THE SOCIAL AND TECHNICAL CONSTRUCTION OF WEATHER:
EL NIÑO AND OTHER CLIMATIC EVENTS IN SUB-SAHARAN AFRICA

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Roger Blench

Overseas Development Institute

Portland House, Stag Place

London, SW1E 5DP

United Kingdom

Tel +44 (0) 171-393-1613

Fax +44 (0) 171-393-1699

Zoë Marriage

Overseas Development Institute

Portland House, Stag Place

London, SW1E 5DP

United Kingdom

Tel +44 (0) 171-393-1613

Fax +44 (0) 171-393-1699

E-mail R.Blench@odi.org.uk

E-mail ZMarri@odi.org.uk

Web Page: http://www.odi.org.uk/rfs/r.blench

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ABSTRACT

Recent concern about the consequences of the El Niño Southern Oscillation (ENSO) has focused more general attention on the role of government in both monitoring and disseminating predictions concerning likely future weather patterns. Governments have become increasingly aware of the significance of such predictions both in developing drought preparedness, reinforcing requests for assistance and providing an alibi for defects in the provision of services to rural areas. The paper argues that the impacts of global climate modelling are as much socio-political as technical and that claims concerning droughts, floods, forest fires and other possible consequences of large-scale oscillations must be decoded as much for their political significance as their predictive element.

N.B. Internet sites dealing with the technical aspects of this topic are listed at the end of the paper. Live hyperlinks are in the electronic version of the paper, to be found at http://www.odi.org.uk/nrp/31.html.

1. The social construction of the weather

Understanding climate is central to building policy in the area of natural resources, both in the immediate, where weather must be predicted in the coming year, and over a longer time-scale, in which conceptual models of climate are constructed on the assumption of consistency in weather patterns. Such models should form the basis for long-range planning, especially in agriculture and water supply.

The monitoring, measuring and modelling of climate is usually conceptualised as a technical matter left to meteorologists and oceanographers and distinguished from the realm of both policy and crisis management. Scientists present technical data, while politicians, relief agencies and NGOs must come up with appropriate responses.

It is becoming increasingly clear, however, that such a simple division cannot be sustained. World weather systems constitute a unity, but climatic patterns and events are categorised according to social constructions. Thus 'drought' and 'floods' exist in relation to what is considered to be normal rainfall rather than as entities that can be defined objectively. Their severity and geographic extent reflects the cartographer's boundaries. In most parts of the world, reliable records are barely a century old and thus normality is defined by a relatively short historical span, or even by personal memory. As longer datasets have become available, through palynology or ice-cores, normality has been redefined in relation to millennia rather than a centuries. Different categories of 'normality' are available and can be selected for the purpose to hand.

Weather is often conceptualised as shock events punctuating a background of acceptable variation. Shocks, such as floods, high winds and drought, are discontinuities that are sufficiently anomalous within the lifetime of observers as to be classified as unpredictable and life-threatening. The nature of the discontinuity is framed by the region's ability to cope. Thus a rainfall deficit over a month in a sparsely populated region is natural variation; but a similar deficit in a heavily populated zone is an event with defined boundaries. Governments may thus be blamed for failing to make adequate preparations for such events. Vulnerability to weather is a function of preparedness rather than the event in itself.

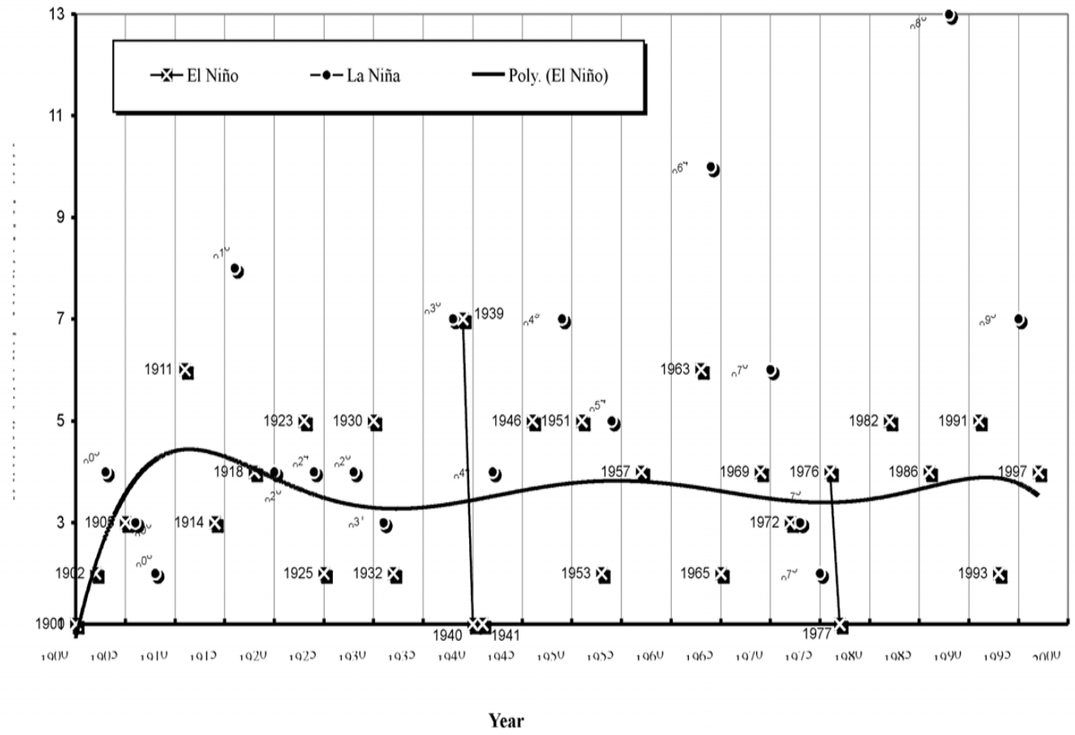
2. Single events versus chain events: between prediction and modelling

Deterministic prediction is confounded by the nature of climate, which is a chaotic system of a probabilistic type that encompasses 'flip-flop' events, i.e. those which may or may not happen but whose occurrence entrains radically different consequences (Lorenz 1964; Gleick 1988). Although the chaotic element in climate was established in principle in the 1960s, its real significance has only become apparent relatively recently. The 20th century has witnessed a history of 'long-range' weather forecasting based on the analysis of recorded data series. Such data show temporary patterns but long-term successes have been undercut by the inherent unpredictability of these systems.

Since the 1980s there has been a notable increase in the capacity to model planetary weather systems. This reflects a greater understanding of the mechanisms of oceanic currents but also simply raw computing power. The calculations necessary to model such large systems can only be performed on recent supercomputers. In addition, the installation of sea-surface temperature (SST) monitors in the oceans provides more immediate data on the movements of water-bodies. Climatic events in specific parts of the world were formerly treated as discrete, and therefore analysed regionally. More recently, the chaining of events previously considered unrelated has been understood more clearly – hence 'teleconnections'.

A prime example of this is El Niño, an ancient name given originally by fishermen to the sporadic movement of a body of warm water from Melanesia to the coast of Chile around the Christmas period, leading to disruption of fishing, floods and increases in sewage-borne diseases such as cholera. The connection between the El Niño oceanic event and the Southern Oscillation atmospheric event was first identified in 1969 and the El Niño Southern Oscillation (ENSO) is now known to resonate with a sequence of events across much of the southern hemisphere. The range of indicators include anomalies in air pressure, ocean temperature, winds and clouds. Typical effects are floods on the coast of Chile, drought in NE Brazil, warm water fish appearing off the western seaboard of the United States, drought in Eastern and southern Africa and New Guinea. This scatter of impacts is due to the energy exchange between the atmosphere and the ocean, resulting in disruption of the atmospheric circulation across the globe. The El Niño cycle lasts for approximately a year and occurs every 3-8 years. Related to it and usually occurring in intermediate years is La Niña, a cold phase resulting in unseasonably low temperatures but much less physical disruption. Figure 1 plots the intervals between El Niño and La Niña events since 1900.

Figure 1. Frequency of El Niño and La Niña events since 1900



The trendline marks the mean frequency of occurrence expressed as an order six polynomial, showing that the overall frequency has remained stable over the last century.

El Niño is responsible for ‘harmonic’ events which need not always co-occur; droughts in New Guinea are by no means always synchronised with those in southern Africa. Although their ‘signal’ is sufficiently strong as to suggest the phenomenon is real, uncertainty over teleconnections has made it possible to bring in other climatic events whose links are less certain. For example, in 1997, there was no drought in Eastern and Southern Africa despite the occurrence of related events in South America and Melanesia. There were, however, disastrous floods in the Horn of Africa, in Sri Lanka and Myanmar; the exact significance of these is still being debated. Similarly, the large-scale forest fires in SE Asia in 1997 and again in Kalimantan in 1998 have been attributed to El Niño. These regions *have* experienced drought but the persistence of fires reflects the economic interest of those who stand to gain from large-scale land clearance. In the case of SE Asia, the political motivation of governments involved is rather transparent. Table 1 shows events that have been attributed to ENSO with some judgement as to their likelihood.

Table 1. ENSO teleconnections: more and less likely

More likely	Less likely
Floods, disease in Chile, Peru	Floods and cholera in the Horn of Africa
Wildlife mortality in Peru	Drought in SE Asia exacerbating forest fires and smog
Greater frequency of hurricanes off Central America	Floods in Myanmar
Drought in NE Brazil	Floods in Sri Lanka

The evolution of improved modelling is often confused with greater predictive capacity. Modelling clarifies the mechanisms that relate oscillatory events such as ENSO; it can provide greater probabilities of the climatic regime in one region if an event occurs elsewhere. But it cannot predict in a deterministic sense, wherein lies the root of the problem; within probabilistic forecasting there must be an incidence of non-hits. Planners and politicians will inevitably want to drive the model harder than it will really permit. Education on the limits to forecasting is critical. El Niño is predictable over longer time-spans to the extent that there seems to be at least one event per decade.

3. Governments and the social role of prediction

Drought in Southern Africa	Mild weather in N. Europe and Eastern United States
Drought in Melanesia	Floods in California
Drought in East-Central Australia	Termite plagues in the Western United States
Wildlife mortality in Kalimantan	

shortfalls (Buckland 1997).

Almost by definition, weather events falling outside the boundaries of 'normal' weather behaviour, cannot be forecast. They can on occasions be traced to some other condition, or combination of conditions, and thus be judged to be more likely if those conditions obtain. Identifying those events connected with El Niño and using that information as a warning signal of when an event is likely to occur offers some sort of prediction, but gives no clue as to the timing, duration or intensity of a possible event. The ENSO recorded in 1997 started later in the year than usual, but developed rapidly, sparking fears of a regime of unprecedented severity.

Where rainfed farming is central to rural livelihoods, government use of weather predictions to advise farmers may be of considerable importance. Until recently, such predictions were based on local or regional information and were probably of limited utility. However, increased awareness of the importance of drought preparedness and the greater availability of global data has assisted countries such as Zimbabwe to use information about ENSO in agricultural meteorology (Unganai 1996). The increased awareness of the need for drought preparedness is undermined by the decreased ability of many subsistence farmers in sub-Saharan Africa to cope with drought as smaller average farm sizes and the use of land with lower agricultural potential leaves farmers less able to prevent seasonal yield

At the same time, international agencies have gradually been acting to make data more accessible. FAO, through its Global Information and Early Warning System (GIEWS) (http://www.fao.org/waicent/faoinfo/economic/giews), has stepped up the monitoring of weather and cropping developments since March 1997 in view of the potential for drought in Southern Africa. Briefing summaries have been expanded to cover South America, mainland and insular SE Asia and Melanesia. The increased attention given to El Niño has brought it to the fore of the political agenda, with corresponding awareness among politicians and farmers. Late in 1997, for example, the official recommendation from the South African government to farmers was to prepare for an El Niño event and to plant maize only on moisture-rich soils. The Zimbabwe government recommended the planting of drought-resistant cultivars (http://www.zimbabwe.net/sadc-fanr/news.htm).

The effect of the El Niño Southern Oscillation over Southern Africa is well documented if still relatively unpredictable. Further north in Africa, though, the situation is open to more debate as weather vagaries are engaged for political advantage. The unseasonal high rainfall in the Horn of Africa from Eritrea to Tanzania at the end of 1997 and the beginning of 1998 coincided with the occurrence of other El Niño phenomena (http://www.fao.org/waicent/faoinfo/economic/giews). Talk of teleconnections provides respectable scientific alibi to justify attributing droughts, famines and high winds to the same disturbance. Where one weather event finishes and the next one starts is determined by subjective discretion; the parameters of the El Niño phenomenon are constructed, and may appear different to meteorologists, farmers and politicians. The formation of the Early Warning Technical Committee reflects an attempt to incorporate indicators from agrometerology, agriculture, nutrition, and the wildlife department (Callear 1997).

Another aspect of this is the changing risk-aversion strategies of farmers. Long experience of climatic unpredictability has induced farmers in rainfed subsistence economies to develop complex cultigen repertoires and cultivar mixtures to ensure yields under all climatic regimes. Yields in such conditions are necessarily lower than monocropping productive races; this has led governments and development projects to encourage high-input, high-risk strategies, for example, planting hybrid maize instead of sorghum and millet. This in turn tends to reinforce certainty in meteorological prediction where doubt should be underlined. Thus the effects of the prolonged drought of the early 1990s in Eastern and Southern Africa were undoubtedly exacerbated by the near-monocropping of maize rather than spreading the risks across a range of crops with greater tolerance of low-rainfall regimes.

Different agricultural strategies are required for 'normal' and for low-rainfall years, and inaccurate information can have serious economic impact on farmers. Farmers will make predictions whatever line the government decides to take but they may not always be free to pursue their own strategy of choice. The dissemination of raw information puts the farmer in the position of having to gamble on the weather. In the simplest scenario the farmer has a binary choice between two crops. In rainfed farming areas of Eastern and Southern Africa the dominance of a few seed companies combined with commercial pressure on farmers and an extremely negative attitude to 'old' crops and open-pollinated varieties as well as the replacement of many traditional livestock breeds with 'modern' breeds has massively increased farmers' susceptibility to climatic shock events.

Drought has previously been perceived as unforeseeable and unavoidable and thus requiring an emergency response. The increased understanding given by early warning systems should reshape our image of it as an element of the weather system and therefore to be factored into longer-term natural resource planning. The balance of crops and livestock, the genetic diversity of cereals and the role of irrigated agriculture need to be rethought in time-swathes as long as a decade if meteorological realism is to be introduced into the planning process. Early warning systems include generators and users of information, and the question arises as to the nature and extent of recommendations for action (Buchanan-Smith 1997). Knowledge of increased risk implies responsibility for the use and dissemination of that information, and decision-makers thus become active participants in the risk-related environment. The success of preventive or mitigating strategies is dependent on the socio-political and economic institutions, as well as the reliability strength of the teleconnection (Glantz 1997). Thus the improvement of El Niño forecasting systems depend not only on the accuracy of the forecast, but also the variations in impacts between El Niño episodes, the way in which forecasts are used, the sources of the forecasts, the credibility of forecasts and the confidence that users have in them (Glantz 1997). The extent of the El Niño phenomenon means that many governments are involved in supporting people affected by the phenomenon either in their own countries or as part of their aid programmes. The status it enjoys on the world political stage has encouraged a larger user group of ENSO information, leading to greater demands for meteorological information.

Case study: El Niño in Ethiopia: 1997

Climatic events provide both a convenient political alibi and a hook to extract emergency funds from international agencies and charities. A failure to deliver on electoral promises can be attributed to unpredictable climatic events. If water needs are not met, it is politically attractive to governments to blame a drought or a flood, or better still a notorious climatic phenomenon, than to accept responsibility for poor water management. The situation in Ethiopia demonstrates this all too clearly. Whether the climate in Ethiopia is actually affected by El Niño is undecidable at present, at least from a technical point of view, and no seasonal forecasting model has yet been developed but different players in the crisis industry have taken positions.

The official Ethiopian government line appears to be that almost all climatic anomalies of the past year have been associated with El Niño (Bekele 1997) and it has capitalised on the political indemnity that El Niño affords to blame it for current water shortages and incipient food deficits. International agencies and NGOs operating in Ethiopia take the opposing view that El Niño is largely irrelevant and that current weather patterns fall within the usual boundaries of climatic variation. This almost certainly reflects their experience of the chronic logistical and institutional problems with service delivery in rural areas. This highlights the changes that take place in decision models: the criteria on which individuals make decisions in the face of decreasing water availability can be changed or undercut by government policy impacted on by perverse incentives.

4. ENSO and media presentations

North and South

A distinctive trend in Northern agriculture is to make it as weather and environment-independent as possible: irrigation, draining, greenhouses, fertiliser, crops bred to tolerate a wide range of rainfall regimes. This has the effect of minimising low rainfall, erosion, cloud-cover, day-length and other external variables. This is much less true in Southern agriculture, usually because of a lack of economic infrastructure to make such investments viable. Ecological features such as extensive rangelands, extreme heat and low aggregate rainfall may also mean that energy costs may be objectively more problematic. This extends further than the agricultural field, and the lack of security mechanisms results in the exacerbation rather than the mitigation of weather events.

As a result, climatic fluxes that affect agriculture, such as El Niño, tend to amplify their effects in the South while the North can largely ignore them. While downstream responses to drought prioritise food security, upstream responses are famine-oriented (Buchanan-Smith 1997).The usual pattern has been to wait for disaster to occur and then rush in and bring emergency assistance with all the usual heart-rending television images that eventually mobilise funds and designer four-wheel drives. Indeed such crises form part of the moral ecology of the North; images of the visible contrast in economies that climatic crises in the south represent inevitably reinforces a feeling of self-satisfaction. For those suffering from drought, however, there is a progression from a dependence on insurance mechanisms, to the disposal of productive assets before the onset of destitution, and the stage at which intervention is made is crucial to the economic recovery that can be made. An effective early warning system indicator should reflect the transition from a reliance on insurance mechanisms to the liquidation of assets (Huss-Ashmore 1997).

More Recently…

1998 has seen a major expansion in media coverage of climatic events and many of these have become strangely attached to El Niño, even where this is manifestly improbable. The usual pattern has been to show dramatic footage of a disaster, preferably in the United States, and then bring on an expert to validate this linkage. In more recent times, the expert has been deleted as El Niño has become such a household word that its association for the viewer with tornadoes, floods etc. is taken almost for granted. A recent (April 1998) CNN broadcast trumpeting a live link to the Mir space station asked the astronaut if he could ‘see’ El Niño. ENSO regularly features in both cartoons

and editorial columns. Similarly, there has been a growth of academic papers attributing socio-political events in the past to its effects. The French and American Revolutions and even the First World War have all been claimed to 'correlate' with El Niño.

This has its humorous side, but of course the disasters reported may be far from amusing. The underlying motivation is hard to discern but it may well be connected with the elimination of chance. With the elimination of 'acts of God', weather events take on a distressingly random appearance. El Niño becomes a similar all-purpose explanatory mode, made all the more ironic because this type of explanation has become so general as to explain nothing.

5. El Niño and global warming: a reinforcing spiral?

ENSO events have considerable historical time-depth and are unlikely to result from human modifications of the planet. Reasonable records suggest that their frequency can be determined with some accuracy as far back as 1900 (Figure 1). But only since 1970 can records be directly linked to its occurrence. Some recent research reports have suggested that the frequency and severity of El Niños is increasing and possibly also changing character (BBC News 7/11/97). Other scientists have emphasised the small number of data points and the impossibility of linear prediction with chaotic phenomena. If the frequency is indeed increasing, then there may be a link with global warming; the movement of a body of warm water from the Indo-Malesian area to the West Coast of South America may be encouraged by high sea-surface temperatures. The two patterns may thus form a reinforcing spiral ('frequency-locking') and the incidence of humanitarian disasters in the ENSO chain be further exacerbated. Such a possibility has yet to be canvassed even in high-profile events such as the Kyoto climate-change conference in December 1997, again presumably because the polluters and contributors to global warming are powerful and wealthy and those countries most starkly affected poor and without influence.

6. Beyond drought: understanding other types of event

There is growing evidence to suggest that El Niño can be correlated with other phenomena, especially in the area of health and insect population fluctuations. An analysis of malaria statistics in Venezuela covering nearly half a century, suggests that a rise in malaria cases almost always follows an El Niño, when the ocean currents and winds in the Pacific are reversed. This increase in malaria accompanies a dry year, when human resistance and mosquitoes' natural predators are adversely affected (Bouma and Dye 1997). A wave of diarrhoea and dehydration resulting from the unusually high temperatures in Peru is also connected to El Niño. The swarming of plague locusts in the semi-arid regions of Southern Madagascar has also been connected with ENSO although the incidence of swarming is strongly related to the fluctuating effectiveness of control programmes.

Epstein (http://www.gov/ogp/Ensoarcl12.html) highlights the effect of the variability of the climate on the earth's biota. He identifies three ways in which weather events affect human health, namely through the distribution and quality of surface water, the life cycle of disease vectors, and the ecosystem dynamics of predator-prey relationships. An increase in the incidence of water borne diseases, vector-borne and agricultural pests is characteristic during and after an El Niño event.

Wildlife

Shock events, notably droughts have also had significant events on wildlife, especially in forest areas. The plight of the sun-bears which are threatened by the loss of habitat in Borneo following drought and fires is worsened by the fact that they now have no protection from hunters (International Herald Tribune, 23/4/98). As with economic recovery, the complications of protecting, reintroducing and rehabilitating bears raised in captivity increase with time and the severity of social and climatic conditions.

7. Conclusion

Climate studies are entering the socio-political arena. Modelling has increased the potential to understand worldwide linkages in the weather but the stance governments should take in transmitting this understanding to rural populations has lagged far behind the scientific findings. There is a premium on certainty where probability is all meteorology can offer. El Niño has the specific property that as a chain event with predictors it is distinct from, say, the forecast that there will be a drought in the West African Sahel every ten years. Sea Surface Temperature measurements can provide some certainty of an El Niño well before drought affects Southern Africa. Possible links to other trends such as greenhouse gas emissions, which may be responsible for creating accelerating cycles of shock events, suggest that developing a more cogent understanding in the policy arena, and taking part in the discourse is becoming a matter of some urgency.

Climatic patterns have been historically ascribed to technical domains with politicians and administrators left to initiate policy responses. Recent events suggest that the characterisation of climatic events is relevant to 'normal' conditions, which are socially defined and accumulate significance from their political and economic context. Weather events are the probabilistic results of chaotic systems and a deterministic forecast cannot be made for this reason. Governments find such uncertainty problematic and information disseminated is often couched in terms far more certain than the data warrants.

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Web-sites

EL NIÑO- GENERAL

http://enso.unl.edu/ndmc/enigma

http://enso.unl.edu/ndmc/enigma/elnino.htm

Understanding ENSO and forecasting drought

http://www.idrisi.clarku.edu/10applic/assaf1/monitorcont.html

Clark Labs ENSO monitor: Southern Africa report

http://www.usda.gov/oce/waob/jawf/enso/impts98.gif

Map showing impacts of the 1997-8 ENSO

http://iri.ucsd.edu/hot_nino/impacts/safr/

http://www.acmad.ne/uk/climat/wclim.htm

http://biz.yahoo.com/fimance/980422/safrica_el-1.html

El Niño impact on South Africa seen as neutral

http://iri.ldeo.columbia.edu/climate/ensohtml/compare.html

Comparison of normal vs ENSO conditions

http://www.idrisi.clarku.edu/10applic/assaf1/monitorcont.html

http://www.info.usaid.gov/fews/imagery/sat_nino.htm

http://www.info.usaid.gov/fews/imagery/ninodef.htm

Famine Early Warning Systems; El Niño tracking.

http://www.fao.org/waicent/faoinfo/economic/giews

FAO Global Information and Early Warning Systems

FORECASTING

http://www.iges.org/ellfb/

Experimental long lead forecast bulletin

http://meteora.ucsd.edu/~pierce/elnino/sasha.html

http://grads.iges.org/nino/fcst0398.html

Statistical forecast of the extreme precipitation and temperature event frequencies for December- January-February 1997-98:

http://typhoon.atmos.colostate.edu/forecasts/1998/chris98/

Rainfall forecasts and verification for North Africa.

http://weather.iafrica.com/forecasts/cip_seasonal_outlook.html

Seasonal outlook: bi-monthly updates

DROUGHT AND FOOD SECURITY

http://www.crseo.ucsb.edu/geos/124.html

Earth Space Research Group reports

http://www.zimbabwe.net/sadc-fanr/news.htm

http://www.zimbabwe.net/sadc-fanr/rewu/fsmb/fsmb.htm

The SADC food security programme.

South Africa- Rainfall graphs:

http://www.usda.gov/oce/waob/jawf/enso/ensosaf.gif

http://lion.meteo.ge.ke/dmc/forum98/stat.html

Statement from the climate outlook forum for 1998:

http://www.dir.ucar.edu/esig/enso/

ENSO teleconnections. Forecasts and African food security.

http://www.ogp.noaa.gov/MPE/EconHD/Glantz95.html

Assessing the use and value of ENSO information for food security in Southern Africa

http://www.fao.org/WAICENT/faoinfo/economic/giews/english/alertes/sanin97.htm

Impact of El Niño and other weather anomalies on crop production in Southern Africa

NOAA

http://www.edc.noaa.gov/ENSO

UN says El Niño to fade in Africa, linger in Asia

http://www.ogp.noaa.gov/enso/enso_linger.html

The economic benefit of climate forecast

http://www.noaa.gov/public-affairs/pr97/aaug97/noaa97-47.html

El Niño climate anomalies can be predicted several seasons in advance.

http://www.ncdc.noaa.gov/ogp/papers/cane.html

Ensemble forecasts for assessing the impact of El Niño on weather systems.

http://www.cdc.noaa.gov/%7Ejsw/mrf/results

http://nic.fb4.noaa.gov/products/analysis_monitoring/enso_advisory/index.html

http://www.noaa.gov/ogp/Ensoarcl12.html/elnino.htm

MEDIA COVERAGE

http://www.dir.ucar.edu/esig/use_tx.html

http://www.enn.com/specialreports/elnino/news/el23.asp

The potential use and misuse of El Niño information in North America