6	7,1
2	15,0	37,6	7,1	9,6	8,7	38,0	27,5	21,5	7,1	38,0	20,6
3	40,1	74,0	35,6	47,4	36,1	141,7	92,5	64,3	35,6	141,7	66,5
4	61,5	139,0	73,0	57,1	79,7	190,2	155,4	93,3	57,1	190,2	106,2
5	98,5	111,2	85,1	103,9	114,4	184,8	154,6	119,6	85,1	184,8	121,5
6	124,7	101,6	78,0	80,6	109,6	159,0	140,5	111,0	78,0	159,0	113,1
7	96,3	66,2	64,0	63,6	88,8	112,3	115,9	104,0	63,6	115,9	88,9
8	66,6	44,7	41,8	37,6	67,8	53,9	66,6	63,7	37,6	67,8	55,3
9	64,5	17,0	26,2	26,1	47,5	37,6	45,9	40,4	17,0	64,5	38,2
10	54,1	11,3	26,7	14,2	30,6	27,9	17,9	29,8	11,3	54,1	26,6
11	39,0	12,4	12,1	5,8	16,3	10,2	13,4	15,2	5,8	39,0	15,6
12	20,6	3,4	9,5	16,7	9,6	15,1	29,2		3,4	29,2	14,9
13	6,7	6,0	2,7	44,3	33,2	47,0	100,2		2,7	100,2	34,3
14	4,3	32,3	5,0	63,9	92,6	93,7	157,6		4,3	157,6	64,2
15	22,7	54,3	24,4	69,0	151,6	105,9	142,6		22,7	151,6	81,5
16	54,8	59,7	42,0	77,8	136,3	105,5	145,7		42,0	145,7	88,8
17	93,8	63,7	63,5	64,9	134,7	104,5	94,3		63,5	134,7	88,5
18	95,8	63,5	53,8	35,7	83,9	66,6	54,6		35,7	95,8	64,8
19	77,2	52,2	62,0	21,2	69,4	68,9	29,9		21,2	77,2	54,4
20	59,1	25,4	48,5	11,1	31,5	38,0	17,5		11,1	59,1	33,0
21	44,0	13,1	43,9		13,9	34,5			13,1	44,0	29,9
22	47,0	6,8	18,6			15,5			6,8	47,0	22,0
23	30,5		5,7						5,7	30,5	18,1
24	16,3		3,6						3,6	16,3	10,0

temperatures on a multi-decadal scale. Yet much has been made of studies that showed that variations in received solar energy were too small to account for the observed climate variations. The authors then erroneously assumed that no causal relationship existed. Their studies failed to address the well-documented historical linkages that demonstrate the presence of this synchronous behaviour. Why did the IPCC scientists deliberately omit mention of this information? The most likely reason is that these scientists used annual time scales in their studies, not realising that their conclusions were scale dependent.

What then is an appropriate time unit for examining the relationship between variations in solar activity and global air temperatures? The obvious candidate is the length of the double sunspot cycle. In the analyses that follow, we are simply using a solar-related time unit. In principle this is a logical extension from a 24-hour day, to a 365-day year, to a 21-year solar period. The difference is that the length of the solar period is not precise but varies within a narrow range. The reasons are given in the joint paper referred to above.

SOLAR PERIODICITY TABLE

The years during which the sunspot minima associated with the double sunspot cycle occurred are readily identified in the annual sunspot data. These, together with the number of years between them are as follows: 1843 (24) 1867 (22) 1889 (24) 1913 (20) 1933 (21) 1954 (22) 1976 (20) 1996 (21) 2017.

It was now possible to produce a solar periodicity table that will allow any time series data to be rearranged and analysed using the solar period as a basic time unit. This is shown in table 1.

It is a simple matter to substitute the available data values for each year, and carry out the analyses in Excel. Table 2 shows the sunspot data for each year in the solar periodicity table.

Each column in the table begins with the year in which the solar minimum associated with the double sunspot cycle occurred. The data were analysed row by row and then plotted in the periodicity graph (figure 2).

Note in particular the difference in the distribution of the sunspot numbers and their ranges in the alternating cycles.

PERIODIC BEHAVIOUR

Table 3 is based on information in P D Tyson's book *Climate change and variability in southern Africa*. It was published in 1987 – a year before the establishment of the IPCC. It must be stressed that the interest is in sequences of years, not individual years. This is where other researchers made a fundamental mistake. They searched for linkages between solar activity and climate on a yearly basis instead of a periodic basis. When they could not detect it they assumed that no linkage was present.

It is a simple matter to construct table 4 from this information. It shows the years in which the double sunspot cycles commenced in the left-hand column and the period year numbers in the top row. The grouping of wet and dry sequences and the correlation with the double sunspot cycle is even clearer than before.

Compare this information with figure 2 above. Note the dominance of wet years associated with the first sunspot cycle (years 1 to 11), and dry years with the second sunspot cycle (years 12 to 22). The association of the alternating sunspot cycles with the wet and dry periods is very clear. It is a suitable basis for the prediction of the likelihood of drought sequences in the years ahead.

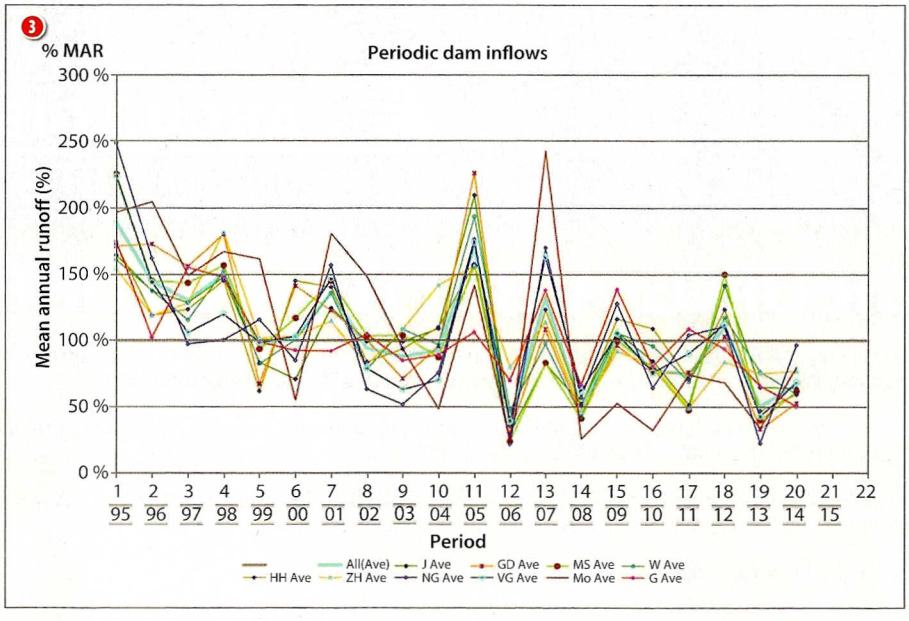


Table 3 Periodic range of wet and dry rainfall sequences (after Tyson 1987)

Years	Wet/dry
1971–1980	Wet
1962–1970	Dry
1953–1961	Wet
1944–1952	Dry
1933–1943	Wet
1925–1932	Dry
1916–1924	Wet
1905–1915	Dry

Table 4 Periodic behaviour of South African rainfall

Period starting	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1996														?	?	?	?	?	?	?	?			
1976	W	W	W	W	W																			
1954	W	W	W	W	W	W	W	W	D	D	D	D	D	D	D	D	D	W	W	W	W	W		
1933	W	W	W	W	W	W	W	W	W	W	W	D	D	D	D	D	D	D	D	D	W			
1913	D	D	D	W	W	W	W	W	W	W	W	W	D	D	D	D	D	D	D	D				
1889																	D	D	D	D	D	D	D	D

All indications are that we are now on the threshold of global cooling associated with the second and less active solar cycle. The delayed solar minimum occurred earlier this year (January 2008). A severe global drought will almost certainly be one of the consequences

DROUGHT ALERT

It is important to note that periodicity in the data was used as the prediction tool and not the sunspot cyclicity.

Figure 3 is a river flow prediction model prepared by Alwyn van der Merwe. It shows the periodic dam inflows for ten sites in the South African interior. For each record, the average for each period year was determined using the method described above. These period year averages were then plotted in the figure. The process was repeated for the remaining sites.

We are at present in period year 13 (2007–2008). Note the very clear, well above average recorded river flows for the present hydrological year (13). Even more importantly, note the succession of below average river flows in the period years that lie ahead (14 to 20). Analyses of other long hydrological data series show similar characteristics.

This prediction model is based on the thoroughly studied, synchronous linkage between periodic solar activity and the hydro-meteorological processes. It has been tested and verified. The likelihood of prolonged, severe droughts from next year onwards is very real.

Can we venture an estimate of how severe the droughts are likely to be? There were five dry (drought) sequences during the past century. One of them was the Great Depression drought. As a first estimate there is therefore a 20 % likelihood of it being repeated in the years ahead.

As I write these notes there is a considerable volume of international Internet traffic expressing concerns relating to the lack of solar activity during the past year and the possibility that the world may be entering an ice age. While this may be premature, the linkage between the abnormally cold weather being experienced in the northern hemisphere and the abnormal lack of sunspot activity during this period is causing considerable concern.

All indications are that we are now on the threshold of global cooling associated with the second and less active solar cycle. The delayed solar minimum occurred earlier this year (January 2008). A severe global drought will almost certainly be one of the consequences.

Reference

This article should be studied in conjunction the paper by Alexander, Bailey, Bredenkamp, Van der Merwe and Willemse, Linkages between solar activity, climate predictability and water resource development, *Journal of the South African Institution of Civil Engineering*, Vol 49 No 2 June 2007, pages 32–44, Paper 659, and the references therein. □