Observed Impact of Climate Variability on Rubber *(Hevea brasiliensis)* Productivity in Songkhla Province, Southern Thailand.

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ABSTRACT

Recent evidence has revealed anomalous fluctuations of climate in the southern Thailand, particularly in the Songkhla province where is one of the major rubber plantation areas. Therefore, the effects of climate variations on rubber productivity were investigated. The study was conducted in the 4 rubber plantation sites all situated in Hat Yai district, Songkhla province where rubber clone RRIM600 was grown. Rainfall and evaporation data measured at the station in Hat Yai district during 1982-2011 were analyzed. The results showed that the annual rainfall totals increased significantly at the rate of 28.70 mm/year. Likewise, the annual number of rainy days has a significant increasing trend of 0.77 days/ year. During May 2008-March 2012, annual rainfall total and the annual number of rainy days tended to be higher. Particularly in 2011, there was exceptionally high rainfall amounts occurred during summer period leading to twice leaf-defoliations. This climate fluctuation also caused a delay of tapping. During April 2009-March 2012, the accumulated dry rubber yield per year tended to decrease, whereas annual rainfall totals and the annual number of rainy days increased. This may indicate that increasing rainfall amounts with higher rainy days cause a decrease in tapping days per year resulting in the reduction of rubber productivity.

Keyword: climate variability, dry rubber yield, rainfall, rainy days, tapping days

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ORIGINAL

INTRODUCTION

It is acknowledged that global climate is now changing and its anomalous year-to-year variations have been evident in many parts of the world. Over the past 50 years, a significant rise in the global temperature is very likely due to the anthropogenic-induced increase in greenhouse gas concentrations. One of the most serious concerns with such a change is an increase in extreme events such as floods, droughts and severe tropical storms (e.g., IPCC, 2007a, b; Maslin, 2004; Tressferth, 2003).

Craufurd and Wheeler (2009) showed that temperature is a major determinant of the plant development. Under warmer climate conditions, crop development stages will be shortened, leading to reduce the yield and production (Sanjeeva and Vijayakumar, 1992; Cynthia and Parry, 1994; Craufurd and Wheeler, 2009). Satheesh and Jacob (2011) illustrated that if both maximum and minimum temperatures increase by 1 ˚C, natural rubber productivity will reduce by 9-10% in the agro climatic conditions of Kerala.

Variability of rainfall has been recognized as an important factor for agriculture in Thailand as most of the country's agricultural areas are rain-fed that depends heavily upon rainfall. Therefore, the fluctuations of rainfall have considerable agricultural impacts, especially the southern Thailand where is under strong influence of the southwest monsoon which often causes heavy rainfall events and severe floods (Sdoodee, 2007; Limsakul *et al*., 2010). Rubber is a major industrial crop for natural production in southern Thailand. Naturally, the rubber tree is originally from the tropical rainforest, growing well with mean daily air temperature of 25-28°C, annual rainfall amounts exceeding 2,000 mm and high number of rainy days ranging from 100-150 days (Watson, 1989). Given the above-mentioned facts, rubber production in the southern Thailand may be affected by ongoing climate variability. Hence, the objective of this study was to investigate the effects of climate

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variability especially rainfall fluctuations on rubber productivity in Hat Yai district, Songkhla province, southern Thailand.

MATERIALS AND METHODS

In this study, the historical data of annual rainfall totals, the annual number of rainy days and pan evaporation during 30 years (1982-2011) measured at the Kho Hong Meteorological station in Hat Yai district, Songkhla province were used to analyze long-term trends and interannual variability. Rainy days are defined as days with at least 1 mm of rain. The field experiment was conducted in Hat Yai district, Songkhla province to collect the data related to rubber production. Four rubber plantation sites with clones RRIM600 were chosen to be investigated. They were sampled for the assessment of tapping days and latex yield during May 2008-March 2012. The data of latex yield were expressed in gram per tree per tapping (g t^{-1} t^{-1}) and kilogram per tree per month (kg t^{-1} month^{-1}), respectively. Accumulated dry rubber yield was then assessed as kilogram per rai per year (kg rai^{-1} year^{-1}). The anomalies of annual rainfall totals were plotted to relate with the yield of rubber. Rainfall amounts, the number of rainy days, tapping days and latex yield in each year during May 2008-March 2012 were assessed and the mean of each year were compared using Duncan's multiple rang test at the 5% level of significance.

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RESULTS AND DISCUSSION

Our results show that annual rainfall totals in Hat Yai district, Songkhla province during 30 years (1982-2011) have increased significantly by 28.70 mm/year (Figure 1a). A similar significant increase can also be seen in the annual number of rainy days, as Figure 1b showing the increasing trend at the rate of 0.77 days/year. When considered the increasing trends of both atmospheric variables together, it is suggested that rainfall events in Hat Yai district are getting more frequent but their intensity remain unchanged. From Figure 2, it is also evident that rainfall underwent a remarkable change in comparison with evaporation, leading to unbalance of water availability with surplus rainfall accumulation particularly the period since 1993. There was only short dying period during 1989-1992 when evaporation was higher than rainfall (Figure 2). During 1882-1988, rainy period was interrupted by drying period. Since 1998 onwards, there has been a marked increase of annual rainfall, particularly in year 2000 and 2010, where there were severe floods occurring in Hat Yai district, Songkhla province (Doungmusik and Sdoodee, 2012). It should be noted that over the past 30 year, there was no marked change in evaporation in Hat Yai district (Figure 2).

Figure 3a shows that the drying period in 2008 took place during February and April. This situation was similar to the 30-year climatology of rainfall. Following this period, there was a rainy reason with exceptionally high rainfall amounts starting from May to August. Therefore, the farmer started tapping on the 7-years old rubber tree in May. In 2008, rainfall reached peak in November with total annual amounts 2,452.8 mm. In year 2009, however, there was abnormally raining during summer months (March until May), therefore, the farmer started tapping in May. Considering total annual rainfall, it was comparable amounts between 2008 and 2009. In year 2010, a drying period in summer was during February and April, then, the rain started in September with the peak in November. This resulted in severe flooding at the end of the year (Figure 3c). The rainfall fluctuations were

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evident during summer months in year 2011, with noticeably high rainfall amounts (Figure 3d). As a result, leaf defoliation of rubber trees occurred twice causing a delay of tapping. This was due primarily to anomalously high rainfall amounts during summer period, particularly those occurred in March, leading to the outbreak of powdery mildew (*Oidium heveae Steinm*.), and consequently a delay of young leaf emergence. Moraes (1997) reported that the rubber tree normally presents deciduous behavior with a defoliation period of about 2–3 weeks followed by a new leaf emergence. However, Johnton (1989) showed that an increase of rainfall during summer caused fall leaflets due to the infection of powdery mildew disease. Therefore, open-tapping period in year 2011 was delayed to start in June, and then tapping period was only 9 months leading to a marked decrease of tapping days. It was also found that the rubber yield decreased during high rainfall period. Joseph and Jacob (2010) pointed out that the extreme weather in terms of heavy rain events can substantially reduce harvesting intensity through reduced tapping days.

During May 2008-February 2009, latex yield was low although there was a high tapping days. This was due to the first year of open tapping with low latex yield per tapping (Table 1). In 2009, the highest latex yield was found with the highest tapping days because of low rainy days (160 days). Consequently, latex yield tended to decrease in year 2010 and 2011, with lower tapping days (104 days and 87 days, respectively). However, there was no significant difference among year 2009, 2010 and 2011.

Table 2 shows that the accumulated dry rubber yields decreased during May 2010-March 2012 compared with that during Apr 2009-Mar 2010. This was due to a significant decrease of the tapping days. It was remarkable that, the number of rainy days affected the tapping days under fluctuation rainfall. Jiang (1988) also reported that high normally rainfall causes less production of latex yield because of less sunshine and fewer favorable days of tapping.

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Dry rubber content (%DRC) of rubber tree among the four years of tapping was no significantly different (Figure 4), and percentage dry rubber content varied from 30.13 to 32.68 percentages, although rainfall tended to increase. This implied that there was no impact of fluctuation rainfall on dry rubber content.

CONCLUSION

During the 30-year period, annual rainfall totals in Songkhla province significantly increased with higher annual number of rainy days. This leads to rainfall events are getting more frequent but their intensity remain unchanged. The results also indicated that there were seasonal-to-interannual fluctuations in distribution patterns of rainfall. During April 2009-March 2012, heavy rain events caused decreases in tapping days, leading to the reduction of rubber productivity. Furthermore, rainfall occurred during summer period caused the breakout of leaf disease, particularly with powdery mildew.

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ORIGINAL

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ORIGINAL

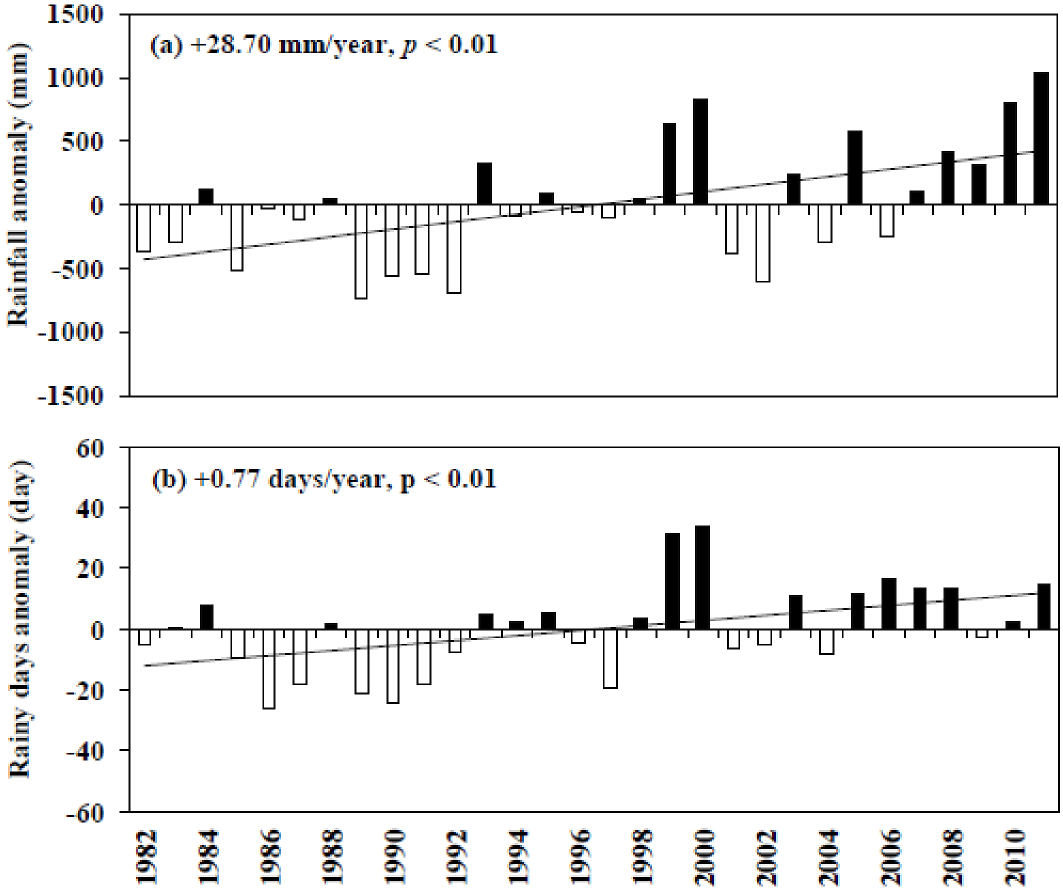

Figure 1. Anomalies and the linear trends of annual rainfall totals (a) and the annual number of rainy days (b) during 1982-2011 in Songkhla province.

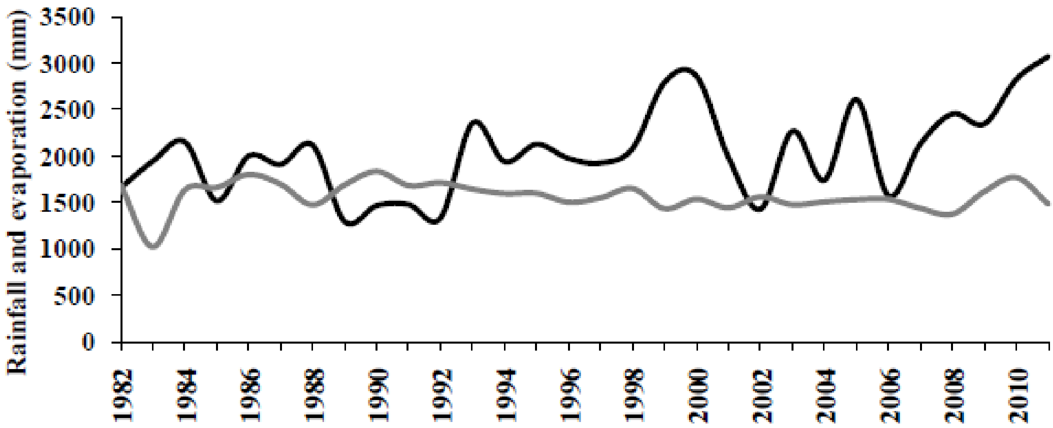

Figure 2. Changes of annual rainfall totals (—) and annual evaporation (▬) during 1982-2011 in Songkhla province.

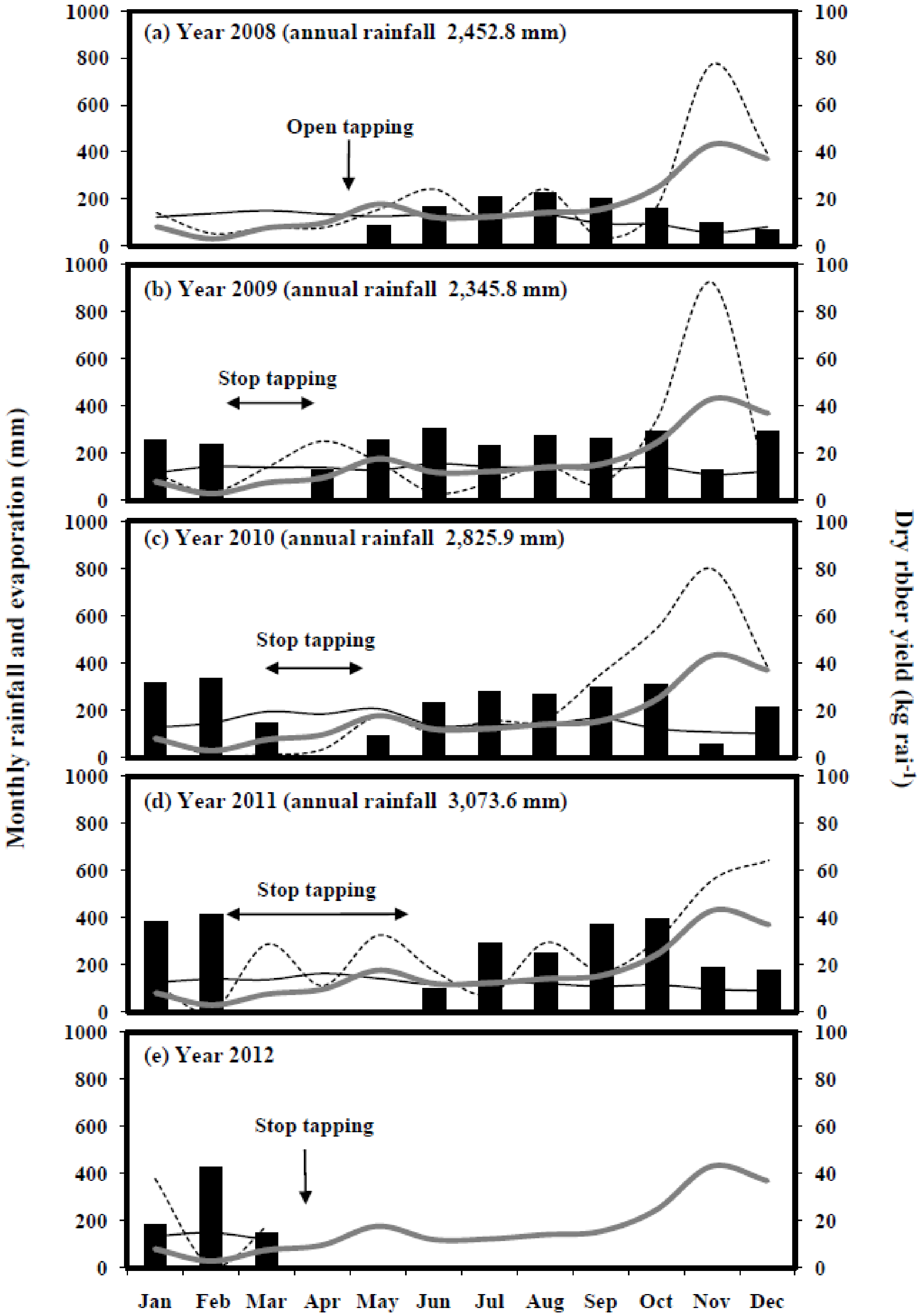

Figure 3. Monthly rainfall (----), evaporation (—), dry rubber yield (■) during May 2008-March 2012 and the 30- year rainfall average (▬) in Songkhla province.

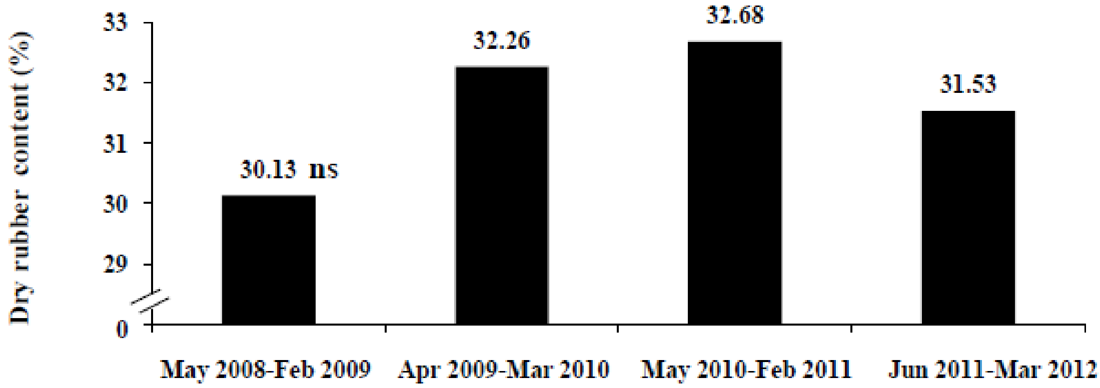

Figure 4. Percentage of dry rubber content (DRC) of rubber trees during May 2008-March 2012 in Hat Yai district, Songkhla province.

ns = Non-significant difference

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Table 1. The annual number of rainy days, annual tapping days and latex yield during 2008-2011 at Hat Yai district, Songkhla province.

Year	Rainy days	Tapping days	Latex yield	
			(g $t^{-1}t^{-1}$)	(kg $t^{-1}month^{-1}$)
2008	176	114^{ab*}	49.95^{b}	0.66^{b}
2009	160	152^{a}	79.32^{a}	1.12^{a}
2010	164	104^{b}	76.37^{a}	0.95^{a}
2011	180	87^{b}	75.95^{a}	0.91^{ab}
F-test	ns	*	*	*
C.V. (%)	44.56	23.61	11.38	19.78

* = Means with different superscripts in each column indicate significant difference ($P \leq 0.05$) by Duncan's multiple range test.

ns = Non-significant difference

Table 2. Annual tapping days and accumulated dry rubber yield during May 2008-March 2012 at Hat Yai district, Songkhla province.

Year	Tapping days	Accumulated dry rubber yield (kg rai^{-1} year^{-1})
May 2008-Feb 2009	114^{ab}*	162.16^{c}
Apr 2009-Mar 2010	152^{a}	290.98^{a}
May 2010-Feb 2011	104^{b}	253.45^{ab}
Jun 2011-Mar 2012	87^{b}	244.23^{b}
F-test	*	*
C.V. (%)	23.61	14.4

* = Means with different superscripts in each column indicate significant difference ($P \leq 0.05$) by Duncan's multiple range test.

ns = Non-significant difference

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