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CLIMATIC UNCERTAINTY AND NATURAL RESOURCE POLICY: WHAT SHOULD THE ROLE OF GOVERNMENT BE?

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Recent concern about the consequences of the El Niño Southern Oscillation (ENSO) has focused attention on how policy implications are interpreted and acted upon, and the role government has in monitoring and disseminating predictions of weather patterns. Fundamentally, decision-makers become active participants in the risk-related environment as many governments are involved in supporting people affected by the phenomenon either in their own countries or as part of their aid programmes. The paper argues that the interpretations of global climate modelling are not purely technical, but are policy-related, and 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.

Policy conclusions

- 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.
- The El Niño Southern Oscillation (ENSO), a subject of current concern, is a typical probabilistic event whose teleconnections are far from understood. Absolute statements about its effects confuse modelling (increasingly well understood) with deterministic prediction (inherently static), creating unreal expectations amongst users of the information.
- Policy-makers need to be aware of the gap that has opened up between the development of global weather modelling and the reality of weather prediction and consider how this can be presented in a form most useful to those in fragile environments whose livelihoods are most at risk.

Notions of climate: technical and political

Understanding climate is central to building policy in the area of natural resources, both in yearly weather forecasting, and prediction over a longer time-scale, in which conceptual models of climate are constructed on the assumption of some 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 are 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 are 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 being entities that can be defined in themselves. Their severity and geographic extent reflect 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 century or so. Different strata of normality are available and can be selected (socially or politically) for the purpose to hand.

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 (Gleick 1989). The chaotic element of climate has only been realised relatively recently; the 20th century has witnessed a history of ‘long-range’ weather forecasting based on the analysis of recorded data series. All such data show temporary patterns and this has been responsible for some ephemeral successes. However, in the long term, the results have been undercut by the inherent unpredictability of these systems.

Weather can be thought of as shock events overlaying a background of acceptable variation. Shocks, such as floods, high winds and drought are sufficiently anomalous within the lifetime of observers as to be classified as unpredictable and life-threatening. Governments are frequently blamed for failing to make adequate preparations for such events. Vulnerability to weather events is a function of a region’s ability to cope rather than the event in itself.

Single events versus chain events: between prediction and modelling

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. Shock climatic events in specific parts of the world have usually been treated as discrete, and therefore analysed regionally. One effect has been to understand much more clearly the chaining of events previously considered unrelated – ’teleconnections’. A prime example of this is El Niño, an ancient name given originally by fishermen to the occasional movement of a body of warm water to the coast of Chile around the Christmas period, leading to disruption of fishing, floods and increases in sewage-borne diseases such as cholera. In 1969 the relationship between the El Niño oceanic phenomenon and the Southern Oscillation atmospheric component was identified, and the ENSO is now known to resonate with a sequence of events across much of the southern hemisphere. The range of indicators includes 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 southern Africa and New Guinea and a tendency towards higher than average rainfall in eastern Africa. 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, most strongly in the tropics and subtropics. The El Niño cycle lasts for up to eighteen months 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 which result in much less physical disruption. Figure 1 plots the intervals between El Niño and La Niña events since 1900.

The frequency of El Niño events is a matter for discussion, particularly in the light of media attention and concerns about global climate change, but the trendline on the figure below, marking the mean frequency of occurrence expressed as an order six polynomial, shows that the overall frequency has remained stable over the last century to date.

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, and improved observation is an element needed for progress to be made. 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, and hence the political agenda (see NRP 28).

The evolution of improved modelling is often confused with greater predictive capacity. Modelling clarifies the mechanisms that relate oscillatory events such as ENSO; it may provide greater probabilities of the climatic regime in one region if an event is recorded elsewhere. But even within probabilistic forecasting there is an incidence of non-hits: modelling cannot predict, in a deterministic sense, and here lies the root of the problem. Planners and politicians will inevitably want to drive the model harder than it will really permit, and education on the limits to forecasting is critical. El Niño is foreseeable over longer timespans to the extent that there seems to be at least one event per decade. Nonetheless, as a chaotic rather than a stochastic process, its impact is that of a shock event (see Table 1).

Table 1. ENSO impact and teleconnections: subjects for debate

More likely	Less likely
Floods, disease in Chile, Peru	Floods 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
Drought in southern Africa	Mild weather in northern Europe and eastern USA
Drought in Melanesia	Floods in California
Drought in eastern Australia	

Weather dependency: North vs South

A distinctive trend in Northern agriculture is to make it as weather- and environment-independent as possible: irrigation, drainage, 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 which would make such investments viable. Ecological features such as extensive rangelands, extreme heat and low aggregate rainfall may also mean that these are objectively more problematic.

As a result, shock events that affect agriculture, such as El Niño, have strong effects in the South while the North has been able largely to ignore them. 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-drive vehicles. Indeed such crises form part of the moral ecology of the North; the visible contrast between their own economies and those in the South inevitably reinforces a feeling of self-satisfaction, meaning that justification is not needed for expensive emergency operations.

Governments and prediction

Almost by definition, shock weather events, falling outside the boundaries of 'normal' weather behaviour, cannot be predicted. They can on occasions be traced to some other condition, or combination of conditions, and thus be judged to be more likely if the other conditions obtain. Identifying what events are connected with El Niño and using such information as warning signals 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 is 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 have assisted countries such as Zimbabwe to factor information about ENSO in agricultural meteorology (Unganai 1996).

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), has stepped up monitoring of weather and cropping developments since March 1997 in view of the potential for a drought in southern Africa. Briefing summaries have been expanded to cover South America, mainland and island 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 has recommended the planting of drought-resistant cultivars http://www.fao.org/.

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 (see Box 1). The unseasonal high rainfall in the Horn of Africa from Eritrea to Tanzania at the end of 1997 and beginning of 1998 coincided with the occurrence of other El Niño phenomena (GIEWS, 1998), and talk of teleconnections provides respectable scientific jargon 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.

Box 1. 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 uncontrollable climatic events. If water needs are not met, it is politically attractive to governments to blame a notorious climatic phenomenon than to accept responsibility for poor water management. The situation in Ethiopia demonstrates this; whether the weather in Ethiopia is affected by El Niño is undecidable at present, at least from a technical point of view, but different players in the crisis industry have taken positions: the Ethiopian government has capitalised on the political indemnity that El Niño affords and has blamed it for water shortages and incipient food deficits. International agencies and NGOs operating in Ethiopia take the 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.

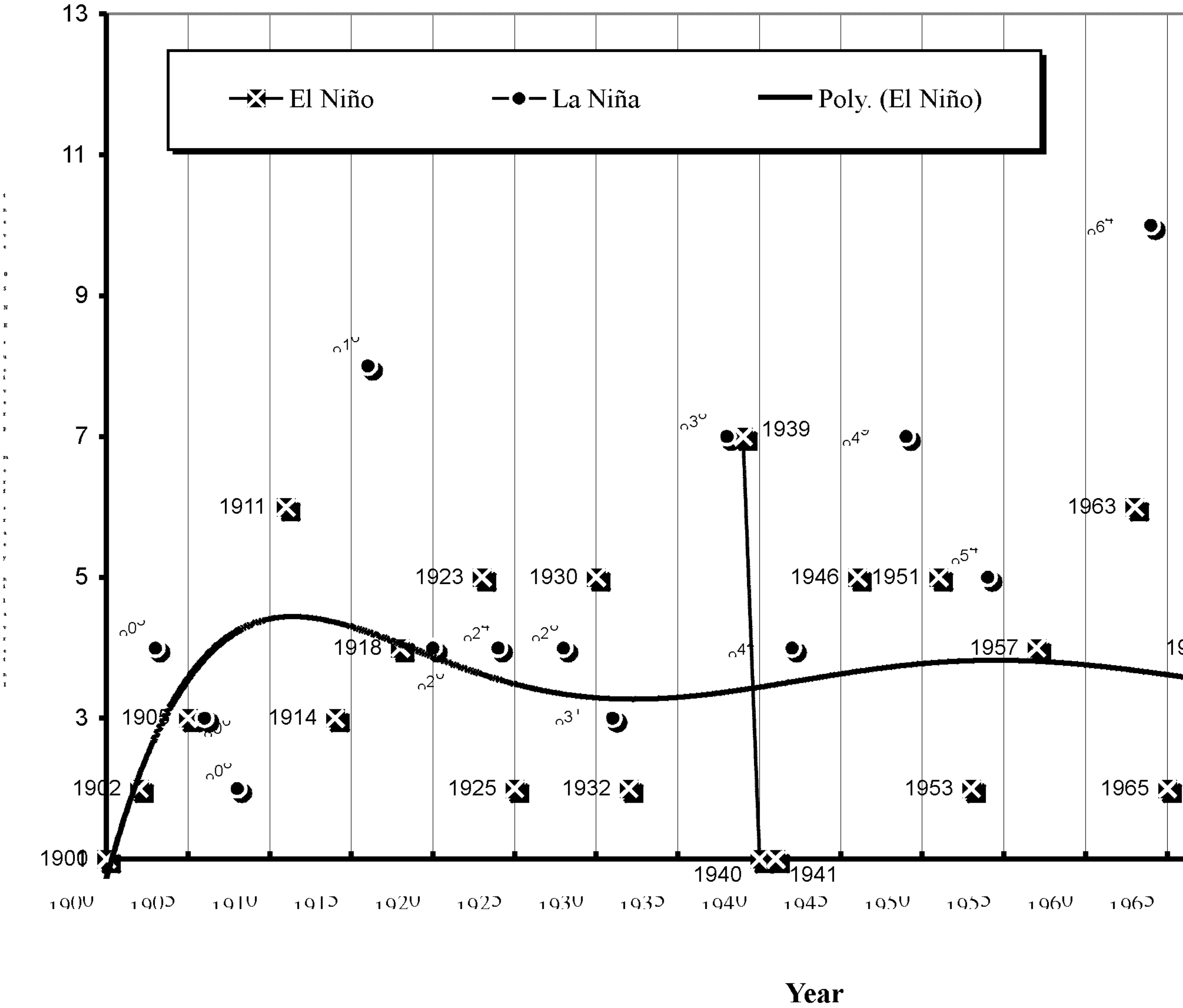
Another aspect of this is the changing risk-aversion strategies of farmers. Long experience of uncertainty about weather patterns has induced farmers in rainfed subsistence economies to develop complex cultigen repertoires and cultivar mixtures to ensure yields under all conditions. Such practice necessarily yields less 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. Such recommendations derive from (and 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 was 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 their own predictions whatever line the government decides to take, but they may not always be free to pursue their 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 small 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.

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 could increase and possibly also change in 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 does increase, 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, again presumably because the polluters and contributors to global warming are powerful and wealthy and those countries most starkly affected poor and without influence.



Beyond drought: El Niño as a health event

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 can be expected during and after an El Niño event.

There is growing evidence to suggest that El Niño can be correlated with such 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 such incidents are highly dependent on the fluctuating effectiveness of control programmes.

Conclusion

Climate studies are metamorphosing from the technical to the socio-politcal. Modelling has increased the potential to understand worldwide linkages in the weather but governments' responses in transmitting this understanding to rural populations remain idiosyncratic. 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, a reasonable assumption 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 hits 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.

References

BBC (1997) *From our own correspondent: El Niño special edition*. Transmitted November 1997

Bouma, M.J., and C. Dye (1997) 'Cycles of malaria associated with El Niño in Venezuela', *JAMA – Journal of the American Medical Association*, 278, 21:1772–1774

GIEWS (Global Information and Early Warning System on Food and Agriculture) (1998) 'Heavy rains attributed to El Niño cause extensive crop damage in parts of Eastern Africa'. *Special Report*, 5.2.98. FAO Secretariat

Gleick, J. (1989) *Chaos: Making a New Science,* London: Heinemann. Nicholson, S.E. and E. Kim (1997) 'The relationship of the El Niño Southern oscillation to African rainfall', International Journal of Climatology, 17, 2: 117–135

Unganai, L.S. (1996) 'Historic and future climatic change in Zimbabwe', *Climate Research*, 6, 2:137–145

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

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

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

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

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

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

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

http://news.bbc.co.uk/hi/english/sci/tech/newsid_25000/25433.stm

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

A more detailed paper on this subject can be found at
http://www.odi.org.uk/nrp/el_nino.html

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