CONCLUSION AND RECOMMENDATION

Conclusion

The study of estimation Evapotranspiration by using remote sense data in paddy field and teak plantation can be concluded as follow :

1. Energy balance and evapotranspiration

1.1 Energy balance

A study of energy balance in Sukhothai paddy field during January 2002 to August 2004 (total 2 years and 8 months) can be concluded that the daily average of solar radiation (Rs) throughout study period was 19.3 MJ m^{-2} day^{-1} while the daily averaged of net radiation (Rn) was 13.2 MJ m^{-2} day^{-1} which was 70.4% of Rs. The average of net radiation and percentage of latent heat (LE), sensible heat (H) and storage in soil and water (Gs, Gw) were averaged at 9.5, 3.0, 0.4 and 0.2 MJ m^{-2} day^{-1} or 72.3, 22.9, 3.1 and 1.7 % of Rn, respectively. The daily average of bowen ratio throughout period was 0.4.

In teak plantation, it can be also concluded that the daily averaged net radiation (Rn) throughout period was 14.8 MJ m^{-2} day^{-1} or 78.2 % of Rs. The Rn was used for LE, H and Gs with value of 10.6, 3.4 and 0.8 MJ m^{-2} day^{-1} or 71.9, 23.2 and 5.5 % of Rn, respectively while bowen ratio was 0.4 throughout study period.

1.2 Evapotranspiration

The daily average of actual evapotranspiration (ET_a) in paddy field during rice planting season was 4.5 mm while the daily averaged of pan evaporation (Epan)

was 4.0 mm. In off planting period, the daily average of ET_a was 3.9 mm while the daily averaged of Epan was 5.1 mm.

The daily average of ET_a in teak plantion during dry season was 3.7 mm while the daily averaged of Epan was 3.9 mm. In rainy season, the daily average of ET_a was 4.1 mm while the daily averaged of Epan was 4.7 mm.

1.3 Estimation ET from general meteorological data

To establish mathematical models for estimating daily actual evapotranspiration for paddy field and teak plantation for particular month, the meteorological factors such as air temperature (Ta), wind speed (Ws), relative humidity (RH) and soil water tension (pF) were employed in the regression analysis. The most suitable models have been selected by possible regression which were presented in Table 32

Table 32 The monthly suitable models for estimation daily ET in paddy field and teak plantation

Months	models	
	Paddy field	Teak plantation
January	$ET_{Jan} = -1.355+1.226WS$	$ET_{Jan} = 10.26-0.365T_a$
February	$ET_{Feb} = 2.811+0.318T_a$	non significant available
March	non significant available	$ET_{Feb} = 4.546-0.039RH$
April	non significant available	non significant available
May	$ET_{May} = 25.537-0.043RH-0.484WS$	$ET_{May} = 9.791-0.054RH-1.353WS$
June	non significant available	$ET_{Jun} = 16.77-0.151RH$
July	$ET_{Jul} = -7.042+0.413T_a$	$ET_{Jul} = -8.905+0.547T_a$
August	$ET_{Aug} = 10.337-0.091RH$	$ET_{Aug} = -13.961+0.637T_a$

Table 32 (Cont.)

Months	models	
	Paddy field	Teak plantation
September	non significant available	$ET_{Sep} = 1.724+0.45T_a-0.091RH$
October	$ET_{Oct} = 20.684-0.18RH$	$ET_{Oct} = -10.501+0.449T_a$
November	$ET_{Nov} = -2.102+0.275T_a$	$ET_{Nov} = 4.947+0.433T_a-0.117RH-0.429WS$
December	$ET_{Dec} = 9.079+0.352T_a-0.176RH$	$ET_{Dec} = 3.963+0.241T_a-0.023RH$

2. Estimation of ET_a by using Remote Sensing data

The application of remote sensing for estimation of ET_a in paddy field and teak plantation had been using satellite images analysis (NOAA/AVHRR) which cover Sukhothai paddy field and Lampang teak plantation in January 2002 to August 2004, in which it was clear sky. Classified the different of data by frequency histogram analysis. And land use types was classified by unsupervised classification method, and plant cover was classified by using NDVI parameter. They can be briefly concluded as follow :

2.1 NDVI

Based on the vegetation index detected from remote sensing data, it implied the changing of crown cover in studied area where AWS installed. Therefore, it could be said that by overall, the NDVI in paddy field ranged from -0.98 to 0.87 with an average of 0.002 while in teak plantation ranged -0.23 to 0.95 with average of 0.36.

2.2 Surface temperature

The surface temperature calculated from remote sensing data implying reflectance of heat near surface with different degrees of skin temperature of crown cover in AWS area, indicated daily average of surface temperature ranged from 22.8 to 31.9 degree of celcious with an average of 26.93 ^{0}C, for the paddy field, while in teak plantation it ranged from 21.9 to 27.7 degree of celcious with an averaged of 24.5 ^{0} C.

2.3 Surface albedo

The surface albedo can be implied to the reflecting of short wave that depending on various surface types, it can concluded that the daily averaged of surface albedo in paddy field ranged from 0.04 to 0.24 % with averaged at 0.13 % while in teak plantation ranged from 0.12 to 0.25 % with averaged at 0.18%.

2.4 Estimation of Evapotranspiration by using remote sensing data

The developed mathematical models of the actual evapotranspiration in paddy field and teak plantation derived from remote sensing data which were detected in the same sites for every few days are shown as follows :

1) Paddy field

The suitable model throughout period was

$$ET = -1.21 + 0.73(NDVI) + 0.19(LST) + 4.02(Sur\_alb) \quad : \quad r^2 = 0.71$$

The suitable model in rice planting season was

$$ET = 3.99 + 0.83(NDVI) + 0.01(LST) + 1.61(Sur\_alb) \quad : \quad r^2 = 0.65$$

The suitable model in off rice planting season was

$$ET = -1.93 + 1.42(NDVI) + 0.2(LST) + 7.44(Sur\_alb) \quad : \quad r^2 = 0.85$$

2) Teak plantation

The suitable model throughout period was

$$ET = -2.87 + 0.18(NDVI) + 0.27(LST) + 0.57(Sur\_alb) \quad : \quad r^2 = 0.41$$

The suitable model in dry season was

$$ET = -4.23 - 0.0004(NDVI) + 0.37(LST) - 5.8(Sur\_alb) \quad : \quad r^2 = 0.60$$

The suitable model in rainy season was

$$ET = 3.7 - 0.60(NDVI) + 0.07(LST) + 4.57(Sur\_alb) \quad : \quad r^2 = 0.64$$

Recommendation

1. From this study

1) There are no significant between meteorological data and ET, owing to .location and distance from meteorological station and AWS, and also slighty error of collecting data. Therefore, not recomment to use meteorological data to develop model for predicting ET_a anymore in the future.

2) The ET_a equation from satellite image data are depending on the resolution of satellite imageries. Some part of image had a variety land use type which occasionally affected a non significant between calculation data and direct measurement.

3) Remote sensing data are useful and regurally measurement could be estimated water vapor flux by using indirect parameters such as NDVI, surface albedo and surface temperature. Therefore further study on this is recommend.

2. For the future study

1) For the future study should select more satellite image data period than this study, in order to be better explain the value in each season throughout the year.

2) The analysis of satellite image found that some part of image had cloud cover therefore, the future study must select the clear sky image for high accuracy in each pixel.

3) In case of use NOAA/AVHRR should be select land use area that have more than 3 square kilometer for avoid incorrect area from resampling technique..

4) Should select another parameter that affect to ET_a for study the relationship between ET_a and another factors from satellite image analysis such as soil moisture and etc.