EL NIÑO SOUTHERN OSCILLATION BASED RAINFALL FORECASTS IN SOUTHERN AFRICA. II. DAILY FORECASTS COULD HELP SUMMER PLANTING DECISIONS IN ZIMBABWE

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ABSTRACT

Analysis of historical data of daily rainfall for Harare showed that El Niño Southern Oscillation (ENSO) impacts on the timing of break-of-dry season and follow-up rainfall as well as the frequency of rain events during summer (Nov-Mar). The Southern Oscillation Index (SOI) was a useful indicator of the timing and frequency of these events, defined as 40 mm of rainfall in 3 days. Median dates for the first and second events were 1 December and 17 December respectively; ENSO contributed to a shift in these dates of about 2 weeks. The percent chance of receiving break-of-season rainfall by 1 December during La Niña years was 67% compared to 30% in El Niño years. Maize is a staple food in Zimbabwe and delaying planting after 1 December can result in lower yields. Communal farmers could benefit from this apparent ENSO signal in Zimbabwe by adjusting crop variety, planting time and fertilizer rate. However, poor spatial coverage of long-term (>80 years) daily rainfall data in Zimbabwe limits widespread application.

1. INTRODUCTION

El Niño Southern Oscillation has a significant impact on summer rainfall in Zimbabwe (Cobon, Unganai & Clewett 2003). Annual rainfall is summer-dominant and ranges from above 1200 mm in the Eastern Highlands to less than 600 mm in the lower lying valleys. The country has been classified into five agro-ecological zones with 75% of the communal areas falling within the low rainfall zones where crop production is marginal. Thus, communal farmers in Zimbabwe are highly exposed to climatic risk. Maize is the staple food and delays in the onset and amount of summer rain can reduce crop production, and cause crop failure and famine in communal areas. As growth of maize is temperature dependent delays in planting time can significantly reduce yield. Planting maize after 1 December results in reduced yield, with a four-week delay reducing yield by at least 40% (Gus McLaurin-unpublished data). Timing of the break in dry season is therefore vital for farming in Zimbabwe.

In this paper, we used the climate analysis package Rainman International to assess the impacts of ENSO on timing of break-of-season and follow-up rainfall and the number of rain events. We identify the usefulness of forecasting these events and some key decisions communal farmers can take to help reduce climatic risk.

Keywords: El Niño Southern Oscillation, daily rainfall forecasts, Zimbabwe

2. MATERIALS AND METHODS

Daily rainfall data for Harare/Belvedere from the Department of Meteorological Services in Zimbabwe was compiled for the period 1897-1997; data was missing for a total of 16 years. The impact of ENSO on timing of the break-of-dry season (first event), follow-up rainfall (second event) and number of rain events were investigated using Rainman International (Clewett *et al.* 1999, Clewett *et al.* 2003). A rain event was defined as 40 mm occurring in 3 days. Categories of the 3 month average Southern Oscillation Index (SOI) (Clewett *et al.* 1991) were compared to climatology at lead-times of 0-3 months (period of forecast skill) for the summer rainfall period (Nov-Mar). The Kruskal-Wallis (KW) and Kolmogorov-Smirnov (KS) (Conover 1971) tests assessed the significance of SOI relationships with rainfall. Statistical significance was indicated if KW and KS tests were at least 0.9, with KW test indicating difference of the SOI categories from climatology and KS indicating SOI category specificity.

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3. RESULTS

Mean annual rainfall at Harare was 818 mm. Median date, percent chance of occurrence and KS/KW probability for break-of-season rainfall (first event), follow-up rainfall (second event) and number of rain events are shown in Table 1. Median dates for the first and second events were 1 Dec and 17 Dec respectively.

Table 1. Median date, percent chance of occurrence and KS/KW probability for break-of-season rainfall (first event), follow-up rainfall (second event) and number of rain events at Harare for rainfall period (Nov-Mar) and SOI (Aug-Oct)

	SOI<-5	SOI>5	All Years
No of years	30	21	85
First event			
-Median date	11 Dec	26 Nov	1 Dec
-% chance by 1 Dec	30	67	48
-% years after median 1 Dec	63	24	46
-KS/KW	0.99	0.96	0.99
Second event			
-Median date	25 Dec	12 Dec	17 Dec
-% years after median 17 Dec	60	33	47
-KS/KW	0.90	0.92	0.86
Number of rain events			
-Median events per period	6	9	7
-% years more than median 7	33	71	46
-KS/KW	0.96	0.98	0.99

When SOI was >5 these dates occurred 5 days earlier and when SOI<-5 it occurred 8-10 days later, a total shift from climatology attributed to ENSO of about 2 weeks. ENSO shifted the median number of rain events (6 SOI<-5, 9 SOI>5) from the climatology median of 7. The period of forecast skill extended to a lead-time of 3 months for the Nov-Mar rainfall period (KW>0.95 for all 0-3 month lead-times). The percent chance of occurrence of first and second events is shown in Figure 1.

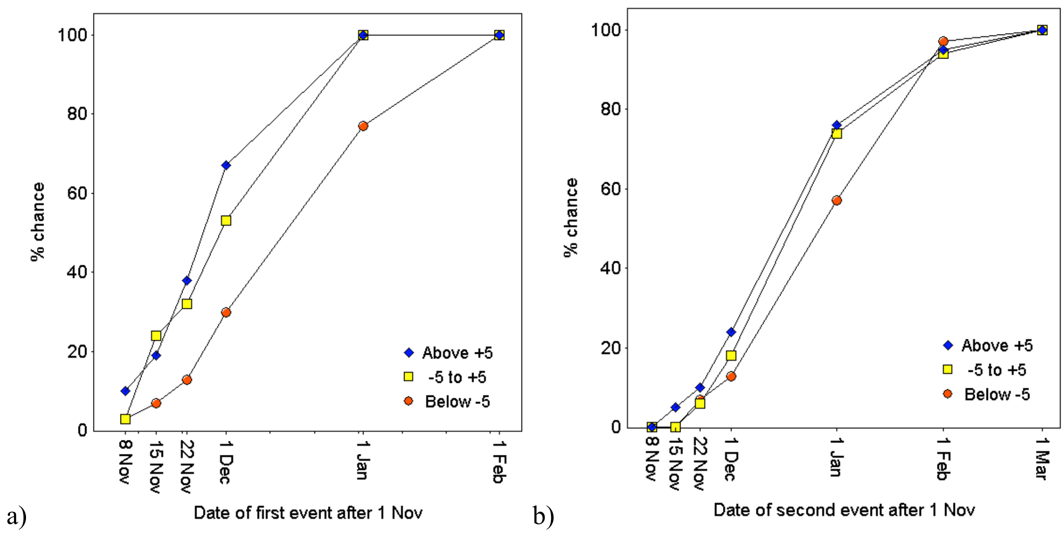

Figure 1. Percent chance of receiving 40 mm in 3 days at Harare during rainfall period (Nov-Mar) and 3 month average SOI (Aug-Oct) for a) first event (KW=0.99) and b) second event (KW=0.86). (Source Rainman International).

4. DISCUSSION

ENSO impacts on the timing and frequency of rainfall events during summer at Harare, as well as on the amount of summer rainfall in Zimbabwe (Cobon *et al.* 2003). The amount, timing and frequency of rainfall events is important for key decisions such as crop variety, fertilisation rate and planting date (Klopper 1999, Phillips Makaudze & Unganai 2001). Many communal farmers grow maize, the staple food, in marginal areas. To reduce climatic risk they tend to plant short-season varieties that are relatively low yielding but need less moisture. Delaying planting maize in December results in significant reductions in potential yield. Thus a significant shift in the timing of rain and the ability to forecast it with some accuracy has the potential to help communal farmers. A shift in the planting window of 2 weeks and more frequent rain events may help provided farmers have adequate time to prepare, that forecasts can be disseminated and tailored for local areas and farmers have some understanding and confidence in using probabilistic forecasts. The lead-times of the forecasts of up to 3 months indicate adequate time for farmers to purchase suitable seed and fertilizer.

This study was limited by spatial availability of suitable long-term daily rainfall data. Analysis of data from more locations is required to provide confidence that a national or regional ENSO signal exists, particularly for the lower rainfall zones where most communal farmers live. Data from local stations is important for application of this work by communal farmers. Communal farmers could benefit from the extraction and compilation of more daily rainfall records.

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