ENSO, THE SOUTH AFRICAN CLIMATE AND SUGARCANE PRODUCTION

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Introduction

Atmospheric and oceanic phenomena such as El Niño Southern Oscillation (ENSO) may be used to forecast drought with varying degrees of reliability (Nicholls, 1991). This information can be used to plan and manage the production of sugarcane. The ENSO phenomenon is described by Philander and Rasmussen (1986). The warm phase of the ENSO constitutes positive sea surface temperature anomalies in the eastern Pacific and negative values of the Southern Oscillation Index (SOI). Work by Lindesay *et al.* (1986) showed that the warm phase of ENSO (popularly named El Niño) does affect South African rainfall.

The aim of this work is to investigate the connection between the warm phase of ENSO and the South African sugar industry rainfall and yields. Results would indicate the need, or otherwise, for further research into ENSO-based drought mitigation strategies for sugarcane production.

Keywords: El Niño, ENSO, drought, weather

Method

Monthly rainfall totals (December to March) were analysed for five regions. A total of 48 stations were included in the analysis. The CANEGRO model (Inman-Bamber, 1991) was used to simulate yield from long term weather data for the different regions. A total of 34 stations with daily weather data were used for this purpose. Rainfall and yield data were normalised to the long term mean.

Rainfall and yield data were divided into two categories according to the state of ENSO. The El Niño category is defined as summers where the SOI during the preceding November was in the consistently negative phase (according to the system by Stone and Auliciens, 1992). All other data were regarded as part of the normal category. Cumulative distribution functions of the two categories were compared. The relative strength of the connection between El Niño and rainfall during given months (or yield) in a given region was determined through a non-parametric rank test (Rice, 1995).

Results

Rainfall probabilities for El Niño and normal seasons are given in Table 1. It is evident that probabilities for low rainfall increase dramatically during El Niño seasons. The non-parametric distribution test revealed that the North Coast and Zululand regions are worst affected. The Midlands are affected early in the season, while the South Coast is not. Mpumalanga seems least affected. El Niño's worst effect is during February. This applies to all regions except Mpumalanga and Swaziland. January rainfalls are least affected, except for the Midlands.

Historical yield data from the industry contain trends caused by factors other than climate. This complicates the investigation into the effect of El Niño on yields. Simulated yields using historical weather data from the industry indicate a strong link between El Niño and sugarcane yields (Figure 1). This is a result of low total and badly distributed rainfall during summer, especially during the important month of February.

Conclusions

The El Niño phenomenon affects rainfall in the South African sugar industry, especially during February. Temporal rainfall distribution is affected adversely throughout the summer, as shown by low simulated yields during El Niño summers. These results suggest that further investigation into drought mitigation strategies is warranted.

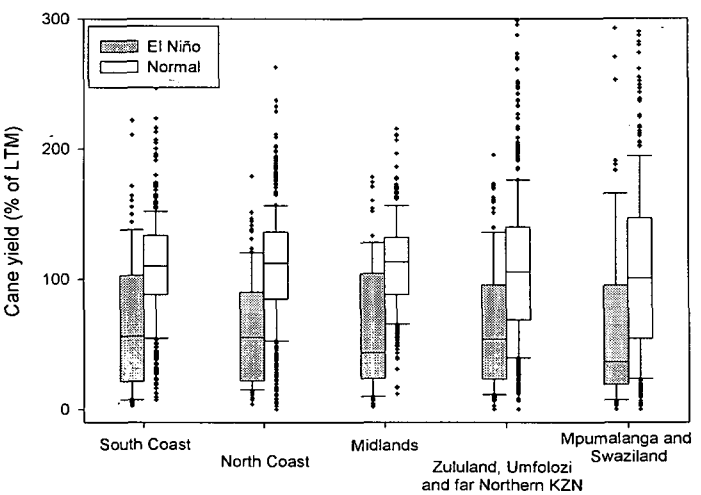

Figure 1. Box and whisker plots comparing relative yields after El Niño and normal seasons for the five regions of the sugar industry. Each box indicates the data set's 10th, 25th, 50th, 75th and 90th percentile. An outlier is plotted as a single cross (+).

Table 1. Probability (%) of not exceeding the specified rainfall total (expressed as % of long term mean) for different periods and regions for El Niño and normal seasons.

DECEMBER										
% of LTM	South Coast		North Coast		Midlands		Zululand & Umfolozi		Mpumalanga & Swaziland	
	El Niño	Normal	El Niño	Normal	El Niño	Normal	El Niño	Normal	El Niño	Normal
60	29	23	38	20	27	16	44	23	29	22
80	50	44	54	36	53	36	63	42	46	41
100	63	62	76	57	80	45	76	62	71	65
120	70	73	86	69	90	65	87	73	75	76
140	80	81	90	79	97	76	91	80	75	81

JANUARY										
% of LTM	South Coast		North Coast		Midlands		Zululand & Umfolozi		Mpumalanga & Swaziland	
	El Niño	Normal	El Niño	Normal	El Niño	Normal	El Niño	Normal	El Niño	Normal
60	15	23	28	27	43	7	44	31	38	28
80	34	47	44	45	60	26	57	44	46	47
100	53	56	68	54	80	48	65	56	63	66
120	74	73	78	62	90	66	72	67	71	70
140	88	82	86	75	97	79	78	77	79	80

FEBRUARY										
% of LTM	South Coast		North Coast		Midlands		Zululand & Umfolozi		Mpumalanga & Swaziland	
	El Niño	Normal	El Niño	Normal	El Niño	Normal	El Niño	Normal	El Niño	Normal
60	64	31	69	26	47	24	57	33	70	34
80	84	44	90	41	73	38	82	47	70	44
100	91	57	99	52	93	48	96	56	78	53
120	98	66	99	61	93	56	99	65	78	60
140	98	74	99	72	97	73	99	72	83	68

MARCH										
% of LTM	South Coast		North Coast		Midlands		Zululand & Umfolozi		Mpumalanga & Swaziland	
	El Niño	Normal	El Niño	Normal	El Niño	Normal	El Niño	Normal	El Niño	Normal
60	66	28	49	30	23	23	48	29	38	25
80	71	42	66	42	40	38	73	44	54	40
100	76	57	78	57	67	48	80	57	67	58
120	78	70	85	67	67	61	85	66	79	66
140	89	77	90	74	87	79	91	74	83	75

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