# Is Climate Prediction Model Flawed?

***The following was written by Dr GF Midgley and Prof LG Underhill in response to the article by Prof WRJ Alexander on his multi-year climate prediction model, which appeared in the January/February 2007 edition of the Water Wheel.***

The article by Prof Alexander makes five main points, as follows:

1) There is a 21-year periodicity evident in a multi-year "rainfall cycle" in South Africa.
2) Based on this, it is possible to project rainfall and/or river flow changes by interpolation within this cycle (and an attempt at "verification" is presented).
3) The 21-year cycle implies that "current simulation models" of water resources should be rejected (although no "current simulation models" are referenced by the author).
4) Global climate model projections for South Africa are incorrect because they do not account for the 21-year cycle.
5) Climate change will not cause any negative impacts in South Africa – and more specifically, that there is no evidence that Kokerboom (*Aloe dichotoma*) populations are subject to early impacts of climate change (as one example).

## THE 21-YEAR PERIODICITY

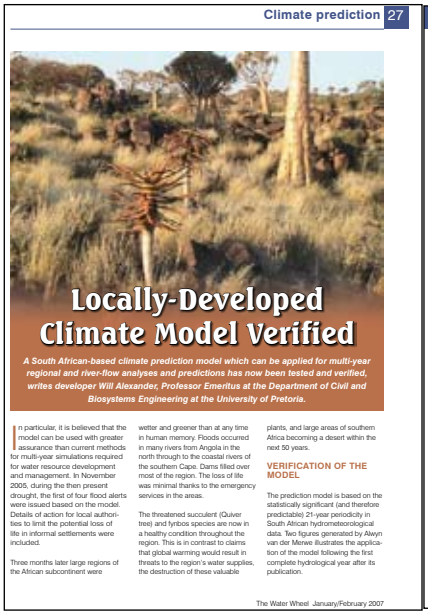
Alexander cited his 2004 article (Alexander 2004), published in *Water SA*, that identified a statistically significant (at the 5% level) 21-year periodicity between rainfall, measured as Vaal Dam water inflow data, and the sunspot cycle. This paper forms the basis for much of the material that Alexander has circulated in many forms over the past few years to challenge the consensus opinion on climate change and water resources, and therefore deserves a degree of scrutiny.

We have reanalyzed key data sets presented in this paper, and find that the analysis is inappropriate and flawed for a number of reasons. Firstly, Alexander derived a correlation between two smoothed data sets to show the apparent influence of sunspots on rainfall, which is questionable statistical practice. Secondly, this analysis used the 5% level as statistically significant in literally hundreds of tests, implying a likely positive result for every twenty statistical tests conducted, by chance alone.

Thirdly, the paper made the following statement in its "Methods" section: "Mathematical/statistical analyses were deliberately avoided as these are hypothesis- testing procedures where the problem was not in testing the hypotheses but in identifying them. Consequently graphical procedures were used. These are far more effective in this situation." Roughly translated – this means the author abandoned formal statistics where it was convenient to do so and simply eye-balled the data. Our formal re-analysis of the key data set presented, using appropriate statistical approaches, directly refutes the results reported by Alexander (2004) – we find no link between sunspots and inflow to the Vaal Dam. We aim to publish this result fully in due course.

Our analysis collapses virtually the entire edifice of Alexander's (2004) arguments, but one important point remains – Alexander (2004) suggested that rainfall increased in South Africa during the 20th century, and concluded from this that climate change would be beneficial for the country. We wish to point out that this increasing trend in rainfall was to a substantial degree due to the fact that the rainfall time series analysed in Alexander (2004) began in 1921, at the beginning of a deep drought that lasted more than a decade. A simple recovery of rainfall to normal levels and above over the next few decades would have yielded the observed increase in rainfall – yet this evidence of natural rainfall variability (expected in a drought-prone region) appears to have eluded Alexander.

We would also point out that projections of rainfall change in summer rainfall regions "downscaled" from global climate models (Hewitson and Crane 2006) indicate that some increases in rainfall are projected for parts of the summer rainfall region of South Africa under global warming



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Locally-Developed Climate Model Verified

*A South African-based climate prediction model which can be applied for multi-year regional and river-flow analyses and predictions has now been tested and verified, writes developer Will Alexander, Professor Emeritus at the Department of Civil and Biosystems Engineering at the University of Pretoria.*

In particular, it is believed that the model can be used with greater assurance than current methods for multi-year simulations required for water resource development and management. In November 2005, during the then present drought, the first of four flood alerts were issued based on the model. Details of action for local authorities to limit the potential loss of life in informal settlements were included.

Three months later large regions of the African subcontinent were wetter and greener than at any time in human memory. Floods occurred in many rivers from Angola in the north through to the coastal rivers of the southern Cape. Dams filled over most of the region. The loss of life was minimal thanks to the emergency services in the areas.

The threatened succulent (Quiver tree) and fynbos species are now in a healthy condition throughout the region. This is in contrast to claims that global warming would result in threats to the region's water supplies, the destruction of these valuable plants, and large areas of southern Africa becoming a desert within the next 50 years.

### VERIFICATION OF THE MODEL

The prediction model is based on the statistically significant (and therefore predictable) 21-year periodicity in South African hydrometeorological data. Two figures generated by Alwyn van der Merwe illustrates the application of the model following the first complete hydrological year after its publication.

The Water Wheel January/February 2007

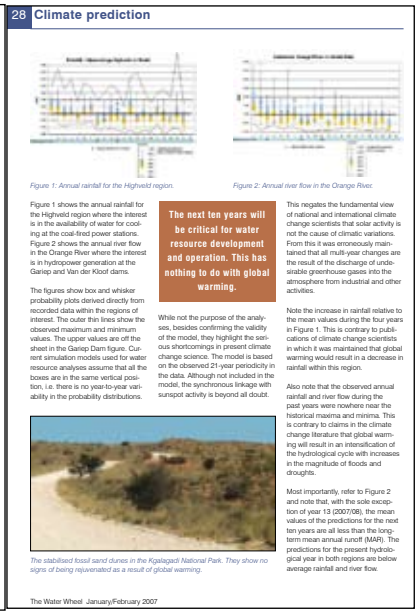

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Figure 1: Annual rainfall for the Highveld region.



Figure 2: Annual river flow in the Orange River.

Figure 1 shows the annual rainfall for the Highveld region where the interest is in the availability of water for cooling at the coal-fired power stations. Figure 2 shows the annual river flow in the Orange River where the interest is in hydropower generation at the Gariep and Van der Kloof dams.

This figures show box and whisker probability plots derived directly from recorded data within the regions of interest. The outer thin lines show the observed maximum and minimum values. The upper values are off the sheet in the Gariep Dam figure. Current simulation models used for water resource analyses assume that all the boxes are in the same vertical position, i.e. there is no year-to-year variability in the probability distributions.

**The next ten years will be critical for water resource development and operation. This has nothing to do with global warming.**

While not the purpose of the analyses, besides confirming the validity of the model, they highlight the serious shortcomings in present climate change science. The model is based on the observed 21-year periodicity in the data. Although not included in the model, the synchronous linkage with sunspot activity is beyond all doubt.

This negates the fundamental view of national and international climate change scientists that solar activity is not the cause of climatic variations. From this it was erroneously maintained that all multi-year changes are the result of the discharge of undesirable greenhouse gases into the atmosphere from industrial and other activities.

Note the increase in rainfall relative to the mean values during the four years in Figure 1. This is contrary to publications of climate change scientists in which it was maintained that global warming would result in a decrease in rainfall within this region.

Also note that the observed annual rainfall and river flow during the past years were nowhere near the historical maxima and minima. This is contrary to claims in the climate change literature that global warming will result in an intensification of the hydrological cycle with increases in the magnitude of floods and droughts.

Most importantly, refer to Figure 2 and note that, with the sole exception of year 13 (2007/08), the mean values of the predictions for the next ten years are all less than the long-term mean annual runoff (MAR). The predictions for the present hydrological year in both regions are below average rainfall and river flow.



*The stabilised fossil sand dunes in the Kgalagadi National Park. They show no signs of being rejuvenated as a result of global warming.*

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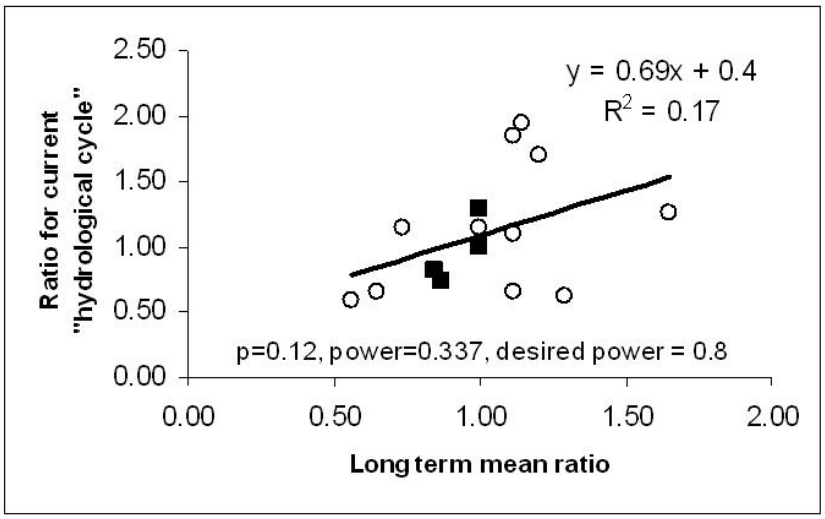


*Figure 1: Regression of combined data for observed rainfall for the Highveld Region (squares) and river flow data for the Orange River (open circles) presented in Alexander (2007), expressed as a ratio relative to the long term mean, against the matching long term means for "hydrological years" of the "hydrological cycle" of 21-year periodicity identified by Alexander (2004). Ratio data were digitized from Figures 1 and 2 of Alexander (2007). The regression is far from statistical significance ($p>0.1$), showing that the observed data cannot be used to verify the Alexander (2004) "multi-year model" – especially because the power of the test is low due to the small sample size.*

scenarios, although rainfall intensity may increase in concert with dry spell duration. The use of simple mean annual rainfall measures is inadequate to formulate policy responses, and we thus question Alexander's simplistic conclusions.

Our analysis, together with several other statements in Alexander (2004), suggest that this paper should not have passed a scientific peer review process.

## QUESTIONING ALEXANDER (2007) AND THE VERIFICATION OF THE "ALEXANDER MODEL"

An analysis of the two graphs presented in Alexander (2007) show that these data can in no way be taken as verification of the Alexander (2004) "multi-year model". A simple regression analysis shows a non-significant relationship ($p>0.1$) between the yearly means plotted and the observed data (see Figure 1, although with such a small data set the power of the test is below a desirable level, additionally undermining its use for "verification". Furthermore, both the observed ratio data and the means plotted show a normal distribution around a mean of ~1 – i.e. they are normally distributed variables with no discernible correlation whatsoever between them, and thus each is indistinguishable from a random sample from a normal distribution. We find it extraordinary that this set of graphs should have been invoked to "verify" the model, as nothing could be statistically further from the truth.

It was also stated that "The next climate reversal from drought to flood conditions based on the analysis of historical data is only expected to occur in 2016. This confirms the linkage with the double sunspot cycle." We ask how a projection such as stated in the first sentence above can be taken to confirm a relationship that has been proposed using the same data set?

## REJECTING "CURRENT SIMULATION MODELS"

Alexander (2007) criticised "current simulation models used for water resource analyses [that] assume that all the boxes [i.e. means and variance measures in Figures 1 and 2 of Alexander (2007)] are in the same vertical position, i.e. there is no year-to-year variability in the probability distributions." From point 2) above, this assumption by "current simulation models" appears to be correct at least for the means. In other words, the ratio of rainfall for particular years of the "hydrological cycle" relative to the long term mean are merely normally distributed about a mean of 1. The fact that "current simulation models" are not referenced by Alexander (2007) and remain incognito makes more detailed response impossible.

Criticising current global climate models Alexander (2007) stated that current lack of dune erosion in the Kalahari, verdant growth of desert vegetation (and fynbos vegetation, incidentally, for which no evidence was given), and recent rainfall events "disprove" the projections of current global climate models, such as used by the IPCC (2001). This charge is simply absurd, as climate projections and their impacts are generally made for the latter half of the 21st century, and observations of 2006 events can in no way provide a test of these.

## *ALOE DICHOTOMA* (KOKERBOOM) POPULATIONS SHOW NO SIGN OF CLIMATE-INDUCED STRESS

Alexander (2007) apparently cited a single lengthy motor-car trip to the Orange River and southern Namibia reportedly covering two degrees of latitude (details available on request, in which he appears to have underestimated the latitudinal range he covered). His casual observations and photographs of a few populations, at most, appear to be the evidence that these populations no signs of climate impacts. This is, to put it mildly, a premature and unjustified conclusion. Kokerbooms have a latitudinal range of >12 degrees (see Figure 2), being found in tens of populations from Nieuwoudtville in the south to the Brandberg massif, farther north than Windhoek, in Namibia. Alexander (2007) had simply not done the botanical and ecological fieldwork necessary to make this statement.

Data collected by the South African National Biodiversity Institute, now in revision for an international scientific journal following their presentation at both national and international conferences, show clearly from sampling of hundreds of individual plants across all

size classes, that northern populations are in decline, as would be expected according to early climate change impacts, while many central and most southern populations (i.e. possibly including some of those observed by Alexander) are stable or even thriving as climate warms and becomes more suitable to their physiology. Matched photographs of Kokerboom populations taken decades apart also confirm declines in key regions.

## CONCLUSION

We suggest here that the Alexander (2004) "multi-year model" of rainfall in South Africa is without basis in fact, that the paper in which it was originally published appears to be scientifically flawed, and therefore that the conclusions inferred from it are not supported. Furthermore, the data and statements presented in Alexander (2007) can in no way be interpreted as a verification of this "multi-year model", nor as criticism of climate change projections. While we are strong proponents of scientific debate and skepticism, bias and self-delusion are not a good basis for progress. The famous American physicist Richard Feynman summed this up when he stated "the easiest person to fool is yourself". This is the reason the practice of statistical analysis has evolved to remove subjectivity as far as possible, and peer review is widely applied to ensure that basic principles of scientific enquiry are adhered to.

We are perplexed and concerned that the premiere mouthpieces of the Water Research Commission have published these and other apparently scientifically indefensible articles on this topic by the same author, apparently without the due review process (though we make the latter statement with caution, and would withdraw it without hesitation in the face of evidence of appropriate scientific review).

We note that the results presented in Alexander (2004) have been the basis for a sustained level of criticism by this author against climate change response policy in South Africa, and indeed more widely, and therefore that this and related work deserves a careful re-analysis using appropriate statistical methods, and retraction if it is confirmed to be incorrect.

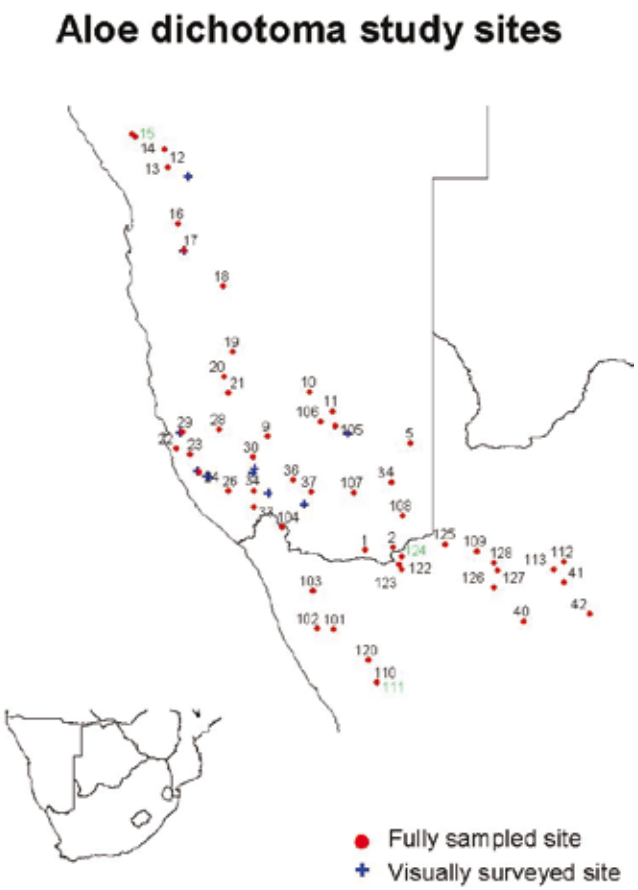


*Figure 2: Aloe dichotoma populations throughout the known range of the species sampled by SANBI staff to assess population viability and adult plant mortality. This study confirmed for the first time, using genetic studies, that Kokerbooms growing at altitude on the Brandberg (site 15) and on other remote sites are in fact of this species, a necessary precursor to publishing this work.*

- Dr Midgley is the chief specialist scientist: Global Change and Biodiversity Programme at the SA National Biodiversity Institute, and Prof Underhill is the director: Avian Demography Unit at the Department of Statistical Science, University of Cape Town.
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