



THE SAHEL IS GREENING

Philipp Mueller

The Global Warming Policy Foundation
Briefing Paper No 2

GWPF REPORTS

Views expressed in the publications of the *Global Warming Policy Foundation* are those of the authors, not those of the GWPF, its Trustees, its Academic Advisory Council members or its Directors.

THE GLOBAL WARMING POLICY FOUNDATION

Director

Dr Benny Peiser

BOARD OF TRUSTEES

Lord Lawson (Chairman)
Lord Barnett
Lord Donoghue
Lord Fellowes
Rt Rev Peter Forster
Bishop of Chester

Sir Martin Jacomb
Henri Lepage
Baroness Nicholson
Lord Turnbull

ACADEMIC ADVISORY COUNCIL

Professor David Henderson (Chairman)
Adrian Berry (Viscount Camrose)
Sir Samuel Brittan
Sir Ian Byatt
Professor Robert Carter
Professor Vincent Courtillot
Professor Freeman Dyson
Christian Gerondeau
Dr Indur Goklany
Professor William Happer
Professor Terence Kealey
Professor Anthony Kelly
Professor Deepak Lal

Professor Richard Lindzen
Professor Ross McKittrick
Professor Robert Mendelsohn
Professor Sir Alan Peacock
Professor Ian Plimer
Professor Gwyn Prins
Professor B P Radhakrishna
Professor Paul Reiter
Dr Matt Ridley
Sir Alan Rudge
Professor Philip Stott
Professor Richard Tol
Dr David Whitehouse

The Sahel is greening

Philipp Mueller

Philipp Mueller is the Assistant Director of the Global Warming Policy Foundation. He holds an MA in Global Affairs from the University of Buckingham.

Introduction



Global warming has both positive and negative impacts. However, very often only the negative consequences are reported and the positive ones omitted. This article will show an example of a positive effect of warming. The people living in the Sahel, a semiarid area just south of the Sahara desert, spanning the entire African continent from the Atlantic Ocean to the Red Sea, were suffering from several devastating droughts and famines between the late 1960s and the early 1990s. The draughts were triggered by decreases in

rainfall from the early 1950s to the mid-1980s.¹ Global warming was supposed to increase the frequency and severity of the droughts, which would make crop-growing unviable and cause even worse famines.² According to the United Nations, the outlook for the people in the Sahel was bleak.³

The Sahel is greening

However in sharp contrast to this gloomy outlook, it seems that global warming has exactly the opposite effect on the Sahara and the Sahel. The Sahara is actually shrinking, with vegetation arising on land where there was nothing but sand and rocks before.⁴ The southern border of the Sahara has been retreating since the early 1980s, making farming viable again in what were some of the most arid parts of Africa. There has been a spectacular regeneration of vegetation in northern Burkina Faso, which was devastated by drought and advancing deserts 20 years ago. It is now growing so much greener that families who fled to wetter coastal regions are starting to come back. There are now more trees, more grassland for livestock and a 70% increase in yields of local cereals such sorghum and millet in recent years. Vegetation has also increased significantly in the past 15 years in southern Mauritania, north-western Niger, central Chad, much of Sudan and parts of Eritrea.⁵ In Burkina Faso and Mali, production of millet rose by 55 percent and 35 percent, respectively, since 1980.⁶ Satellite photos, taken between 1982 and 2002, revealed the extensive re-greening throughout the Sahel.⁷ Aerial photographs and interviews with local people have confirmed the increase in vegetation.⁸

Causes of the greening

The main reason for the greening of the Sahara and the Sahel has been an increase in rainfall since the mid-1980s.⁹ Of the 40 rainfall stations across the Sahel, most of them have been observing an increase in rainfall.¹⁰ If sustained, the increasing rainfalls could revitalize drought-ravaged regions, reclaiming

them for farming.¹¹ The United Nations' Africa Report of 2008 confirmed that the greening of the Sahel is now well established and that increases in rainfall are the main driver of the change in the vegetation cover. The report noted that there was a 50% increase in vegetation in parts of Mali, Mauritania and Chad during 1982-2003.¹² Vegetation changes play a significant role in the rainfall variability.¹³ The increase in rainfall has allowed more plants to grow, which in turn increases precipitation even more. Plants transfer moisture from the soil into the air by evaporation from their leaves and hold water in the soil close to the surface, where it can also evaporate. The darker surface of plants compared with sand also absorb more solar radiation, which can create convection and turbulence in the atmosphere which might create rainfall. Vegetation effects account for around 30 percent of annual rainfall variation in the Sahel.¹⁴ The increased vegetation will fix the soil, enhance its anti-wind-erosion ability, reduce the possibility of released dust and consequently cause a decline in the numbers of sand-dust storms.¹⁵

However, the greening cannot be explained solely by the increase in rainfall. There were vegetation increases in areas where rainfall was decreasing, suggesting another factor was responsible for the greening in these areas.¹⁶ This other factor might have been the rise of atmospheric CO₂ levels. The aerial fertilization effect of the ongoing rise in the air's CO₂ concentration increases greatly the productivity of plants. The more CO₂ there is in the air, the better plants grow. Rising atmospheric CO₂ levels also have an anti-transpiration effect, which enhances the water-use efficiency of plants and enables them to grow in areas that were once too dry for them.¹⁷

Possible explanations for the increase in rainfall

It is not clear what has caused the increase in rainfall and there are several possible explanations for it. A study by Reindert Haarsma and his colleagues of the Royal Netherlands Meteorological Institute, which is based on a climate model, suggests that the increase in rainfall was triggered by an increase in surface temperatures in the Sahara. Haarsma *et al* argue that the Sahara heats up faster than the Atlantic Ocean, which creates lower atmospheric pressure above the desert. This leads to air with more moisture moving in from the Atlantic and more rainfall over the Sahel. According to Haarsma's climate model, higher temperatures over the Sahara would cause 1-2 millimetres of extra daily rainfall in the Sahel during the months of July to September by 2080, which would be 25 to 50 percent more rainfall that fell in the drought-ridden region in 1980.¹⁸

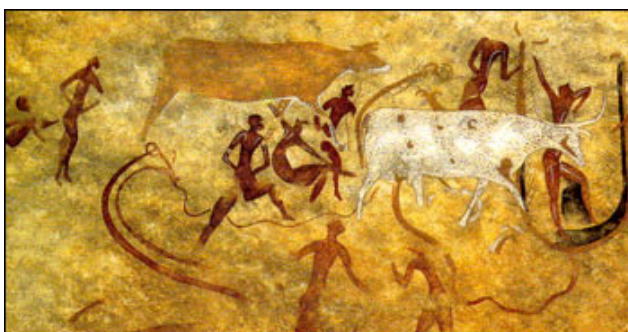
There are other possible explanations. Recent climate modelling suggests a strong link between sea surface temperature anomalies and rainfall in the Sahel. Using a global circulation model and a number of sea surface temperature scenarios, Giannini *et al* were able to reproduce much of the observed rainfall variation in the Sahel between 1930 and 2000. Their study might explain 25-30 percent of inter-annual rainfall variations.¹⁹ James Hurrell

of the U.S. National Centre for Atmospheric Research and Martin Hoerling of the U.S. National Oceanic and Atmospheric Administration claim that the increase in rainfall is linked to temperature changes in the Atlantic Ocean and is partially caused by greenhouse gas emissions. They drew this conclusion after analysing 60 computer models that imitate the climate. According to Hurrell and Hoerling, for much of the period 1950-2000, the southern Atlantic Ocean was warmer than the northern Atlantic Ocean. This drew rain-bearing monsoon winds away from the Sahel, contributing to the very dry conditions there. From the 1990s, however, the situation changed and the northern Atlantic Ocean became warmer than the southern Atlantic, partly because of higher levels of greenhouse gases in the atmosphere. As a result, say Hurrell and Hoerling, there has been more rainfall in the Sahel.²⁰

Other scientists argue that the Sahara's climate is strongly influenced by high altitude winds that disperse monsoon rains on the desert below. Unpredictable shifts in the wind pattern can lead to prolonged droughts or, as apparently happening now, life-sustaining rainfall.²¹ As these various attempts of explaining the increasing precipitation – stressing the roles of Sahara surface temperatures, sea surface temperature and winds respectively – show, climate scientists have not yet fully understood the complex interactions between surface and ocean temperatures, evaporation and wind patterns that determine the climate of the Sahara and the Sahel.

When the Sahara was a savannah

The greening of the Sahara and the Sahel is not unprecedented. During the Holocene Climate Optimum (9000-4000 BC), whose early and middle parts were possibly 2-5 degrees Celsius warmer than now, the northern half of



Africa received more abundant and more stable rainfall. What is now the Sahara desert was a green savannah then. Rock paintings in south-eastern Algeria from this period show savannah animals such as elephants and zebus (cattle). Bones of crocodiles and hippos were found in the Sahara together with sediments

showing that big lakes and rivers existed there until 6,000 years ago. Experts in paleoclimate think that the Sahara's climate is twisted between two extremes: it is either wet enough to create and sustain a green savannah or it does not support vegetation. They claim that there is threshold to be crossed to get from one extreme to the other. Scientists have shown that, when the greening first starts due to some more rainfall, vegetation itself influences the climate, producing even more rainfall. In the Holocene, says Professor Peter deMenocal of Columbia University, first the greening and then the desertification of the Sahara might have been a matter of a century, maybe

even only decades. This indicates that the increasing precipitation could quickly green the Sahara.²²

There were earlier examples of a “green Sahara”. North African climate reconstructions have revealed three periods during which the Sahara was almost completely covered with extensive grasslands, lakes and rivers over the course of the last 120,000 years. Dr Rik Tjallingii, Professor Martin Claussen and their colleagues from the Center for Marine Environmental Research and the Alfred-Wegener-Institute in Germany studied a marine sediment core off the coast of Northwest Africa to find out how the vegetation and the hydrological cycle of the Sahara and Sahel changed over this period. They tried to reconstruct the vegetation cover of the last 120,000 years by studying changes in the ratio of wind-transported and river-transported particles found in the core. They claim that the three “green” periods were caused by an increase in precipitation that resulted in a much larger vegetation cover, which in turn caused less wind dust, even more rainfall and stronger river activity. According to the scientists, the “green Sahara” periods corresponded with changes in the direction of the earth’s rotational axis which determine the level of solar energy that reaches the tropical Atlantic Ocean. The higher solar energy is believed to have increased evaporation over the ocean and to have pushed the African monsoon further north, increasing rainfall over the Sahara.²³

The future climate of the Sahara and the Sahel

Climate scientists do not agree how the future climate of the Sahara and the Sahel will look like. Some climate models simulate a decrease in rainfall; others – for example Haarsma *et al* mentioned above – predict an increase in rainfall. According to Professor Claussen, North Africa is the area of greatest disagreement among climate scientists. Claussen explains that forecasting how global warming will affect the Sahel is complicated by the region’s vast size and the unpredictable influence of high-altitude winds that disperse monsoon rains.²⁴ Claussen has considered the likelihood of a greening of the Sahara due to global warming and concluded that an expansion of vegetation into today’s Sahara is possible as a consequence of CO₂ emissions. His climate models suggest that the rate of greening could be fast, up to 10 percent of the Sahara per decade.²⁵ There is uncertainty regarding the future climate of the Sahel and the Sahara and it is obvious that nobody really knows if the future climate will be wetter or drier. The only certainties are the observed increases in vegetation and rainfall during the last three decades.

Conclusion

In spite of the gloomy predictions of even more frequent and severe droughts and famines caused by global warming, vegetation in the Sahel

has significantly increased in the last three decades. This has been a very welcome and very beneficial development for the people living in the Sahel. The increase in rainfall, which was probably caused by rising temperatures, and rising CO₂ concentrations might even - if sustained for a few more decades - green the Sahara. This would be a truly tremendous prospect.

Endnotes

1. Olsson, Lennart, "Greening of the Sahel", Encyclopaedia of Earth, 29 August 2008, http://www.eoearth.org/article/Greening_of_the_Sahel
2. McCarthy, Michael, "Climate Change: time for action", The Independent, 3 December 2005, <http://www.independent.co.uk/environment/climate-change-time-for-action-517911.html>
3. Integrated Regional Information Networks, "Sahel: Backgrounder on the Sahel, West Africa's poorest region", 2 June 2008, <http://www.unhcr.org/refworld/country,,LRIN,,CPV,,4847bb8f0,0.html>
4. Cohen, Bonner, "Sahara Desert Greening, Thanks to Global Warming", The Heartland Institute, 1 October 2009, http://www.heartland.org/publications/environment%20climate/article/25973/Sahara_Desert_Greening_Thanks_to_Global_Warming.html
5. Pearce, Fred, "Africa's deserts are in 'spectacular' retreat", New Scientist, 18 September 2002, <http://www.newscientist.com/article/dn2811-africas-deserts-are-in-spectacular-retreat.html?full=true&print=true>
6. Olsson, L., Eklundh, L. And Ardo, J., "A recent greening of the Sahel – trends, patterns and potential causes", Journal of Arid Environments, 2005, Volume 63, pp 556-566.
7. Owen, James, "Sahara Desert Greening Due to Climate Change?", National Geographic, 31 July 2009, <http://news.nationalgeographic.com/news/2009/07/090731-green-sahara.html>
8. Olsson, Lennart, "Greening of the Sahel", Encyclopaedia of Earth, 29 August 2008, http://www.eoearth.org/article/Greening_of_the_Sahel
9. Haarsma, Reindert et al, "Sahel Rainfall variability and response to Greenhouse Warming", Geophysical Research Letters, 2005, Vol. 32, p. 2, http://portal.iri.columbia.edu/~alesall/ouagaCILSS/articles/haarsma_grl2005.pdf
10. Olsson, Lennart, "Greening of the Sahel", Encyclopaedia of Earth, 29 August 2008, http://www.eoearth.org/article/Greening_of_the_Sahel
11. Owen, James, "Sahara Desert Greening Due to Climate Change?", National Geographic, 31 July 2009, <http://news.nationalgeographic.com/news/2009/07/090731-green-sahara.html>
12. Goklany, Indur, "Trapped Between the Falling Sky and the Rising Seas: The Imagined Terrors of the Impacts of Climate Change", Social Science Research Network, 2009, p. 30, http://papers.ssrn.com/sol3/papers.cfm?abstract_

id=1548711

13. Olsson, Lennart, "Greening of the Sahel", Encyclopaedia of Earth, 29 August 2008, http://www.eoearth.org/article/Greening_of_the_Sahel

14. Van Noorden, Richard, "More plants make more rain", Nature News, 2006, <http://www.nature.com/news/2006/060925/full/news060925-1.html>

15. Piao, S., Fang, J., Zhou, L., Tan, K. and Tao, S., "NDVI-indicated decline in desertification in China in the past two decades", Geophysical Research Letters, 2005, Volume 32.

16. Olsson, Lennart, "Greening of the Sahel", Encyclopaedia of Earth, 29 August 2008, http://www.eoearth.org/article/Greening_of_the_Sahel

17. Iso, S.B., "CO₂ and the Biosphere: The Incredible Legacy of the Industrial Revolution", Department of Soil, Water & Climate, University of Minnesota, 1995.

18. Brahic, Catherine, "Hotter Sahara could mean more rain for Sahel", SciDevNet, 20 September 2005, <http://www.scidev.net/en/news/hotter-sahara-could-mean-more-rain-for-sahel.html>

19. Olsson, Lennart, "Greening of the Sahel", Encyclopaedia of Earth, 29 August 2008, http://www.eoearth.org/article/Greening_of_the_Sahel

20. Kigotho, Wachira, "Decades of droughts predicted for southern Africa", SciDevNet, 2 June 2005, <http://www.scidev.net/en/news/decades-of-drought-predicted-for-southern-africa.html>

21. Cohen, Bonner, "Sahara Desert Greening, Thanks to Global Warming", The Heartland Institute, 1 October 2009, http://www.heartland.org/publications/environment%20climate/article/25973/Sahara_Desert_Greening_Thanks_to_Global_Warming.html

22. Hennig, Rainer, "African climate change: Blooming Sahara or hunger and war?", Afrol News, 21 December 2007, <http://www.afrol.com/articles/27592>

23. Daily Science, "The Green, A Desert in Bloom", 7 October 2008, <http://www.sciencedaily.com/releases/2008/09/080930081357.htm>

24. Owen, James, "Sahara Desert Greening Due to Climate Change?", National Geographic, 31 July 2009, <http://news.nationalgeographic.com/news/2009/07/090731-green-sahara.html>

25. Hennig, Rainer, "African climate change: Blooming Sahara or hunger and war?", Afrol News, 21st December 2007, <http://www.afrol.com/articles/27592>

Bibliography

Bast, Joseph, and Bast, Diane Carol (eds). "Climate Change Reconsidered: The 2009 Report for the Nongovernmental International Panel on Climate Change (NIPCC)". The Heartland Institute, 2009. Pp 1-868. <http://www.nipccreport.org/reports/2009/pdf/CCR2009FullReport.pdf> [accessed February 2011]

Brahic, Catherine. "Hotter Sahara could mean more rain for Sahel". SciDevNet, 20 September 2005. <http://www.scidev.net/en/news/hotter-sahara-could-mean-more-rain-for-sahel.html> [accessed April 2011]

Cohen, Bonner R. "Sahara Desert Greening, Thanks to Global Warming". The Heartland Institute. 1 October 2009. http://www.heartland.org/publications/environment%20climate/article/25973/Sahara_Desert_Greening_Thanks_to_Global_Warming.html [accessed March 2011]

Daily Science. "The Green Sahara, A Desert in Bloom". 7 October 2008. <http://www.sciencedaily.com/releases/2008/09/080930081357.htm> [accessed March 2011]

Goklany, Indur. "Trapped Between the Falling Sky and the Rising Seas: The Imagined Terrors of the Impacts of Climate Change". Social Science Research Network. 2009. Pp 1-71. http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1548711 [accessed February 2011]

Haarsma, Reindert, Selten, Frank, Weber Nanne and Kliphuis, Michael. „Sahel Rainfall variability and response to Greenhouse Warming“. Geophysical Research Letters. Vol. 32. 2005. Pp 1-4. http://portal.iri.columbia.edu/~alesall/ouagaCILSS/articles/haarsma_grl2005.pdf [accessed April 2010]

Hennig, Rainer. "African climate change: Blooming Sahara or hunger and war?". Afrol News. 21st December 2007. <http://www.afrol.com/articles/27592> [accessed December 2010]

Integrated Regional Information Networks. "Sahel: Backgrounder on the Sahel, West Africa's poorest region". 2 June 2008. <http://www.unhcr.org/refworld/country,,IRIN,,CPV,,4847bb8f0,0.html> [accessed May 2011]

Iso, S.B. "CO₂ and the Biosphere: The Incredible Legacy of the Industrial Revolution". Department of Soil, Water & Climate, University of Minnesota. 1995.

Kigotho, Wachira. "Decades of droughts predicted for southern Africa". SciDevNet, 2 June 2005. <http://www.scidev.net/en/news/decades-of-drought-predicted-for-southern-africa.html> [accessed April 2011]

McCarthy, Michael. "Climate change: time for action". The Independent.

3 December 2005. <http://www.independent.co.uk/environment/climate-change-time-for-action-517911.html> [accessed May 2011]

Olsson, Lennart. "Greening of the Sahel". The Encyclopaedia of Earth. 29 August 2008. http://www.eoearth.org/article/Greening_of_the_Sahel [accessed March 2011]

Olsson, L., Eklundh, L. And Ardo, J. "A recent greening of the Sahel – trends, patterns and potential causes". Journal of Arid Environments. 2005. Volume 63. Pp 556-566.

Owen, James. "Sahara Desert Greening Due to Climate Change?". National Geographic. 31st July 2009. <http://news.nationalgeographic.com/news/2009/07/090731-green-sahara.html> [accessed November 2010]

Pearce, Fred. "Africa's deserts are in 'spectacular' retreat". New Scientist, 18 September 2002. <http://www.newscientist.com/article/dn2811-africas-deserts-are-in-spectacular-retreat.html?full=true&print=true> [accessed May 2011]

Piao, S., Fang, J., Zhou, L., Tan, K. and Tao, S., "NDVI-indicated decline in desertification in China in the past two decades", Geophysical Research Letters. 2005. Volume 32.

Van Noorden, Richard. "More plants make more rain". Nature News. 25 September 2006. <http://www.nature.com/news/2006/060925/full/news060925-1.html> [accessed May 2011]

Vidal, John. "Climate Change will devastate Africa, top UK scientist warns". Guardian. 28 October 2009. <http://www.guardian.co.uk/environment/2009/oct/28/africa-climate-change-sir-gordon-conway?INTCMP=SRCH> [accessed May 2011]

The Global Warming Policy Foundation is an all-party and non-party think tank and a registered educational charity which, while open-minded on the contested science of global warming, is deeply concerned about the costs and other implications of many of the policies currently being advocated.

Our main focus is to analyse global warming policies and their economic and other implications. Our aim is to provide the most robust and reliable economic analysis and advice.

Above all we seek to inform the media, politicians and the public, in a newsworthy way, on the subject in general and on the misinformation to which they are all too frequently being subjected at the present time.

The key to the success of the GWPF is the trust and credibility that we have earned in the eyes of a growing number of policy makers, journalists and the interested public.

The GWPF is funded entirely by voluntary donations from a number of private individuals and charitable trusts. In order to make clear its complete independence, it does not accept gifts from either energy companies or anyone with a significant interest in an energy company.

Views expressed in the publications of the Global Warming Policy Foundation are those of the authors, not those of the GWPF, its Trustees, its Academic Advisory Council members or its Directors.

Published by the Global Warming Policy Foundation

For further information about the GWPF or a print copy of this report contact:

The Global Warming Policy Foundation
1 Carlton House Terrace, London SW1Y 5DB
T 020 7930 6856
M 07553 361717
www.thegwpf.org

Registered in England, no 6962749
Registered with the Charity Commission, no 1131448

