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Observing the present and considering the past to ponder the future

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Modern humans have had a long and intimate relationship with climate change, and acutely so within Africa. There remains much debate about the details concerning the evolutionary pathways that lead from the ancient hominin fossil remains that have been found in southern and east Africa, to us as *Homo sapiens* today. But it is clear that a fiducial moment in our history as humans was the change in climate that took place across much of central and eastern Africa around 2.5 million years ago—perhaps even earlier—which caused the largely woodland forest environment to adapt and change to become the open grassland savanna we are familiar with today.

This climate-induced environmental change triggered major speciation and adaptation of early bipedal hominins, and ultimately shaped our evolutionary development and the ensuing migration into the rest of the world from our origins in Africa. We are therefore, in a sense, *all* Africans. This realisation might help to elevate Africa within global environmental consciousness. Or perhaps more importantly, it might prompt Africans to contemplate their future in the face of the probable negative consequences of global climate change on their continent, which contributes only a modest 8% of global greenhouse gas emissions.

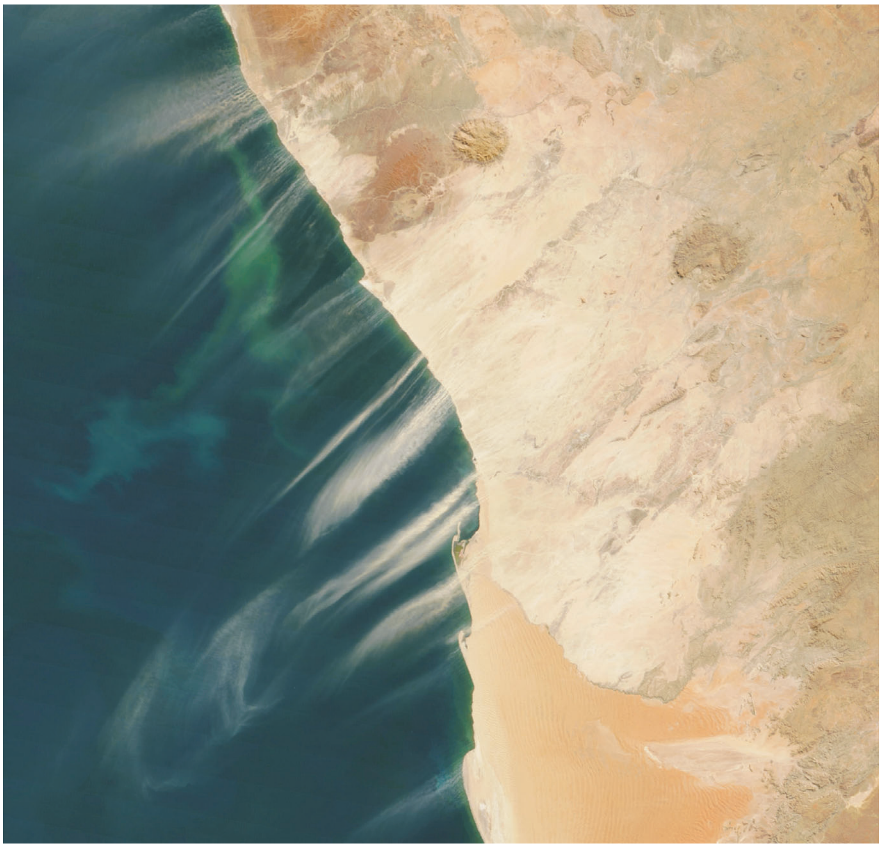
Rather than taking a position of 'we didn't cause the problem so we don't need to fix it', Africa could again play a leading role in the future of humanity by taking the lead on devising and implementing practical and effective responses to the challenges of climate change. The significantly different economic and political landscape of Africa, compared with the major industrialised nations of the world, is clearly an additional challenge here. But it serves to emphasise the crucial need for African responses designed by Africans, rather than as license to justify inaction or indecision.

The breadth and detail of the scientific, economic and social issues presented at the 5th European Geosciences Union–Alexander von Humboldt International Conference on 'Climate Changes and African Earth Systems—Past, Present and Future' is evidence that this collective response is not only possible, but already under way.

Conference discussions included input from biologists, ocean and atmospheric scientists, geologists, environmental lawyers, and economic and social scientists. This indicates that the level of interest in and concern about climate change is clearly very broadly felt, but perhaps more importantly that the consequences are likely to impact widely and, in some cases, unexpectedly.

An example is the significant increase in woody vegetation cover that has taken place in parts of the western Cape, and across many other parts of the world,[1] in response to increased CO_2 levels since the 1930s (woody plants require more CO_2 to grow than grasses and so benefit from increased atmospheric CO_2 levels). Long-term climate data from South Africa show that although there has been no discernible decrease in rainfall, warming has been accompanied by a *decrease* in evaporation and consequent increase in soil moisture in arid and semi-arid environments. These combined and apparently paradoxical effects of increased warming and CO_2 and decreased evaporation have been beneficial to woody vegetation growth. This apparent paradox was explained by Timm Hoffman of the University of Cape Town as a consequence of an associated decrease in wind run (less wind leads to less evaporation).

A key theme that emerged during the conference concerned the debate about adaption and mitigation, and specifically the potential role of geo-engineering as a possible tool for controlling global climate. This debate was fuelled by the intense media interest in a scientific



A view from space of part of the Atlantic Ocean along the Skeleton Coast in Namibia taken from the MODIS sensor on the NASA Terra satellite on 13 July 2003. The streams of dust that can be clearly seen blowing off the continent into the ocean are a primary source of Fe which leads to naturally occurring phytoplankton blooms, like the one seen in this image as the colourful swirls of blue and green within the ocean. This is essentially an occurrence of Ocean Iron Fertilisation (OIF) occurring naturally. Image Credit: Jacques Descloitres, MODIS Rapid Response Team, NASA/GSFC.

experiment scheduled for this year in the southern ocean by scientists on board the German research vessel *Polarstern*. The aim of the experiment is to test the idea that fertilisation of the ocean (using iron sulphate) would increase the abundance of phytoplankton, which in turn will increase the amount of CO_2 extracted from the atmosphere through photosynthesis, thereby providing an engineering solution to lowering atmospheric CO_2 and therefore warming.

The focus in the media was on whether this experiment should be done at all, because it was seen as a breach of the international Convention on Biodiversity which Germany ratified in 1993, together with 168 other nations. This is an important discussion because it emphasises just how complicated any global response to climate change is going to be—for several reasons.

First, it demonstrates that even doing experiments needed to establish whether particular options are even viable is fraught with ethical, legal, political and public media challenges. Second, the very concept of geo-engineering as an act of mitigation—as opposed to changing our behaviour—elicits wide-ranging reactions. These vary from outright condemnation (on philosophical grounds) to more ambivalent responses which choose to await confirmation of whether it could work at all, through to cautious scepticism because of possible unknown side effects.

For example, Pedro Monteiro of the South African Council for Scientific and Industrial Research pointed out that even if ocean iron fertilisation works, it is likely to also lead to a reduction in nutrient transport from the southern ocean to the north Atlantic, which would almost certainly impact negatively on an already-stressed northern hemisphere fisheries industry. The environmental and political consequences of these are obvious.

However, the case for pursuing these geo-engineering experiments at least, even if we choose not to implement the ideas as solutions, was forcefully made by the keynote address by Nobel laureate Paul Crutzen, now retired but previously from the Max Planck Institute for Chemistry in Mainz, Germany. He has proposed an alternative geo-engineering possibility[2] which would reduce the amount of solar radiation that strikes the earth, and thus lower rates of warming. This would require placing significant amounts of sulphur dioxide into the stratosphere, where the molecules would reflect sunlight back into space—thereby increasing the Earth's albedo.

Crutzen's argument is that we should be considering these engineering options only as a last resort, but given that a >60% reduction in greenhouse gas production is needed to stabilise anthropogenic climate change, and that we are struggling politically and economically to reach agreements to reduce these by only 25–40% (Kyoto Protocol targets), these drastic options might be needed. The dilemma is that we do not know if these interventions will work, and we have only begun to think about what side effects could arise. If we cannot do the experiments, we will never know.

Another important theme concerned communication, specifically the concept of 'downscaling' information: tailoring information about climate change, its potential consequences, and the actions that could be taken to adapt to or mitigate against these consequences, to specific cultural, social and geographical needs. This will require a close understanding and collaboration between community leaders, and social and physical scientists.

It also poses significant challenges to climate modellers who are attempting to translate global scale predictions into robust regional predictions about the likely effects of climate change—predictions that could be used to inform regional/national policy making. To do this robustly requires much more complex numerical models than we have at present, as well as more complete environmental monitoring data against which to test these higher resolution models.

Effectively communicating the possible outcomes of climate change and the probability of a solution being effective, both of which incorporate statistical uncertainty, is a major challenge for the scientific community. For example, the Intergovernmental Panel on Climate Change has estimated that the earth will warm by between 1.4°C to 5.8°C over the next century. The uncertainty is not binary, implying that the predicted warming either does or does not happen. Scientific uncertainty simply means that the exact size and timing of the change cannot be perfectly predicted, but it is happening and it *will* have consequences—about which we urgently need to consider and respond.

This type of uncertainty is inherent in the weather forecasts we rely on and use on a daily basis (apparently without much trouble), but it needs to be much better incorporated into the public language used to discuss climate change. A dedicated event aimed at encouraging public, media and scientific communication that was held at the Kirstenbosch Botanical Gardens as an integral part of the conference, was an inspired decision of the organisers.

Crutzen developed the idea of the Anthropocene[3] as a new geological era which began in the early 18th century, when the impact of human beings first influenced earth's environment on a global scale. This longer-term perspective leads to the sobering realisation that we humans may be the first species to claim the ignominious honour of engineering its own extinction by knowingly causing major global-scale climate changes to which we are ill-adapted.

But to end on a positive note would more accurately reflect the overall success and sense of the conference. Robert Costanza from the University of Vermont concluded his keynote address (delivered live from Vermont via Skype to minimise his CO_2 footprint!) with the statement: 'If we can really understand the past we can create a more desirable future'. This nicely echoes the meaning of *Iphakade*, which is isiXhosa for 'observe the present and consider the past to ponder the future', something achieved during five very successful and inspiring days in Cape Town in January 2009.

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