Seasonal Rainfall Probability using the RAINMAN SST Forecast Phase System (Phases 3,6,9) in the Philippines

ABSTRACT

Rainfall variability is an inherent characteristic of Philippine climate. Research and experience over the recent decades have shown that the El Niño Southern Oscillation (ENSO) plays a critical role in explaining rainfall variability in the Philippines. Although ENSO is not the only source of rainfall variability in the country, better knowledge of such variability is valuable for the agricultural and water resources sectors. The relationship between ENSO and variations in rainfall has been studied using the RAINMAN 4.1. Results of analyses show that the SST Forecast Phase System of RAINMAN has considerable skill for the period October to March (OND & JFM), using one month lead time. However the skill of the forecast starts to decrease from April to September (AMJ & JAS). The peak response of ENSO on rainfall occurs during the winter season October to March (OND & JFM) and tapers down during the summer monsoon (AMJ & JAS) of the following year and this is corroborated by the results of previous studies (Jose, et al.1997).

INTRODUCTION

The El Niño Southern Oscillation (ENSO) significantly influences Philippine climate. It has two phases, the warm phase or popularly known as El Niño and the cold phase named La Niña. Climatological studies have shown that during El Niño, drier than normal conditions are experienced in many parts of the country causing dry spells or drought as in the case of the 1997-98 El Niño.

Recent studies have found that the sea surface temperature anomaly in the Niño 3.4 region and rainfall in the Philippines have a strong correlation (see Figure 1). Based on previous studies the peak response of tropical-cyclone activity, and rainfall in the Philippines to the Niño3.4 region occurs during the northeast monsoon season (OND & JFM) (Jose, et al.). An El Niño event is manifested in the Philippine local climate by drier-than-normal weather conditions that can last for one or more seasons, causing dry spells or even drought in many parts of the country. These dry weather conditions are caused by suppressed tropical cyclone activity in the western equatorial Pacific and weak monsoon activity characterized by the delayed onset of the rains, monsoon "breaks", and an early termination of the monsoon season. The probability of having a drier than normal weather condition during OND & JFM is increased by El Nino over the Philippines.

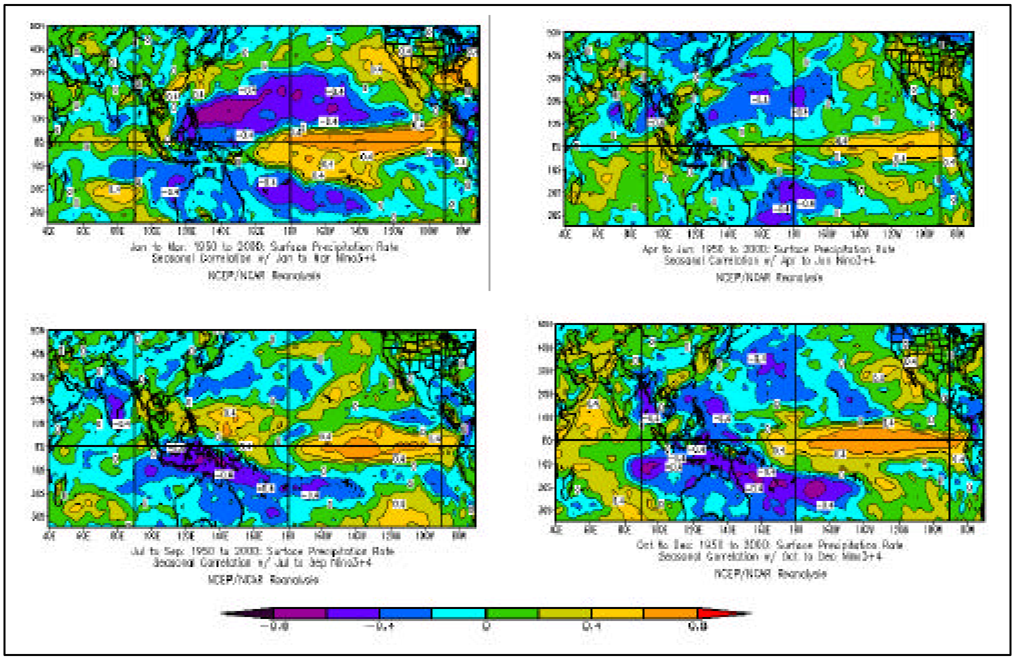

Figure 1: Seasonal Correlation of SST Anomalies in the Niño 3.4 Region on Quarterly Rainfall

Abnormalities in local climate as manifested by ENSO conditions have both negative and positive impacts on the various sectors of society and environment. Previous studies confirmed that major drought events in the country are associated with warm episodes in the central and eastern equatorial Pacific. These drought events wreak havoc on agricultural production. As records show, shortfalls in rice production coincided with El Niño years. Noticeable decrease in rice production has been noted during the1982-83 and the 1997-98 strong El Niño.

Activities to enhance the capability of PAGASA to provide timely and relevant climate information for the agriculture and water resources sectors include the development of tools and methodologies for translating ENSO forecasts into local climate forecasts as well as the development of various indicators/indices for assessing potential impacts of ENSO on the agriculture and water resources sector.

One significant breakthrough in seasonal climate forecasting in the Philippines is the use of the RAINMAN software to generate probabilistic seasonal rainfall forecasts. The main seasonal forecast tools evaluated in this study is the Sea Surface Temperature (SST) Forecasting System to assess the influence of ENSO on monthly rainfall. In communicating the seasonal climate forecasts, the use of probabilistic forecast through the use of pie charts to describe the likely outcome has been explored in this study.

METHODOLOGY

Over the last few years, efforts have been made to improve PAGASA's capabilities to produce timely and relevant climate information for the agriculture and water resources sectors. An important tool that can help assess seasonal climatic patterns and variability of rainfall is through the use of RAINMAN.

The data used in the analysis consists of monthly precipitation from 51 synoptic stations OF pagasa. This dataset is based on surface station observations. Seasonal rainfall analysis was done on Philippine Rainfall for four overlapping seasons (JFM, AMJ, JAS, OND) for 51 synoptic stations. Chance of rainfall for each station was computed using RAINMAN version 4.1 through the SST Forecast Phase System. Result of seasonal analysis for each station is represented by pie charts. Each pie chart corresponds to an individual forecast for each of the 51 stations. The main seasonal forecast tool used in the analysis is the SST Forecasting System.

The first SST Forecast Phase System is the All Years Climatology. This simply uses the climate that has been observed and recorded in each year in the past to provide a forecast for the future. The second SST Forecast phase system used is the Pacific Effects. The phase system enables the main effects of the Pacific ocean to be tested namely, Cooler Pacific Ocean pattern where Phases 1, 4 and 7 are combined, Neutral Pacific Ocean pattern where Phases 2, 5 and 8 are combined and Hotter Pacific Ocean pattern where Phases 3, 6 and 9 are combined. For this study the seasonal analysis was based on Phases 3,6,9 Pacific SST warm and All Years Climatology.

Pie charts showing the probability of rainfall for each category are then mapped for the four regular seasons to show the spatial distribution of rainfall that are likely to occur for each station when the sea surface temperature is warm. (Phases 3,6,9)

DISCUSSION OF RESULTS

Seasonal rainfall for JFM was computed using Phases 3,6,9 in the RAINMAN software (Figure 2). Most parts of the central Philippines show an increase chance of rainfall being in the lower tercile during this period. Results also reveal a statistically significant relationship between SST Phases 3,6,9 and Philippine rainfall in these areas since Kruskal-Wallis (KW) probability is 0.9 and skill score is greater than 7.6.

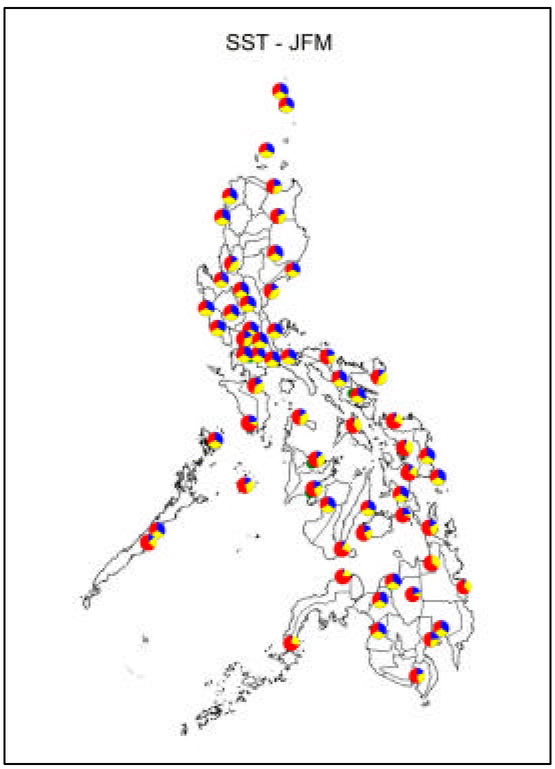

Figure: 2 Seasonal Climate Forecasts during JFM (Phases 3,6,9)

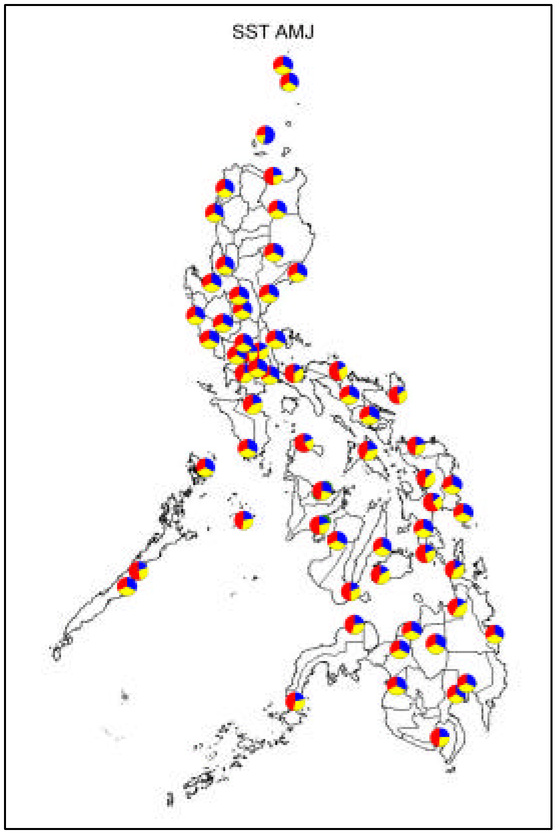

Figure 3: Seasonal Climate Forecasts during AMJ (Phases 3,6,9)

Analysis done on the second quarter rainfall (Figure 3) shows that approximately 23 out of the 51 synoptic stations have an increase chance of being in the lower tercile using the SST Phases 3,6,9, while only one station (Calayan) has significant chance of being in the upper tercile when the SST is warm. For the remaining stations, there is a 33% chance for each of the tercile (33%) category occurring. Most of the stations that was found to have an increase chance of rainfall in the lower tercile is in the central Philippines and results of analysis are statistically significant.

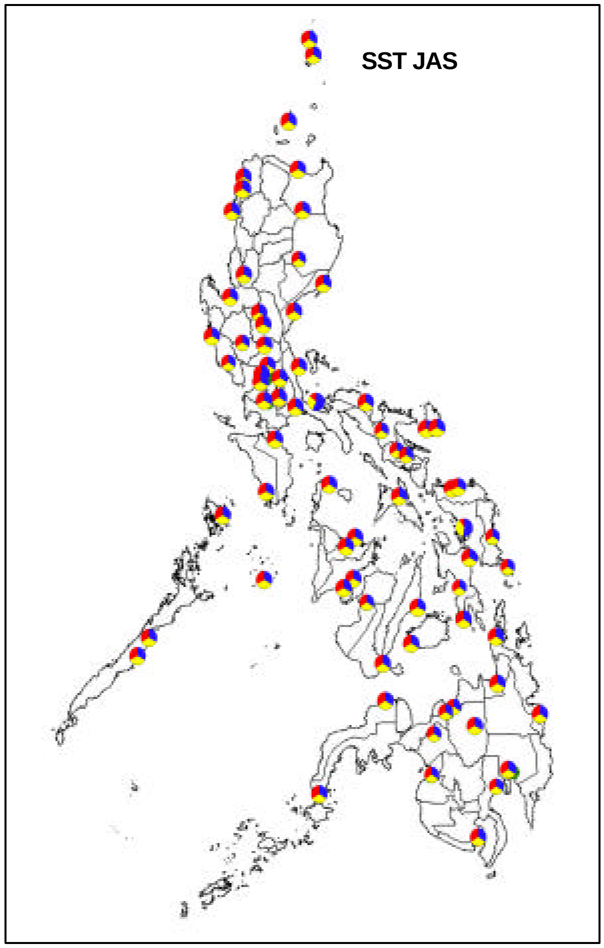

Figure 4 - Seasonal Climate Forecasts during JAS (Phases 3,6,9)

This period (JAS) coincides with the peak of the southwest monsoon and the peak of the typhoon season. Monthly average tropical cyclone activity during this season is about 3. Analysis done on seasonal rainfall for this period (Figure 4) shows that majority of the stations analyzed have equal chances of rainfall falling under the three tercile categories (upper, middle, lower). Terciles are used to represent three broad sectors of the probability distribution that are equally likely, climatologically. For all the stations analyzed the results are not statistically significant during this period. Skill of the forecast is generally low during this season because KW probability is less than 0.9 and the Skill score is below 7.6.

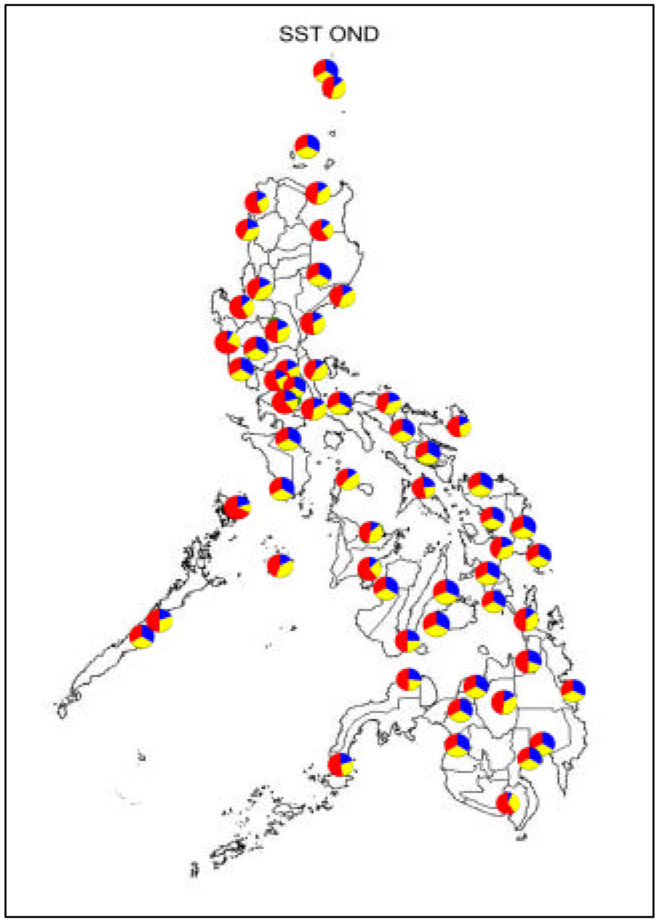

Figure 5 - Seasonal Climate Forecasts during OND (Phases 3,6,9)

Result of analysis during the OND period (Figure 5) shows that most of the stations in the Philippines are statistically significant when the Pacific SST is warm. Out of the 50 stations, at least 40 stations show statistically significant results because KW probability is above 0.9 and skill score is above 7.6. The probability of receiving rainfall in the lower tercile is increased when the Pacific SST is warm as shown by the seasonal rainfall analysis during the OND season. Generally the peak response of El Niño in the Philippines is during this season.

CONCLUSION

Based on the above rainfall analyses, the peak response of El Niño in the Philippines is during the northeast monsoon season (OND & JFM) and decreases during the summer monsoon of the following year (AMJ & JAS). This is corroborated by previous studies (Jose,et.al.1997) and is also shown in the results of the seasonal analysis on rainfall for the four overlapping seasons (JFM, AMJ, JAS & OND). The probability of receiving rainfall in the lower tercile is generally increased in an El Niño episode during the JFM and OND seasons. During the AMJ season, approximately 23 out of the 51 synoptic stations have an increased chance of being in the lower tercile using the SST Phases 3,6,9, while only one station (Calayan) has significant chance of being in the upper tercile, when the SST is warm. For the remaining stations, there is a 33% chance for each of the tercile category occurring. In the central Philippines, most of the stations have an increased chance of rainfall in the lower tercile. Seasonal analysis done on JAS shows that the results are not statistically significant because KW probability is less than 0.9 and skill score is below 7.6. Using climatology as the SST Phase Forecast System for JAS, there are equal chances for each of the three categories occurring. However, from October to March the SST Forecast Phase System of RAINMAN was found to have considerable skill for this period, since KW probability is greater than 0.9 and Skill score is above 7.6.

REFERENCES

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