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INFLUENCE OF *EL NIÑO/LA NIÑA* EPISODES ON THE RAINFALL REGIME OF THE DL_1 REGION OF THE NORTH CENTRAL PROVINCE OF SRI LANKA

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Abstract: In view of the significance in terms of agricultural production and its dependency on rainfall, the DL_1 region of the North Central Province (NCP) was chosen to study the influence of *El Niño/La Niña* episodes on the rainfall regime. The rainfall data of two representative stations as mean seasonal rainfall and mean number of rainy days were analyzed based on four seasons i.e. First Inter-Monsoon (FIM), South West Monsoon (SWM), Second Inter-Monsoon (SIM) and North East Monsoon (NEM). Seasonal time series of rainfall data from 1906 to 2000 were divided into *El Niño*, *La Niña* and Neutral years. Student t-test and chi-square test were carried out to determine whether there were significant differences among the mean seasonal rainfall and mean number of rainy days in the time series. Both rainfall amounts and the number of rainy days in SIM seasons showed a statistically significant increase with respect to the situation in Neutral years. Even though it is not statistically significant, an apparent increase of mean seasonal rainfall and the mean number of rainy days in NEM seasons have also been evident during *El Niño* years. Thus, *El Niño* years are likely to produce above normal or at least near normal rains during the Maha season in the NCP. Hence, appearance and progression of *El Niño* type circulation in the Pacific ocean could be safely used as a long-range forecasting tool for rainfall of the *Maha* season in the NCP. Although there were obvious differences of seasonal time series of FIM, SIM and NEM between *La Niña* and Neutral years, statistically significant relationships could not be established. However, the teleconnection between seasonal rainfall during SWM period and *La Niña* events was positive at both locations. This study reveals that there is an influence of *El Niño* and *La Niña* episodes on the seasonal rainfall regime of DL_1 region of the NCP.

Key words: *El Niño/La Niña* episodes, North Central Province, rainfall.

INTRODUCTION

The DL_1 agro-ecological region occupies a large extent of the North Central Province (NCP) of Sri Lanka (Figure 1). It is dominated by a reservoir based irrigation system with a large number of major irrigation tanks along with a cascade of minor tanks. Except for a few major irrigation tanks, which are fed by trans-basin diversion of the Mahaweli river, all other major irrigation and minor tanks are fully dependent on the seasonal rainfall of their respective catchments. In addition, rainfed upland

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cultivation, which provides the livelihood of a majority of peasants in the province, is also heavily dependent on the rainfall during major cultivation seasons. Thus, the amount and the distribution of seasonal rainfall of the NCP determines the agricultural production potential of the region.

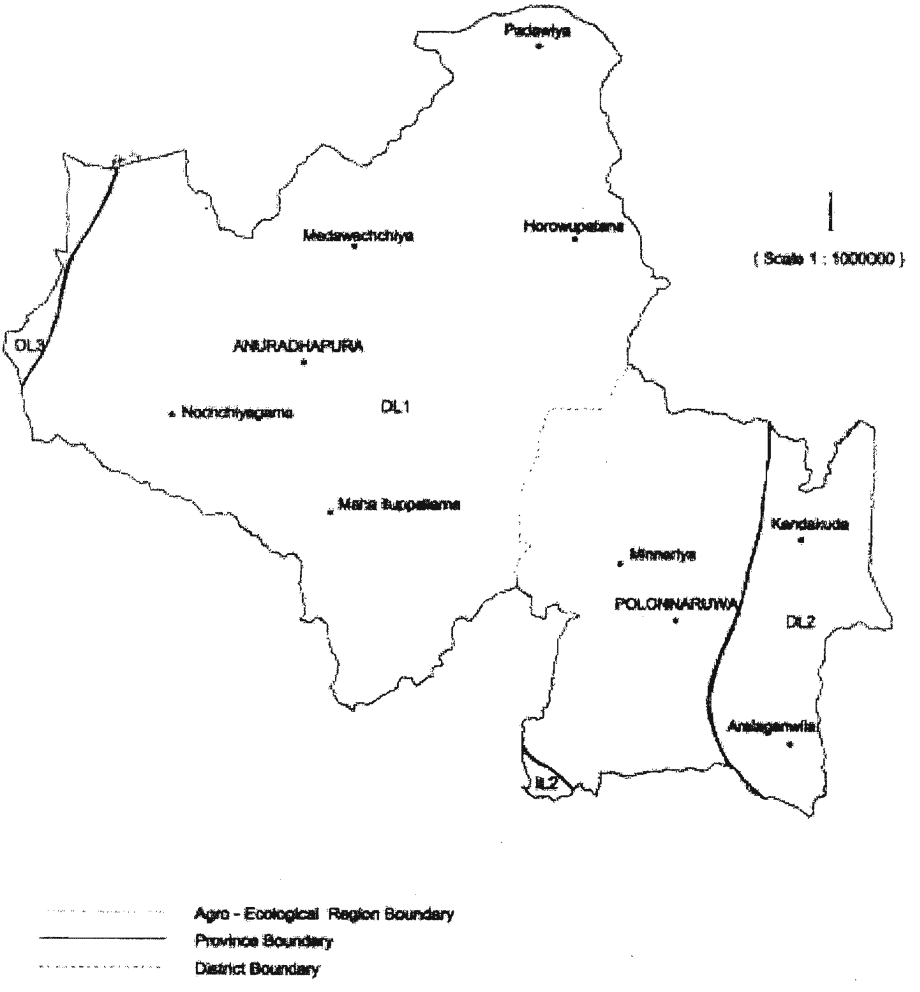

Figure 1: Agro-ecological regions in the North Central Province

The climate, in particular, rainfall of DL_1 region of the NCP exhibits a definite rhythm, mainly attributed to the causes of the seasonal rainfall. During the period of October to November, this region along with the other parts of the country receives ample rains from the Second Inter-Monsoon (SIM) rains, which generally occur due to passage of an Inter Tropical Convergence Zone (ITCZ) over the country. The ITCZ, generally, enhances the regional convection and thus forms low level disturbances and depressions in the vicinity of Sri Lanka. Nevertheless,

when the ITCZ is not active, the rainfall during this period is mainly governed by the convectional activity due to intense heating of land. By December, the NCP begins to receive the North East Monsoon (NEM) rains which would generally extend up to mid January of the following year. Together with the rains of October and November, these NEM rains make up the distinct cultivation season, the *Maha* season. When *Maha* rains retreat, a dry weather usually prevails during late January to early March. By mid March, the DL_1 region generally experiences convectional rains in the form of high intensity rains, possibly with thunder. These rains could occur up to early May and it represents the other distinct cultivation season, the *Yala* season. When the South West Monsoon (SWM) blows over the Wet Zone during the period of mid May to September, the DL_1 region of the NCP experiences a characteristic dry season due to *Föhn* like conditions of the SWM air flow. The rainfall during this period will mainly be in the form of occasional convectional type showers due to intense heating of land during daytime. Due to differences in terrain and albedo across the province, these rains possess a very high spatial variability. However, development of weather systems in the vicinity of Sri Lanka when the "monsoon break" conditions appear during SWM period cause considerable rainfall in the NCP

Apart from the conventional dry period, which comes during mid May to September, dry spells and droughts could occur during any part of the year due to significant negative departures of seasonal rainfall. Meanwhile, excess rainfall during major cultivation seasons does occur inflicting heavy crop losses with subsequent serious social impacts on the society. All these anomalies, either positive or negative, are said to be more frequent and intense during recent times than ever before. These rainfall departures are commonly attributed to shifts in frequency and strength of *El Niño/La Niña* events in the central and eastern Pacific ocean. Some recent studies have emphasized the teleconnection between rainfall in Sri Lanka and occurrence of *El Niño/La Niña* events.[1-6] However, comprehensive climatological analyses have not been undertaken for the NCP within the context of agricultural production. Hence, this study was undertaken to investigate the influence of *El Niño/La Niña* episodes on the seasonal rainfall climatology of the DL_1 agro-ecological region of North Central Province of Sri Lanka

METHODS AND MATERIALS

The rainfall data used in this study consists of daily rainfall data from two representative locations of the NCP, namely, Maha-Illuppallama and Minneriya for the period 1906 to 2000. Even though daily rainfall data from some other stations in the DL_1 region are also available, limited length of those data prevented using them in the study. These daily data were grouped into four different rainfall seasons for use in the study. These seasons are First Inter-Monsoon convectional rainy season (FIM; March-April), South West Monsoon rainy season (SWM; May-September), Second Inter-Monsoon rainy season (SIM; October-November) and North East

Monsoon rainy season (NEM; December-February). The status of each year in terms of *El Niño*, *La Niña* or Neutral, during the period from 1906 to 2000 was identified using published information and was verified against the Southern Oscillation Index (SOI) data taken from the Bureau of Meteorology, Australia.[7]

In this study, a year has been defined from March of one year to February of the subsequent year. This period includes the peak months of *El Niño* and *La Niña* events during October to December. From the original data set of 1906 to 2000, three data sub-sets were extracted for *El Niño*, *La Niña*, and Neutral years. For each type of year, cumulative seasonal rainfall and number of rainy days in each season were determined. A day was considered as a rainy day when the cumulative daily rainfall catch equals or exceeds 0.3 mm. The differences of mean seasonal rainfall in *El Niño*-Neutral and *La Niña*-Neutral were tested with student t-test. Further, the Chi-square test was adopted to test the differences between number of rainy days in each season among different types of years.

RESULTS AND DISCUSSION

Table 1 shows the mean seasonal rainfall during *El Niño* and Neutral years at Maha-Illuppallama and Minneriya. At both locations, SIM rains were significantly higher during *El Niño* years than Neutral years. A similar trend was observed in number of rainy days (Table 2). However, the magnitude of the increase in mean SIM rainfall was higher at Minneriya where the reported increase was 37% compared to 20% increase at Maha-Illuppallama. These results are in agreement with the findings of previous studies.[6] The significantly enhanced rainfall regime during SIM could probably be attributed to the exceptionally high Sea Surface Temperature (SST) during *El Niño* years in some regions of the Indian Ocean and its associated convective activity.[4]

Table 1: Seasonal rainfall of DL_1 agro-ecological region in the NCP during *El Niño* and Neutral years

Season	Seasonal rainfall - mm			
	Maha-Illuppallama		Minneriya	
	El Niño	Neutral	*El Niño*	Neutral
FIM	306	354	192	213
SWM	190	186	264	241
SIM	600*	499	666*	486
NEM	392	375	693	602

*Significantly different at 5% probability level

Table 2: Occurrence of rainy days during *El Niño* and Neutral years at DL_1 agro-ecological region of the NCP

Season	Number of rainy days			
	Maha-Illuppallama		Minneriya	
	El Niño	Neutral	*El Niño*	Neutral
FIM	21	21	14	17
SWM	17	17	10	10
SIM	35*	30	32*	27
NEM	27	25	31	30

* Significantly different at 5% probability level

During *El Niño* years, NEM rains were also increased by 5% and 15% at Maha-Illuppallama and Minneriya, respectively. But, these positive anomalies were not significant (Table 1). Moreover, there was no appreciable change in the number of rainy days of NEM during *El Niño* years over the Neutral years (Table 2). Thus, it is clear that even though *El Niño* episodes are at their peak during NEM season, enhanced rainfall regime during previous two months (SIM) begins to decline during NEM. It should be noted that out of three months of the NEM, only December and first week of January give substantial rainfall to this region. Dry weather usually prevails during the rest of the NEM season. Hence, positive rainfall anomalies that may arise due to *El Niño* type weather conditions during first half of the NEM may not be sufficient to make a significant signatory on mean seasonal rainfall of three month period i.e. December through February. Nevertheless, when the magnitude of the increase in NEM rains is considered, the influence of *El Niño* events is more pronounced at Minneriya (15% increase) where the NEM is effective for two months compared to Maha-Illuppallama (5% increase) where only December and a few days of early January receive NEM rains.

There were no discernible trends in FIM and SWM rains at both locations in response to the occurrence of *El Niño* events (Table 1). Table 2 reveals that mean number of rainy days in these two seasons has also no apparent trend. The lack of any significant association between occurrence of *El Niño* events and FIM rains could be attributed to the fact that *El Niño* events are generally at their early stages of development in the east and central Pacific oceans when the FIM rains are effective over the Dry Zone. Hence, it may not be strong enough to influence the general circulation of the atmosphere and/or SSTs in the vicinity of Sri Lanka to cause a tangible impact on FIM rains. Even though SWM brings ample rain to the western part of the island, it blows over the NCP as a *föhn* like dry desiccating wind. Thus, any rainfall that is received in the NCP during SWM period is mainly due to convection on a local scale. Hence, even if teleconnections between *El Niño*

events and SWM do exist, it may not be noticed in the rainfall of NCP during SWM period.

Table 3: Seasonal rainfall of DL_1 agro-ecological region in the NCP during *La Niña* and Neutral years

Season	Seasonal rainfall - mm			
	Maha-Illuppallama		Minneriya	
	La Niña	Neutral	*La Niña*	Neutral
FIM	324	354	206	213
SWM	281*	186	258	241
SIM	401	499	383*	486
NEM	353	375	606	602

* Significantly different at 5% probability level

Table 4: Occurrence of rainy days during *La Niña* and Neutral years at DL_1 agro-ecological region of the NCP

Season	Number of rainy days			
	Maha-Illuppallama		Minneriya	
	La Niña	Neutral	*La Niña*	Neutral
FIM	20	21	15	17
SWM	23*	17	13	10
SIM	28	30	23	27
NEM	25	25	27	30

* Significantly different at 5% probability level

An apparent decreasing trend was evident between occurrence of *La Niña* events and seasonal rainfall during FIM, SIM and NEM at both locations compared to Neutral years. Out of those, the decreasing trend of SIM rains in *La Niña* years at Minneriya was significant. In contrast, the teleconnection between seasonal rainfall of SWM and *La Niña* events was positive at both locations. Nevertheless, it was significant only at Maha-Illuppallama (Table 3). A similar trend was also observed in the mean number of rainy days (Table 4). In general, the atmospheric circulation during *La Niña* years is an intensification of the normal situation. Thus, it would probably intensify the SWM rains in the southwestern part, the so-called Wet Zone of Sri Lanka.[2] Under such situation, the warmth of the NCP is likely to increase due to katabatic nature of this wind and as such it may enhance

the local convection. During SWM period, the major rainfall producing mechanism in the NCP is local level convection. Therefore, during *La Niña* years an enhanced rainfall regime of SWM could be anticipated.

CONCLUSION

This study clearly demonstrates that there is an influence of *El Niño* and *La Niña* episodes on the seasonal rainfall regime of DL_1 region. In general, both rainfall and the number of rainy days in SIM season showed a statistically significant increase with respect to the situation in the Neutral years. Even though it was not significant, there was an apparent increasing trend of NEM rains during *El Niño* years. Thus, *El Niño* years are likely to produce above normal or at least near normal rains during the *Maha* season in the NCP. Hence, appearance and progression of *El Niño* type circulation in the Pacific ocean could be safely used as a long-range forecasting tool for rainfall of the *Maha* season in the NCP. Although there were obvious differences of seasonal time series of FIM, SIM and NEM between *La Niña* and Neutral years, statistically significant relationships could not be established. Meanwhile, the teleconnection between seasonal rainfall of SWM and *La Niña* events was positive at both locations. Accumulation of rainfall time series over the period of seasons covering several overlapping months would have obscured some of the significant anomalies that exist during the *El Niño* and *La Niña* years. Hence, the temporal sub divisions of seasonal rainfall into smaller time intervals would be recommended in future studies.

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