Six years intensive rainfall observation in Mae Chaem Watershed, Northern Thailand

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1. Introduction

In the tropical monsoon Asia, rainy and dry season is distinct, but the intra-seasonal transition in rainfall during the rainy season was not studied well especially in the mountainous area.

GAME-T established a rain gauge network in the mountainous watershed in northern Thailand and observations have continued since September 1997. From these observations, Dairaku *et al.* (2000) reported the altitudinal increase in rainfall in this watershed using data from 1 June until 23 November 1998. Kuraji *et al.* (2001) found that the altitudinal increase in rainfall was obvious in the two wet seasons in 1998 and 1999 with the increment in 1999 being more than 2.5 times greater than that in 1998. In the two wet seasons, the mean rainfall intensity has no altitudinal dependence, whereas the proportion of hours with rain has a clear tendency of altitudinal increase. The relationship between the spatial scale of the rain event and the altitudinal increase was also examined. In these papers, however, the intra-seasonal transition of rainfall, duration, intensity, spatial scale and altitudinal increase in rainfall were not examined.

The objective of this research is to understand intra-seasonal transition of rainfall characteristics in a mountainous watershed under tropical monsoon climate in Thailand using the data set obtained by GAME-T observation network. One of the advantage of this study is that we use 6 years continuous data from 1998 until 2003 because only 2 years data were used in our previous studies (e.g. Kuraji *et al*, 2001).

To analyze intra-seasonal transition in rainfall, following two topics were examined in this paper:

1. Definition of the regimes in the rainy season,
2. Seasonal transition of the altitudinal increase in rainfall.

2. Study site and methods

GAME-T established a rain gauge network in the Mae Chaem watershed to determine rainfall amount in the mountainous area in the upper Chao Phraya river basin. The Mae Chaem (Chaem River) watershed is located at 18°06’ - 19°10’ N and 98°04’ - 98°34’ E (Fig.1) with a catchment area of 3,853km^2 at the river flow gauging station operated by the Royal Irrigation Department (RID). The name of this station is P.14, and the location is shown in Fig. 2 as No.16. The figure "P" stands for the Ping River showing that the gauging station is located in a sub-catchment of the Ping River basin. The Ping River, 740 km long with a catchment area of 33,898 km^2, flows southward to join the Nan River at Nakhon Sawan Province where the Chao Phraya River is formed. The highest point of the Mae Chaem watershed is the Doi Inthanon (Mt. Inthanon) summit, 2,565 m above sea level, which is the highest peak of Thailand. The lowest point of the watershed is 282 m (No.16 in Fig. 2).

Automatic tipping bucket rain gauges (No.34-T: Ota Keiki Co., 20 cm orifice diameter and 0.5 mm per tip) with pulse-count time-recording data loggers (KADEC-PLS: KONA System Co., one second time resolution) were installed at 15 sites (No.1 - 15 in Fig.2) throughout the catchment. The sites were located in front, or at the back of each field station of the Royal Forestry Department (RFD) for greater security. To avoid effects of under-catch due to surrounding forests and exposed ridges, careful consideration was given to the location of the rain gauges. The rainfall amount in any time period (e.g. season, month, day, hour) is calculated by totaling the number of tips in each period, multiplied by 0.5mm per tip and the data until 2001 were available through GAME-T data center.

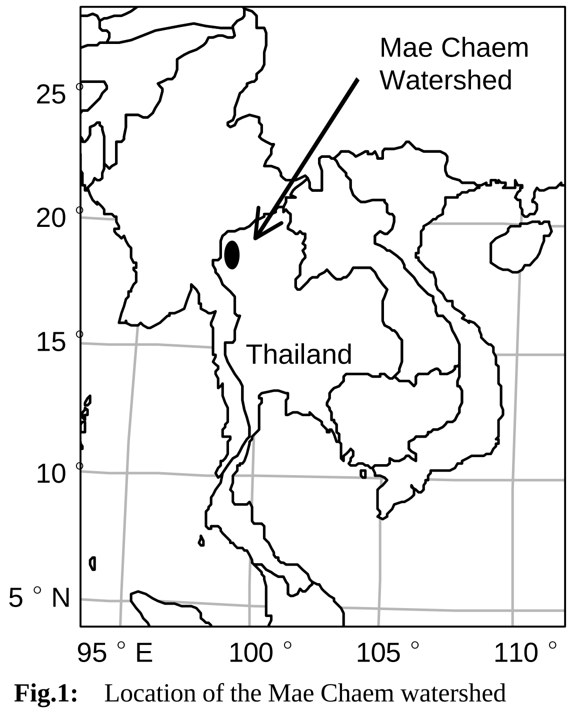

Fig.1: Location of the Mae Chaem watershed

3. Results and discussions

3-1. Seasonal variation and altitudinal increase in rainfall

Rainfall in the region is characterized by large seasonal and inter-annual variations, as well as altitudinal increase. Figure 3 shows the seasonal variation of rainfall at Doi Inthanon (No.7 in Fig.2), Bo Kaeo (No.2 in Fig.2) and POU (No.10 in Fig.2). From Fig. 3, rainfall in these sites had two seasons: wet season (May-October) and dry season (November-April) with a relatively small amount of rainfall in July. The inter-annual fluctuation in rainfall was mainly caused by the fluctuation of rainfall in May, June, August and September and not in July. The rainfall in Doi Inthanon, the highest point in this watershed, had the largest amount of rainfall whereas POU, which locates in the low elevation part of this watershed, had the smallest rainfall throughout the 6 years.

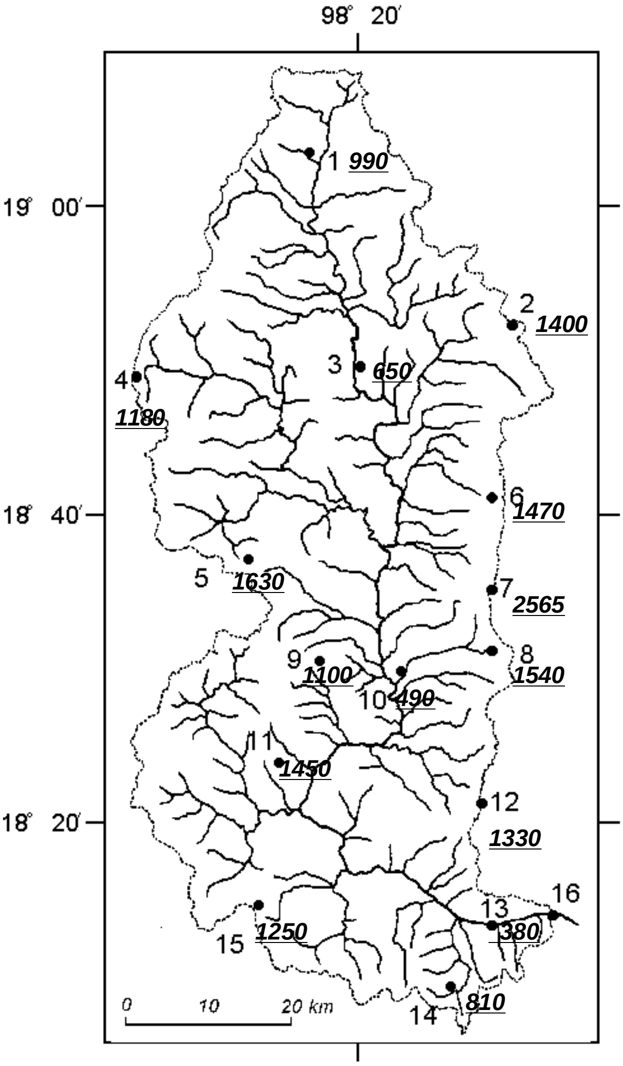

Fig.2: GAME-T rain gauge sites (No.1-15) and the RID river runoff gauging station (No.16). Elevation of all rain gauge stations are also shown.

3-2. Definition of the intra-seasonal regime: seasonal transition of CV_5

Matsumoto (1997) studied the onset and withdrawal of the wet season over the Indochina Peninsula using 5-day averaged rainfall data and showed the distribution maps of the date of onset and withdrawal of the wet season. According to his study, the average date of onset and withdrawal of the wet season in the Upper Chao Phraya river basin is around 28 April and 1 October, respectively.

Figure 4 shows the seasonal change of the coefficient of variation of the 5-day rainfall (CV_5) in the Mae Chaem watershed. Here, CV_5 was calculated as dividing the standard deviation of 5-day rainfall in the 8 sites (No.2,3,4, 7,9,10,11) by the average of them. The CV_5 value is a useful indicator of spatial scale of rainfall (Kuraji *et al.* 2001). From Fig. 4, intra-seasonal change of CV_5 in the rainy season was appeared. Before the early May, the number of non-zero 5-day rainfall sites in a pentad was frequently equal to zero or one or the range of CV_5 values was between 0.5 and 2.5 even almost all pentads have rainfall at all sites. From the early May to the early June, the CV_5 value was clearly decreased to the range between 0.2 and 0.7, but returned back to the range between 0.5 and 1.0 after the early June until late July. After the late July, the CV_5 value was changed again to the range between 0.2 and 0.7 until late September. After that, the CV_5 value gradually increased until late October, the starting point of the next dry season. This seasonal transition pattern of rainfall in the Mae Chaem watershed in the rainy season may be universal, because the phases of seasonal transition of the CV_5 value synchronized for 4 years. From this hypothesis, we define three intra-seasonal regime in the rainy season from the 4 years CV_5 data, as shown in Fig.4 by the vertical broken line. We call these three intra-seasonal regime as early rainy regime (5/11-6/9, 30 days), middle rainy regime (6/10-7/24, 45 days) and late rainy regime (7/25-9/22, 60 days) hereafter.

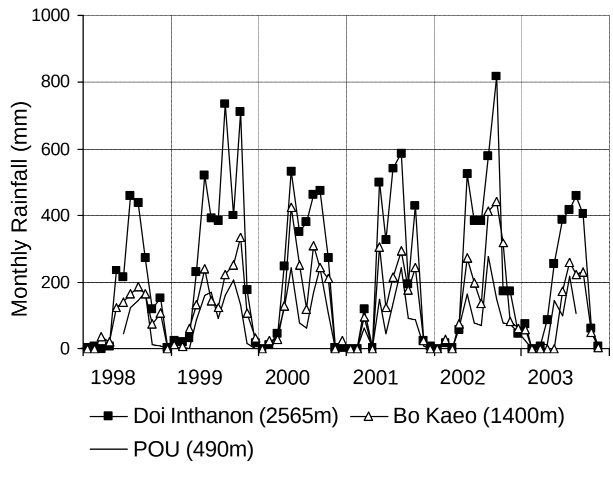

Fig.3: Seasonal variation in rainfall in Mae Chaem watershed, 1998-2003.

3-3. Altitudinal increase in rainfall in the intra-seasonal regime

Dairaku *et al*. (2000) pointed out that the altitudinal increase in rainfall is distinct in the 1998 rainy season in the Mae Chaem watershed. This tendency was also observed in 1999 rainy season and 1998-99 dry season (Kuraji *et al.* 2001).

Fig. 5 shows the relationship between mean daily rainfall and elevation of the 15 sites in the three regimes in the rainy season. Altitudinal increase in rainfall was distinct for all regimes for the 4 years. The relationship between mean daily rainfall and elevation for the early rainy regime was similar with that for the late rainy regime. In the middle rainy season, however, the smaller rainfall in the low elevation sites than these for the early and late rainy regime, corresponding with the “break” of monsoon (Matsumoto, 1997). The mean daily rainfall in the high elevation site was larger than that in the early and late rainy regime in 1999 ands 2001 but smaller than that in 2000 and 2002. As a result, the ”break” of monsoon in the high elevation sites was obvious in 2000 and 2002 but not in 1999 and 2001. The inter-annual variation in rainfall was the highest in late rainy regime in the high elevation area, but the highest in early rainy regime in the low elevation area. In the middle rainy regime, the inter-annual variation in rainfall was not distinct in both low and high elevation area.

4. Conclusions

This paper focused on definition of the 3 regimes in the rainy season and seasonal transition of the altitudinal increase in rainfall in the mountainous Mae Chaem watershed, Northern Thailand.

It was found that the coefficient of variation in 5-day rainfall among 8 sites was a useful indicator to understand seasonal transition in rainfall pattern in the Mae Chaem watershed. Using this indicator, rainy season was divided into early rainy, middle rainy, late rainy regime. The seasonal transition of the altitudinal increase in rainfall were analyzed using these regimes. It was found that all regimes have their original pattern of the altitudinal increase in rainfall.

The definition of regimes in this study might correspond to the larger scale monsoon activity. This fact showed that the monsoon strongly affect the rainfall pattern in the mountainous area. The prevailed mechanism of rainfall in one regime might be different from that in the other regimes.

References

Dairaku K., Kuraji K., Suzuki M., Nipon T., Warin J. and Kowit P., The effect of rainfall duration and intensity on orographic rainfall enhancement in a mountainous area: a case study in the Mae Chaem watershed, Thailand. *J. Japan Soc. Hydrol. & Wat. Resour.* **13**, 57-68, 2000.

Kuraji K., Kowit P. and Suzuki M., Altitudial increase in rainfall in Mae Chaem watershed, Thailand. *J. Meteorol. Soc. Japan*, **79**, 1B, 353-363, 2001.

Kuraji K., Otaki S., Kowit P. and Suzuki M., Intra-seasonal change in rainfall in Mae Chaem Watershed, Thailand. *Proc. 5th Inter. Study Conf. GEWEX in Asia and GAME, Nagoya, Japan*, 285-290, 2001.

Matsumoto, J., Seasonal transition of summer rainy season over Indochina and adjacent monsoon region. *Adv. Atmos. Sci*., **14**, 231-245, 1997.

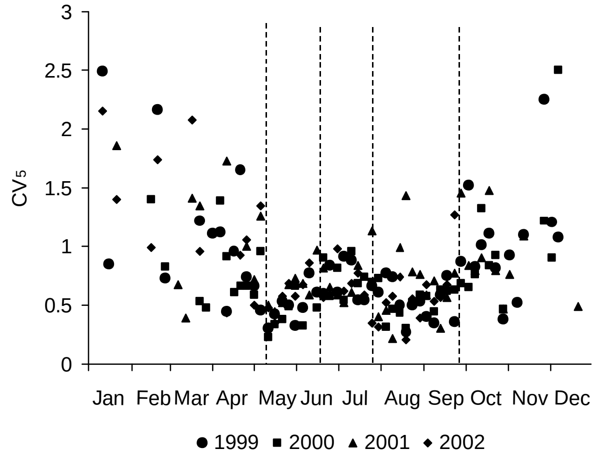

Fig.4: Seasonal variation of the coefficient of variation for 5-day rainfall between 8 sites (CV_5) (1999-2002). The vertical broken lines show the intra-seasonal regime shown in Table. If the number of non-zero 5-day rainfall sites in a pentad was equal to zero, the CV_5 cannot be calculated. If the number of non-zero 5-day rainfall sites in a pentad was equal to one, the CV_5 value (about 2.65 regardless of the rainfall amount) in that pentad was not shown for brevity.

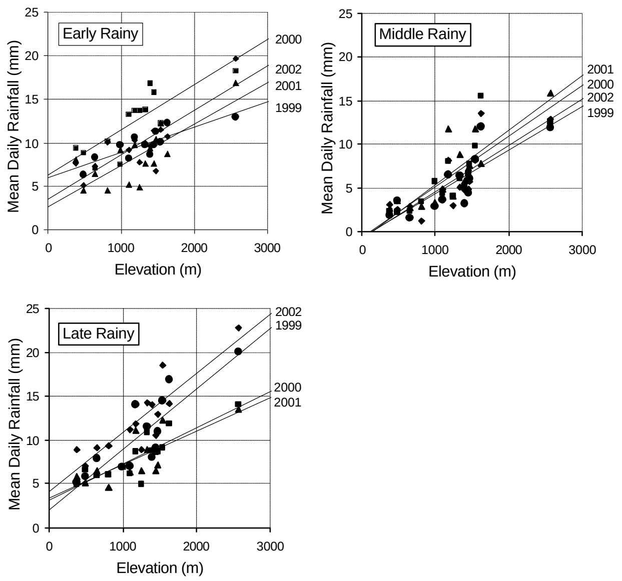

Fig.5: Altitudinal increase in rainfall in early rainy, middle rainy and late rainy season in Mae Chaem watershed for 4 years (1999-2001).