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Irrigation Efficiency of the Greater Chao Phraya and the Greater Mae Klong Irrigation Projects

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ABSTRACT

The irrigation efficiency of each block of the Greater Chao Phraya Irrigation Project(GCPP) and the Greater Mae Klong Irrigation Project(GMKP) were calculated on both wet and dry season during 1995-1998. GCPP was divided into 18 blocks. Each block in GCPP covered the area of one or more irrigation subproject according to the hydraulic boundary of the irrigation area such that the inflow and the outflow of the block could be measured. GMKP was divided into 10 blocks. Each block in GMKP was the same as the irrigation subproject. The Ei of GCPP varied between 14.6-55.4% with the average value of 39.4%. The Ei of GMKP varied between 24.5-51.0% with the average value of 43.2%. In general, the Ei of GMKP was about 4% higher than that of GCPP. Both GCPP and GMKP used the continuous water delivery with the upstream control practices. The Ei on both GCPP and GMKP varied considerably. Borommthart project on the upper right bank of GCPP had the highest Ei of 63.7% while Pakhai project had the lowest Ei of 13.3%. For GMKP, Song Phi Nong project on the upper left bank had the highest Ei of 66.8% while Thamaka project on the right bank had the lowest Ei of 19.2%. The wet season Ei on both GCPP and GMKP had a linear relationship with the annual rainfall. The dry season Ei was linearly related to the water available at the beginning of the dry season and the irrigated area. Besides, the irrigated area was highly correlated to the available water.

Key words: irrigation efficiency, irrigation, water management, Chao Phraya , Mae Klong

INTRODUCTION

The Greater Chao Phraya and the Greater Mae Klong Irrigation Projects are the two largest and the most important irrigation projects in Thailand. They are located in the central plain. These two projects have the combined irrigation service area of about 1.7 million hectares (10.5 million rais) or about 40% of the total irrigation area of Thailand. The Greater Chao Phraya Irrigation Project (GCPP) is the rice bowl of Thailand while the Greater Mae Klong Irrigation Project (GMKP) is the main sugarcane and sugar producing area of the country.

GCPP has two big multipurpose reservoirs, Bhumiphol and Sirikit, with the combined storage capacity of 22,972 mcm. These two reservoirs supply water to GCPP and for other purposes. Normally, the water is insufficient (Kobayashi *et al*. 1994). They can supply less than half of the GCPP area in the dry season.

GCPP is the largest irrigation project in

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Thailand having the irrigation service area of 7.5 million rai. The main crop on both wet and dry season is paddy. The headworks of GCPP is the Chao Phraya Diversion Dam where water is distributed to 25 irrigation subprojects on both left and right banks. GCPP was first developed in 1957. Most of the canals are unlined. The water is distributed by continuous delivery with upstream control. The irrigation efficiencies in many irrigation subprojects are low. Rehabilitation, modernization and management improvement are needed.

GMKP is the second largest irrigation project area of Thailand having the irrigation service area of 3 million rais. Paddy is cultivated in about two third of the area and about one third cultivating sugarcane. The main source of water for GMKP comes from Srinagarind and Vajiralongkorn multipurpose reservoirs (The old name of Vajiralongkorn is Khao Laem). These two reservoirs have the total combined storage capacity of 26,605 mcm. Mae Klong Diversion Dam is the headworks of GMKP where water is diverted to the left and right main canals and distributed to about 3.0 million rais of the cultivated area in 10 irrigation subprojects. Continuous water delivery with upstream control is the method of water delivery and control practices in GMKP. Most of the canals are relatively new comparing with those of GCPP and most of them are concrete lined to reduce the conveyance losses.

Since GCPP and GMKP are the most important irrigation project of Thailand and these two projects require very large amount of irrigation water annually. It happened quite oftenly that the water is insufficient, particularly for GCPP. Besides, each irrigation project has many hundred kilometers length of the canal. High conveyance losses are usually exist. The irrigation efficiency which is one of the indicators reflecting the performance of irrigation system needs to be studied. The irrigation efficiency is useful for making decision on irrigation management improvement, rehabilitation and modernization of the old irrigation system. Therefore, this study is conducted with the following objectives :

(1) analyze the irrigation efficiency of the GCPP and the GMKP irrigation projects.

(2) determine the factors effecting the irrigation efficiency in both irrigation projects.

MATERIALS AND METHODS

Required data

(1) Maps showing canals, drains, control structures and irrigation system boundaries of the Greater Chao Phraya Irrigation Project (GCPP) and the Greater Mae Klong Irrigation Project (GMKP).

(2) Water allocation data including crop data, agro-climatological data, daily rainfall and daily discharge at the major control structures of both projects during 1995-1998. The water allocation data were collected from 25 irrigation subprojects in GCPP and 10 irrigation subprojects in GMKP.

Methods

(1) The general water allocation and distribution methods of GCPP and GMKP were studied.

(2) The water allocation data including the daily and weekly data were collected. The daily data were the rainfall and discharge at the major control structures. The weekly data were the weekly crop data.

(3) The schematic diagram showing the canal and drainage networks, the irrigation area and the water distribution systems in GCPP and GMKP were drawn. The GCPP was divided into 18 blocks as shown in Figure 1. Each block covered one or more irrigation subprojects according to the hydraulic boundary such that the inflow and the outflow of the block could be measured. For example, the block named **Phollathep-Thaboat** covered 2 irrigation subprojects, Phollathep and Thaboat irrigation subprojects. Ten blocks were located on the right (or west) bank while the other 8 blocks were on the left (or east) bank. The GMKP was divided into 10 blocks as shown in Figure 2.

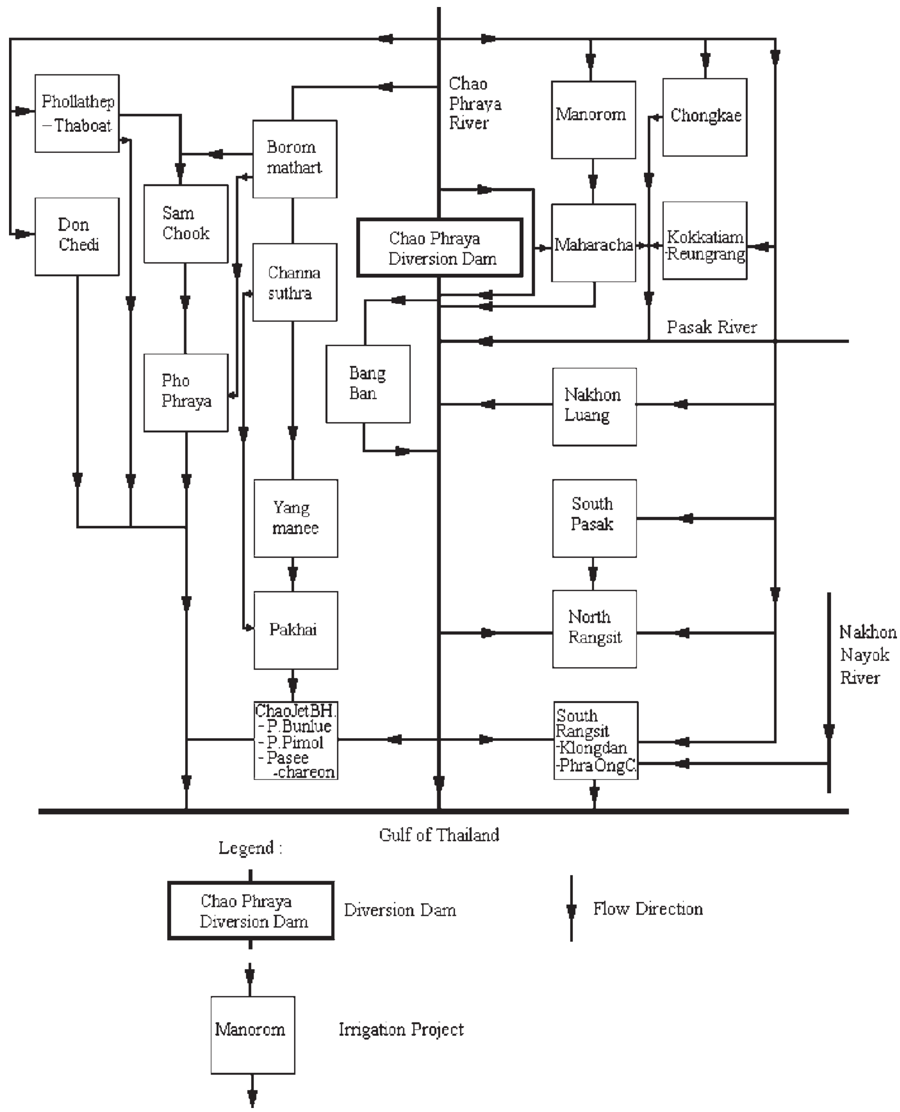


Figure 1 Schematic diagram showing water distribution system of GCPP.

Each block in GMKP was the same as the irrigation subproject. There were 8 irrigation subprojects on the left bank and 2 subprojects on the right bank.

(4) The crop water requirements (ETc = Kc. ETo) and irrigation efficiency for each irrigation subproject of GCPP and GMKP were calculated on weekly basis for both wet and dry season of 1995-1998.

(5) The factors effecting the irrigation efficiency of GCPP and GMKP were analyzed.

Theoretical considerations for irrigation efficiency evaluation

Irrigation Efficiency is usually defined as the percentage of the net irrigation requirement to the gross irrigation supply. In order to determine the irrigation efficiency of any irrigation project or system, the boundary of the irrigation system needs to be defined such that the inflow and outflow of irrigation water can be measured. In most of the irrigation subproject in GCPP and GMKP, there

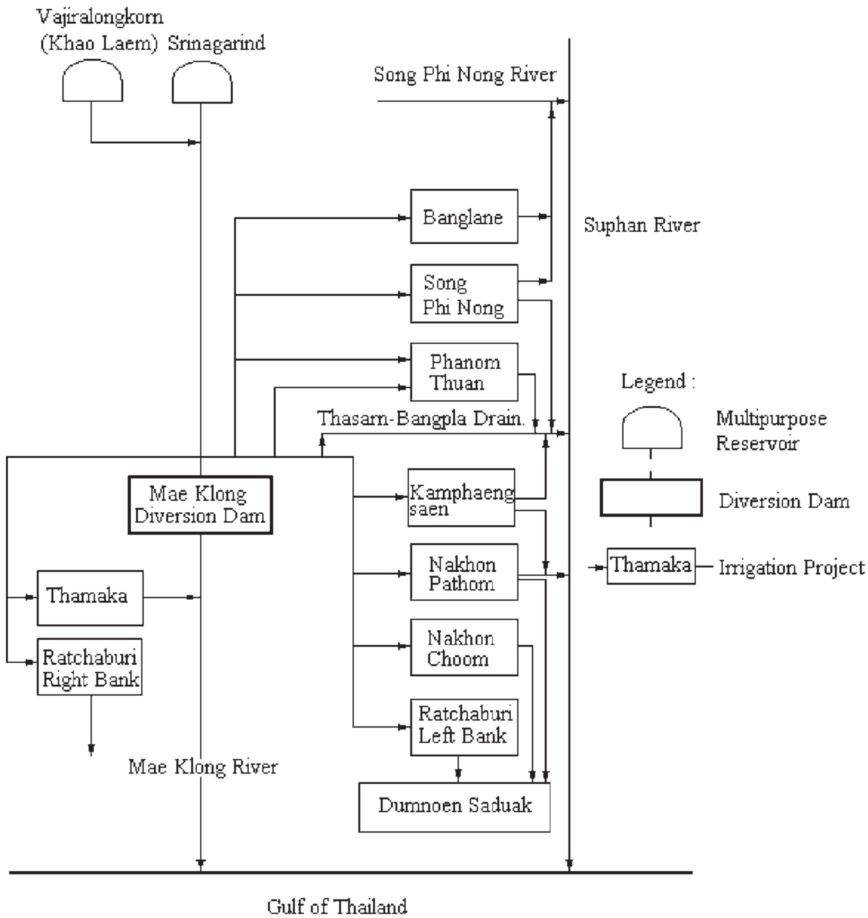


Figure 2 Schematic diagram showing water distribution system of GMKP.

are more than one inflow and outflow points. The gross irrigation supply is calculated from the total inflow minus the total outflow. Kirdpitak (1985) suggested the practical method for calculating the project irrigation efficiency on weekly basis by using the data normally collected by an irrigation project in Thailand. The formula is given below :

$$Ei\ (\%) = 100\,\frac{[ETc + LP + P - Re]}{Q} \quad ...(1)$$

Where Ei = Irrigation efficiency (%)
ETc = Total crop water requirements (cms)
LP = Total land preparation requirements (cms)
P = Total percolation losses (cms)
Re = Total effective rainfall (cms)
Q = Total irrigation supply (cms) which equals to the total inflow minus the total outflow to any irrigation system.

RESULTS AND DISCUSSION

Irrigation efficiency of GCPP

The average of the weekly irrigation efficiency (Ei) of the wet and dry season for 16 blocks out of 18 blocks in GCPP was shown in Figure 3. Since Maharacha and Bang Ban did not have sufficient and reliable data for irrigation efficiency calculation, they were omitted from the analysis. In general, the GCPP Ei varied between

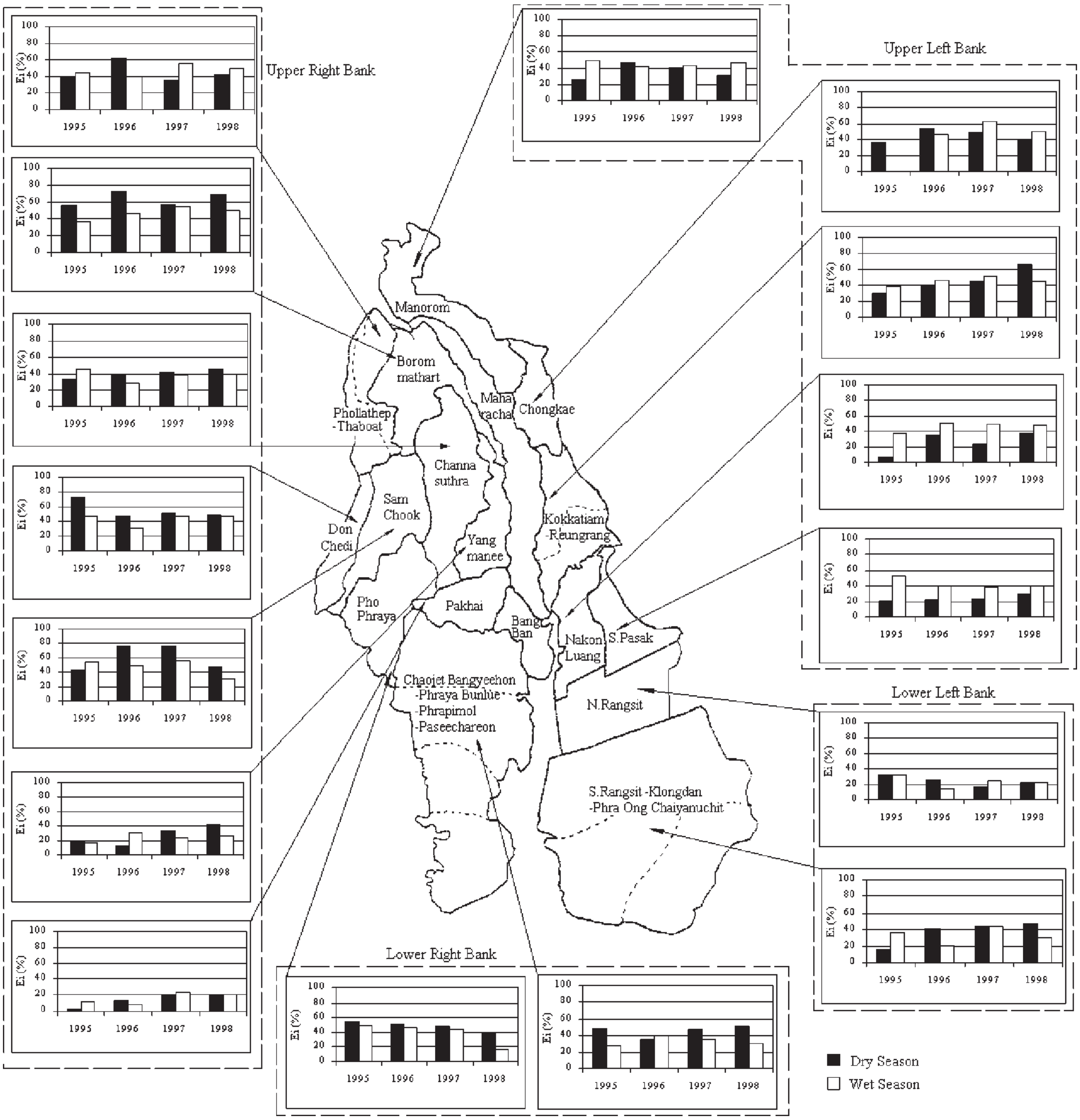


Figure 3 Irrigation efficiency of GCPP.

14.6-55.4% during 1995-1998 with the average value of 39.4%. In dry season, the GCPP Ei varied between 13.3-63.7% during 1995-1998. The 4 year average GCPP Ei was 39.7%. Borommathart irrigation project on the right bank showed the highest Ei of 63.7% while Pakhai irrigation project on the right bank showed the lowest Ei of 13.3%. In wet season, the GCPP Ei varied between 15.8-53.4% during 1995-1998. The 4 year average GCPP Ei was 39.1%, about the same as the dry season Ei.

Seven blocks on the GCPP upper right(or west) bank including Phollathep-Thaboat, Don Chedi, Sam Chook, Borommathart, Channasuthra, Yangmanee and Pakhai taking irrigation water from Makhamtao-U Thong canal, the Suphanburi river and the Noi river had Ei of 43.4% in the dry season and 36.4% in the wet season. On the left (or east) bank , 5 blocks on the upper left bank including Manorom, Chongkae, Kokkatiam-Reungrang, South Pasak and Nakhon Luang had Ei of 35.2% in the dry season and 46.7% in the wet season. Two blocks on the lower left bank including North Rangsit and South Rangsit-Klongdan-Phra Ong Chaiyanuchit had Ei of 30.5% in the dry season and 28% in the wet season.

In general, the right bank Ei (40.7%) was higher than the the left bank Ei (37.6%).

Irrigation efficiency of GMKP

The average of the weekly irrigation efficiency (Ei) of the wet and dry season for each subproject in GMKP was shown in Figure 4. The GMKP Ei varied between 24.5-51.0% during 1995-1998 with the average value of 43.2% which was in the range of the previous study (Vudhivanich *et al.*,2000; Kanoksing *et al.*,2001; AIT,1994). In dry season, the GMKP Ei varied between 29.9-66.8% during 1995-1998. The 4 year average GMKP Ei was 48.4%. Song Phi Nong irrigation project on the upper left bank showed the highest Ei of 66.8%

Figure 4 Irrigation efficiency of GMKP.

while Thamaka irrigation project on the right bank showed the lowest Ei of 29.9%. In wet season, the GMKP Ei varied between 19.2-46.6% during 1995-1998. The 4 year average GMKP Ei was 38.1%, about 10% lower than the dry season Ei. Phanom Thuan irrigation project on the upper left bank showed the highest Ei of 46.6% while Thamaka irrigation project on the right bank showed the lowest Ei of 19.2%. The irrigation project on the left bank had higher Ei than the project on the right bank due to the better canal water distribution system. The irrigation water on the left bank project distributed from main canal to secondary, tertiary and finally to farm land in sequent. On the contrary, some projects on the right bank system distributed water directly from main canal to tertiary system. This made water distribution control difficulty.

Factors effecting Ei of GCPP

The wet season Ei of GCPP had the linear relationship with the annual rainfall with r^2 of 0.9671 as shown in Figure 5. The wet season Ei decreased as the annual rainfall increased. This indicated that the annual rainfall had effect on the wet season Ei. This could be explained as follow. Firstly, as the annual rainfall increased, more water was available to farmers both in term of more effective rainfall in the paddy field and more water available in the Bhumipol and Sirikit reservoirs.

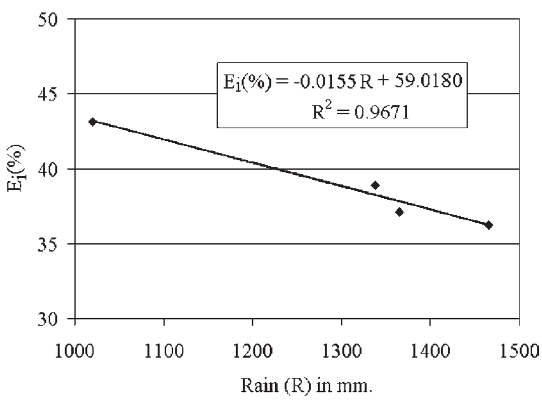
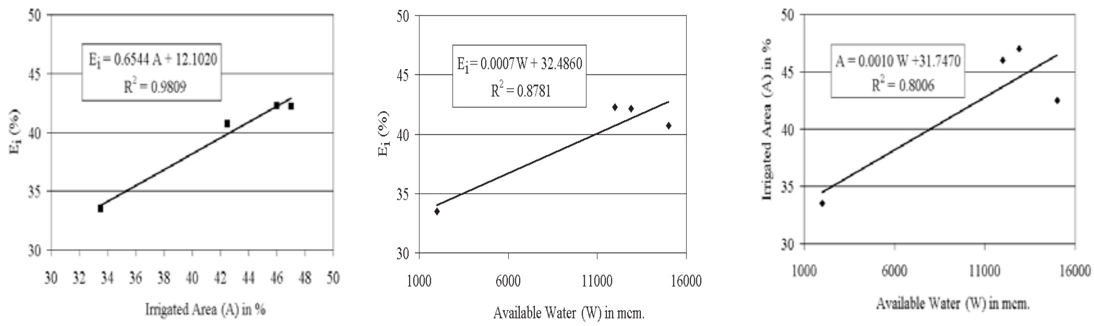


Figure 5 Effect of rainfall on the wet season Ei in GCPP.

Once the farmers and irrigation project staffs realized that water was available. They tended to be more relax on the control and use of irrigation water. The result was the lower efficiency. Secondly, the rainfall had some significant effect on Ei due to the ineffective water delivery and control methods used in GCPP. The GCPP used the upstream control water delivery system by calculating the irrigation water requirements of each canal section on weekly basis. In the calculation, the expected rainfall was estimated. If the actual rainfall was greater than the estimated value. The irrigation water would be used less efficient although each project tries to reduce the irrigation water supply by readjusting the regulators after the rainfall taking place, the water losses were already occurred.

In dry season, the GCPP Ei was linearly related to the water available in Bhumipol and Sirikit reservoirs at the beginning of dry season (W) and the irrigated area (A) as shown in Figure 6. The correlation coefficients (r) among Ei, W and A were higher than 0.9 in general. Dry season Ei was linearly related to A and W with the correlation coefficients (r) of 0.82 and 0.62 respectively. Also the W and A were highly related with r equals to 0.96. The dry season Ei of GMKP was related to A and W in similar manner as the dry season Ei of GCPP in Figure 6. Ei increased as the irrigated area and the amount of water available(W) in the reservoirs at the beginning of the dry season increased. This was due to the fact that when the available water was limited, the irrigation area was decreased. The irrigated area could not be controlled and grouped into one area for effective water distribution. It was spread widely over the irrigation project area. With this situation, high conveyance losses were taking place.

The effect of the annual rainfall, irrigated area and available water on Ei would be useful for improving the irrigation efficiency of GCPP and the irrigation subprojects in GCPP and also for other projects.



Correlation Coefficients

	Irrigation efficiency (Ei) in%	Available water (W) in mcm.	Irrigated area (A) in%
Irrigation Efficiency(Ei) in%	1		
Available Water(W) in mcm.	0.94	1	
Irrigated Area(A) in%	0.99	0.89	1

Figure 6 Effect of irrigated area and the amount of water supply at Chao Phraya diversion dam on dry season Ei in GCPP.

Factors effecting Ei of GMKP

In wet season, Ei decreased as the annual rainfall increases as shown in Figure 7. The annual rainfall was an important factor effecting wet season Ei of GMKP which was the same as the case of GCPP in Figure 5.

In dry season, the situation was different. Ei was related to 2 important factors: the irrigated area and the amount of water available (W) at Mae Klong diversion dam due to the supply from Srinagarind and Khao Laem storage dams as shown in Figure 8.

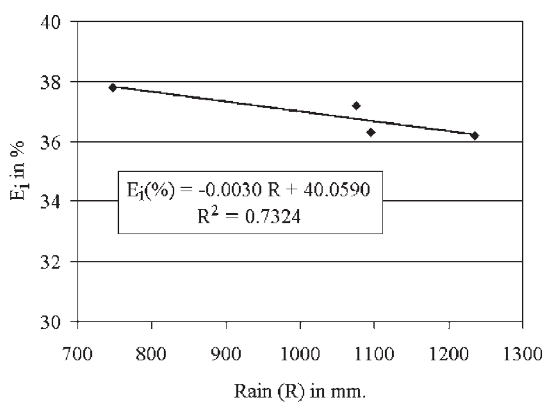
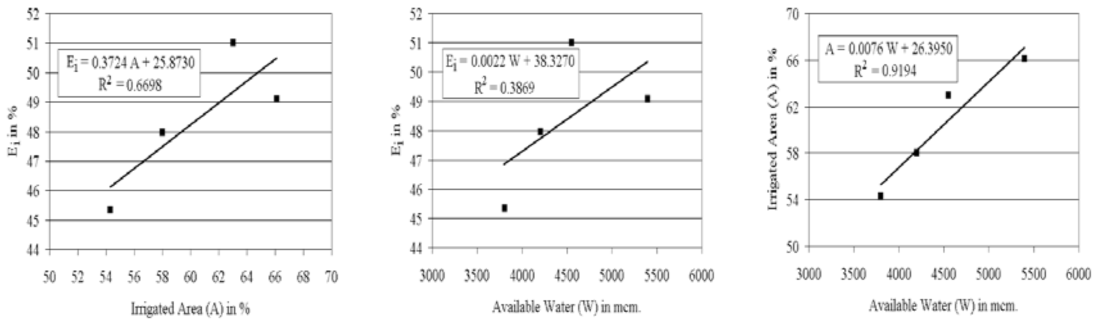


Figure 7 Effect of rainfall on wet season Ei in GMKP.

CONCLUSION

The irrigation efficiencies (Ei) during 1995-1998 varied between 14.6-55.4% with the average value of 39.4% for irrigation block in GCPP and between 24.5-51.0% with the average value of 43.2% for irrigation subproject in GMKP. For GCPP, the Ei on wet and dry season was not different. Borommathart project on the upper right bank showed the highest Ei of 63.7% in dry season while Pakhai project showed the lowest Ei of 13.3%. For GMKP, the dry season Ei was 48.4% on the average which was about 10% higher than the wet season Ei. Song Phi Nong project on the upper left



Correlation Coefficients

	Irrigation efficiency (Ei) in%	Available water (W) in mcm.	Irrigated area (A) in%
Irrigation Efficiency(Ei) in%	1		
Available Water(W) in mcm.	0.62	1	
Irrigated Area(A) in%	0.82	.96	1

Figure 8 Effect of irrigated area and the amount of water supply at Mae Klong diversion dam on dry season Ei in GMKP.

bank showed the highest Ei of 66.8% while Thamaka project on the right bank had the lowest Ei of 19.2%. The analysis showed that Ei of each subproject on GCPP and GMKP varied considerably. The wet season Ei on both GCPP and GMKP had a linear relationship with the annual rainfall while the dry season Ei was linearly related to the water available at the beginning of the dry season and the irrigated area. The irrigated area also was highly correlated to the available water.

The ways to improve Ei on GCPP and GMKP were (1) to develop a practical water allocation strategy to increase the effective use of rainfall in wet season and (2) to control or zone the irrigation area in dry season to reduce the water losses.

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