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PROGRESS REPORT NO. 2

HYDROLOGY OF RAINFED PADDY LAND

A RESEARCH PROJECT

Grant No. 936-5544-G-00-7017-00

H R P L

Submitted by

Amnat Apichatvullop
Acting Project Leader

Water Resources and Environment Institute
Faculty of Engineering
Khon Kaen University

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Project Profile

Country	:	Thailand
Grant No.	:	936-5544-G-00-7017-00
Program	:	U.S.-Israel CDR Program
Project Title	:	Hydrology of Rainfed Paddy Land
Project Leader	:	Sacha Sethaputra
Acting Project Leader	:	Amnat Apichatvullop
Organization	:	Water Resources and Environment Institute Faculty of Engineering Khon Kaen University
Co-investigators	:	Isaac Shainberg Rami Keren
Project Cousultants	:	Charat Mongkolsawat Yongyuth Sukwanachaikul
Authorized Officer	:	Sastri Saowakon Vice Rector for Research Khon Kaen University
Total Project Budget	:	US $ 150,000
Project Duration	:	May 1987 to April 1990
Reporting Period	:	November 1987 - May 1988
Budget Allocation for This Period	:	฿ 1,053,665.50

1. Introduction

Paddy cultivation provides livelihood to the people in many parts of Asia. However, most of the paddy land of Asia is rainfed and only a small percentage is under full irrigation. The rainfed farmers may practice some water control in the paddy land by building bunds to regulate water. This affects the hydraulics and hydrology of the watershed significantly. Moreover, weirs are built on streams to divert streamflow into paddy land for supplementary irrigation during rainless periods in the rainy season. These weirs are built traditionally using timber and earth. Recent development has been to replace traditional weirs by concrete structures. There is a need to understand the hydrology of paddy land in order to plan water resources projects and to efficiently operate them from the watershed point of view. This study intends to develop a hydrologic model for watersheds containing predominantly paddy land.

The project began in May 1987. Five watersheds of varying land use and topography were selected for study. Rainfall, streamflow and ground water were continuously monitored beginning July 1987 (for examples of data, see Table 1). The Israeli collaborators, Drs. I. Shainberg and R. Keren are to assist in developing the infiltration model for the watershed.

2. Objectives for this Period (November 1987 - May 1988)

2.1 Watershed survey

A watershed is to be surveyed for the land use, stream characteristics, water resources facilities, water management practice and social and economic conditions.

2.2 Soil property study

Soil moisture content, matric potential and infiltration characteristics are to be determined.

2.3 Development of mathematical model

A mathematical model of daily water budget in paddy watershed is to be developed.

3. Materials and Methods

3.1 Watershed survey

Ground reconnaissance was carried out using a research assistant. Related secondary data were also collected from government agencies such as the Amphur Office and the Land Department.

3.2 Soil property study

Seventy two soil samples, representing 9 types of soil were collected to determine the moisture content and matric potential. The samples were collected using core samplers and the experiments were carried out by the Department of Soil Science, Faculty of Agriculture. On-Site infiltration experiments were conducted using double-ring infiltrometers.

3.3 Development of mathematical model

A mathematical model of daily water budget was developed. The model is to simulate the streamflow from rainfall and calculate the daily soil moisture in the paddy field receiving supplementary irrigation from weir. The total number of water-stress days suffered by the paddy in the growing season would provide a basis for selecting the desired water allocation within the wateshed.

4. Results

4.1 Watershed survey

See annex 1.

4.2 Soil property study

Results of soil moisture and matric potential experimants have not been reported by the Department of Soil Science at the time this report is being prepared. Typical results of on-site infiltration experiments are shown in Fig. 1. Korat and Roi-Et soils are the two dominant soil series in Northeast Thailand, Korat soil being more sandy.

4.3 Development of mathematical model

See annex 2.

5. Remarks

The emphases in this reporting period have been in-depth survey of watershed, on-site experiments and development of a crude model for daily water budget analysis. As for model development various compoments will need to be investigated in detail. These are rainfall-runoff relationship, water quantity that can be diverted, overland flow from upland into paddy field, irrigation return flow from paddy field, base flow, water distribution and water use efficiency.

One of the Israeli collaborators, Dr. Rami Keren, visited the project from January 5 to 16, 1988. The Israeli soil scientist visited three of the study watersheds. Israeli activities in the project were discussed and outlined (see annex 3). Five Soil Samples are to be sent to Israel for rain simulation experiments. It is tentatively planned to send an Israeli technician to Khon Kaen University to assist in constructing a portable rain simulator.

6. Workplan for the Next Period

6.1 Development of infiltration model
6.2 Development of rainfall-runoff model
6.3 Monitoring of water quantities in a particular subwatershed.

7. References

1) Chuchoke Aryupong (1988) Water Balance Study of Weir Dominated Small Watersheds in Northeast Thailand, Master Thesis, Graduate School, Khon Kaen University (in Thai).

2) Rinfret, J.R. (1985) Diversion Weirs for Small Scale Supplemental Irrigation in Northeast Thailand, Master Thesis, Asian Institute of Technology.

Table 1 Rainfall, Stream Gage and Observation Well Data,
Huai Yang Watershed Amphur Nong Bua Lampu Udon Thani

Date	Rainfall (mm.)		Stream Gage (m.above datum)		Observation Well (m.below surface)		
	station PT_1	station PS_1	station S_1	station S_2	station G_1	station G_2	station G_3
1 Oct.1987	1.50	30.00	1.53	1.41	1.80	0.37	0.34
2	7.00	0	1.53	1.41	1.79	0.34	0.24
3	22.00	41.00	1.60	1.46	1.75	0.32	0.13
4	1.00	0	1.72	1.54	1.75	0.32	0.14
5	26.50	0	1.78	1.65	1.75	0.36	0.15
6	1.00	0	1.90	1.69	1.75	0.39	0.27
7	0.00	0	1.86	1.65	1.75	0.40	0.33
8	9.00	15.00	1.83	1.65	1.75	0.40	0.33
9	1.50	0	1.72	1.57	1.75	0.40	0.33
10	2.00	0	1.62	1.53	1.75	0.40	0.33
11	0.50	0	1.53	1.46	1.75	0.40	0.43
12	0.00	0	1.52	1.46	1.75	0.46	0.49
13	2.50	0	1.45	1.41	1.75	0.49	0.53
14	0.00	0	1.43	1.39	1.75	0.52	0.56
15	3.00	0	1.40	1.37	1.75	0.54	0.59
16	0.00	0	1.39	1.35	1.70	0.60	0.62
17	0.00	0	1.36	1.34	1.71	0.62	0.64
18	0.00	0	1.35	1.35	1.71	0.62	0.64
19	0.00	0	1.37	1.35	1.71	0.63	0.69
20	0.00	40.00	1.35	1.34	1.71	0.64	0.70
21	0.00	0	1.39	1.33	1.71	0.65	0.69
22	3.20	21.40	1.50	1.32	1.71	0.65	0.59
23	5.00	0	1.43	1.37	1.71	0.51	0.51
24	0.00	0	1.40	1.36	1.71	0.52	0.52
25	0.00	0	1.10	1.31	1.71	0.52	0.59
26	0.00	0	1.37	1.32	1.71	0.54	0.60
27	0.00	0	1.37	1.32	1.71	0.54	0.62
28	0.00	0	1.37	1.35	1.71	0.56	0.65
29	0.00	0	1.37	1.38	1.71	0.60	0.69
30	0.00	0	1.36	1.38	1.71	0.60	0.69
31	0.00	0	1.38	1.40	1.71	0.62	0.72
Total	85.70						

Table 1 Rainfall, Stream Gage and Observation Well Data,
Huai Yang Watershed Amphur Nong Bua Lampu Udon Thani

Date	Rainfall (mm.)		Stream Gage (m.above datum)		Observation Well (m.below surface)		
	station PT_1	station PS_1	station S_1	station S_2	station G_1	station G_2	station G_3
1 Nov.1987	0.00	0	1.40	1.42	1.71	0.64	0.74
2	0.00	0	1.39	1.40	1.71	0.65	0.75
3	4.30	0	1.39	1.40	1.75	0.67	0.77
4	0.00	0	1.37	1.35	1.75	0.68	0.78
5	0.00	0	1.37	1.30	1.75	0.68	0.80
6	0.00	0	1.37	1.30	1.75	0.68	0.80
7	0.00	0	1.37	1.30	1.70	0.00	0.80
8	0.00	0	1.37	1.30	1.70	0.00	0.80
9	0.00	0	1.37	1.30	1.70	0.00	0.80
10	0.00	0	1.37	1.30	1.70	0.00	0.82
11	0.00	0	1.37	1.29	1.70	0.00	0.83
12	0.00	0	1.37	1.29	1.70	0.00	0.83
13	19.00	0	1.38	1.29	1.70	0.00	0.87
14	0.50	5.50	1.37	1.29	1.70	0.00	0.89
15	0.00	6.00	1.37	1.30	1.70	0.00	0.92
16	0.00	0	1.37	1.31	1.70	0.00	0.92
17	0.00	0	1.39	1.34	1.70	0.00	0.93
18	9.50	3.00	1.44	1.40	1.70	0.00	0.93
19	0.00	0	1.47	1.40	1.70	0.00	0.94
20	0.00	0	1.48	1.40	1.70	0.00	0.94
21	0.00	0	1.51	1.40	1.70	0.00	0.94
22	0.00	0	1.50	1.41	1.70	0.00	0.94
23	0.00	0	1.44	1.41	1.70	0.00	0.94
24	0.00	0	1.39	1.39	1.70	0.00	0.95
25	0.00	0	1.39	1.35	1.70	0.00	0.96
26	0.00	0	1.39	1.34	1.70	0.00	0.96
27	0.00	0	1.39	1.34	1.70	0.00	0.97
28	0.00	0	1.39	1.34	1.70	0.00	0.97
29	0.00	0	1.37	1.34	1.70	0.00	0.99
30	0.00	0	1.33	1.33	1.70	0.00	1.00
Total	33.30						

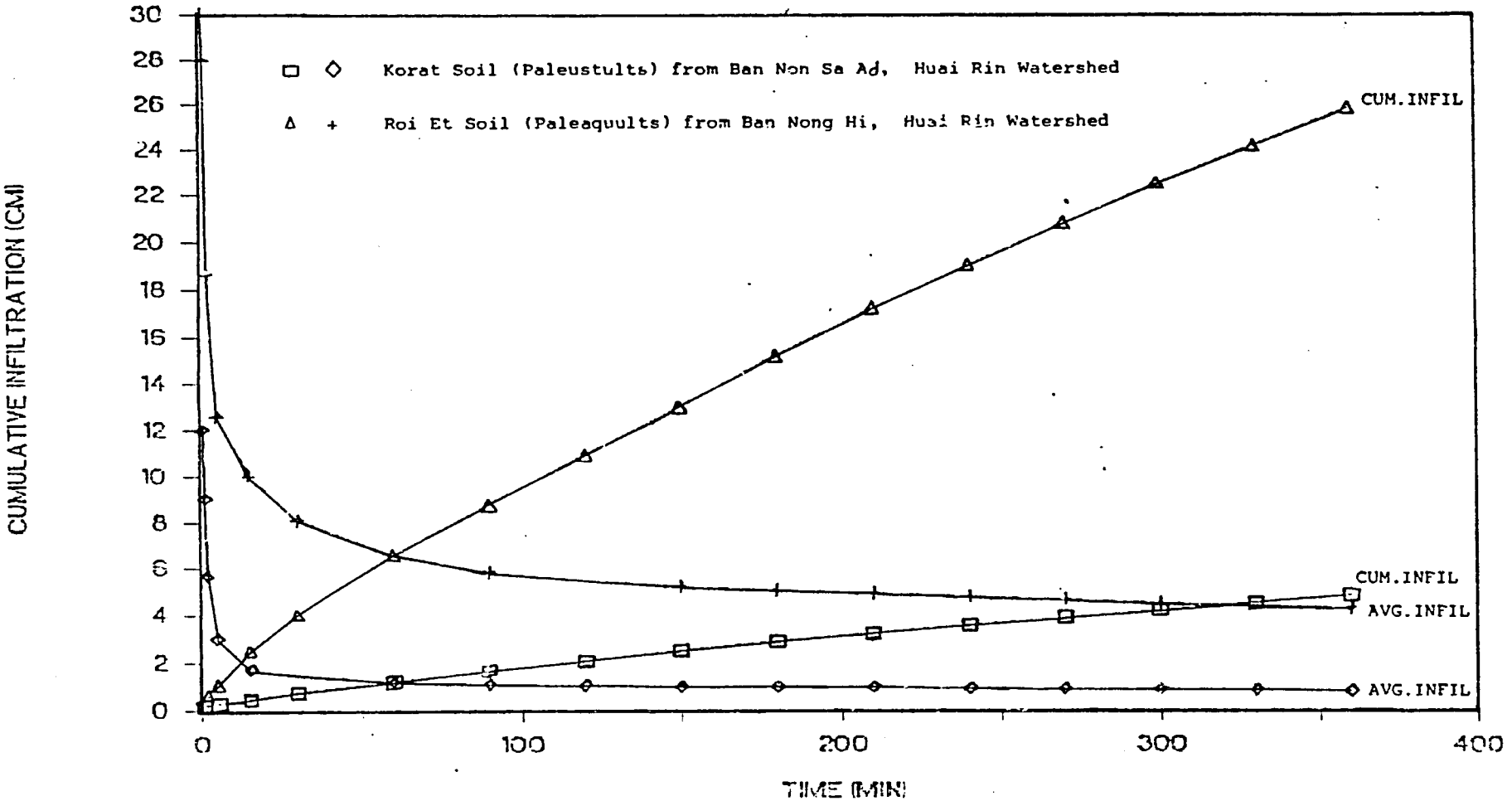

Fig. 1 Typical Infiltration Characteristics of Upland Soils

Annex 1

Reconnaissance Survey of Huai Yang Watershed

Reconnaissance Survey of

Huai Yang Watershed

Water Resources and Environment Institute

Faculty of Engineering

Khon Kaen University

February 1988

Abstract

A ground reconnaissance survey of the Huai Yang watershed in Amphur Nong Bua Lampu, Udornthani, was conducted by Mr. Suvit Boonthithaisong, during the period 5-20 February, 1988. The purpose of the survey is to gather information on physical characteristics of the watershed, land use, water resources facilities, water management practice, and economic conditions.

The Huai Yang watershed has an area of about 47,000 rai (75 sq.km.). The terrain is gently undulating. There are about 35,000 rai of paddy land and 6000 rai of upland. The watershed can be divided into two parts: the upper watershed where the streams are shallow and not so distinct and the lower watershed where the streams are deeper. Private earth weirs with water control gates are numerous and scattered along the streams. Farmers have good knowledge of surface water harvesting and practice efficient water management at least for supplementary irrigation for paddy.

Introduction

This document reports some activities of the project "Hydrology of Rainfed Paddy Land." The activities are field data collection and land and water use assessment. A ground reconnaissance survey of the Huai Yang watershed (for location see map in Fig.1 and 2) in Amphur Nong Bua Lampu, Udornthani, was conducted by Mr. Suvit Boonthithaisong. The purpose of the survey is to gather relevant information on the watershed. These are the physical characteristics such as stream dimensions, land use, water resources facilities, water management practice, social and economic conditions. In addition, other related secondary data are also collected from agencies such as the Amphur Office and the Land Department.

General Description of the Area

The Huai Yang stream is a tributary of the Lam Paniang which drains into the Pong river. The length of the stream is about 16 km. and the drainage area is about 47,000 (75 sq.km.) Most of the land is alluvial plain with some high ground and small hills. There are about 35,000 rai of paddy land and 6000 rai of upland, the remaining area is light forest land (see Fig.3).

There are 8 villages in the area namely: Ban None Khun, Ban Na Loeng, Ban Soke Pladuk, Ban None Khamin, Ban Pek Fuei, Ban Nong Pam, Ban Nong Wa Noi and Ban Nong Wa Yai. The number of households is 1250 and the population is 12,000. Villagers make a living by growing paddy and other upland crops such as cassava and kenaf. In the dry season some villagers do vegetable gardening. Some migrate to other regions to find employment. These villages are about 50-60 years old. Villagers were originally from Maha Sarakam or Roi-Et.

Physical Characteristics of the Huai Yang

Huai Yang and its tributaries originated from the low hill areas of Ban None Khun and Ban Na Loeng. The streams flow in an easterly direction. The water courses can be divided into two parts. From their origins to the confluence the streams are not distinct and quite shallow at most places averaging about 0.6 m. deep and 6 m. wide and dry up most of the time (see Fig.4). The streams are literally private properties. Downstream of the confluence the stream become more distinct, having average dimensions of 2 m. deep and 10 m. wide. This lower part of the stream has some water almost year round except for some very dry summer months (see Fig.5).

Water Resources Facilities

1. Reservoirs

There are 4 reservoirs in the watershed:

- Fai Mai reservoir at Ban Pek Fuei, of dimensions 200 x 350 m and average depth 3.50 m, built in 1985 under the Rural Job Creation Program (Kor Sor Chor).
- Ban None Khun reservoir, of dimensions 100 x 150 m and average depth 3 m., built in 1982 by the Accelerated Rural Development Department.
- Ban None Khamin reservoir, of dimensions 350 m. semicircular and 3 m. deep, built in 1984 under the Kor Sor Chor. The spillway is severely damaged.
- Ban Na Loeng reservoir, of dimensions 90 m x 150 m with depth 2.50 m., built in 1983 under the Kor Sor Chor.

All the reservoirs have no water control structures. They provide water for livestock and for fishery. There are some vegetable gardening near the reservoirs, but just for household consumption.

2. Concrete weirs

There are two concrete weirs on the stream:

- Ban Nong Wa Noi weir, of crestlength 13 m. and height 2.50 m., built in 1985 under the Kor Sor Chor, service area 400 rai (supplementary irrigation).
- Ban Nong Pam weir, of crestlength 10 m. and height 2.50 m., also built in 1985 under the Kor Sor Chor, service area 100 rai.

3. Earth weirs

There are a large number of privately owned earth weirs on the streams, mostly on the tributaries. By ground reconnaissance and interviewing farmers the number of earth weirs was estimated at 180. These earth weirs usually have concrete-lined channels and stoplogs for controlling water (see Fig.6). Farmers use them for several purposes: water control for supplemental irrigation, fishery, storing water for livestock and vegatable gardening. They fail every year and farmers have to take great care in operating and maintaining them during the rainy season.

Water Management

1. Irrigation for paddy

At the beginning of the rainy season (early May) farmers who own land adjacent to streams will insert the stoplogs in the weirs to impound water for the paddy nursery and land preparation. Before transplanting the paddy, farmers have to drain some water from the field. When the paddy settles and begins to grow again water level in the field will be raised again. From then on water level in the field has to be regulated continuously. When the grains begin to mature water has to be drained from the field. Usually there will always be someone tending the paddy field. This person will operate the stoplogs as needed.

2. Dry season water use

Before the end of the rainy season farmers will put all stoplogs in to impound water in the stream behind the weirs. This water will be used for vegetable gardening and fishery. Most households grow vegetables (cucumber, long beans, cabbage, chilli, etc.) for their own consumption. Only a small number of farmers grow vegetables for the local markets. For the upper part of the streams farmers dig small wells or water holes in the streambed to trap water for vegetable gardening.

For fishery farmers who have their own weirs will excavate fish pond of size about 10 m x 7 m and 2 m deep, upstream of their weirs. Fish are usually left to find their own food. Water from the 4 reservoirs is also used for the nearby fish ponds.

3. Water management among facilities

There seem to be some accepted rules in operating the earth weirs that are in series. In filling the weirs, the upstream farmers will impound as much water as they need before releasing to the weirs further downstream. In the event of excessive streamflow or flooding, upstream farmers will notify downstream farmers before releasing excessive water. This is extremely important during transplant because the young paddy can be easily damaged. Also during the ripening of the grains water must be gradually drained from the field because downstream field may be harvesting.

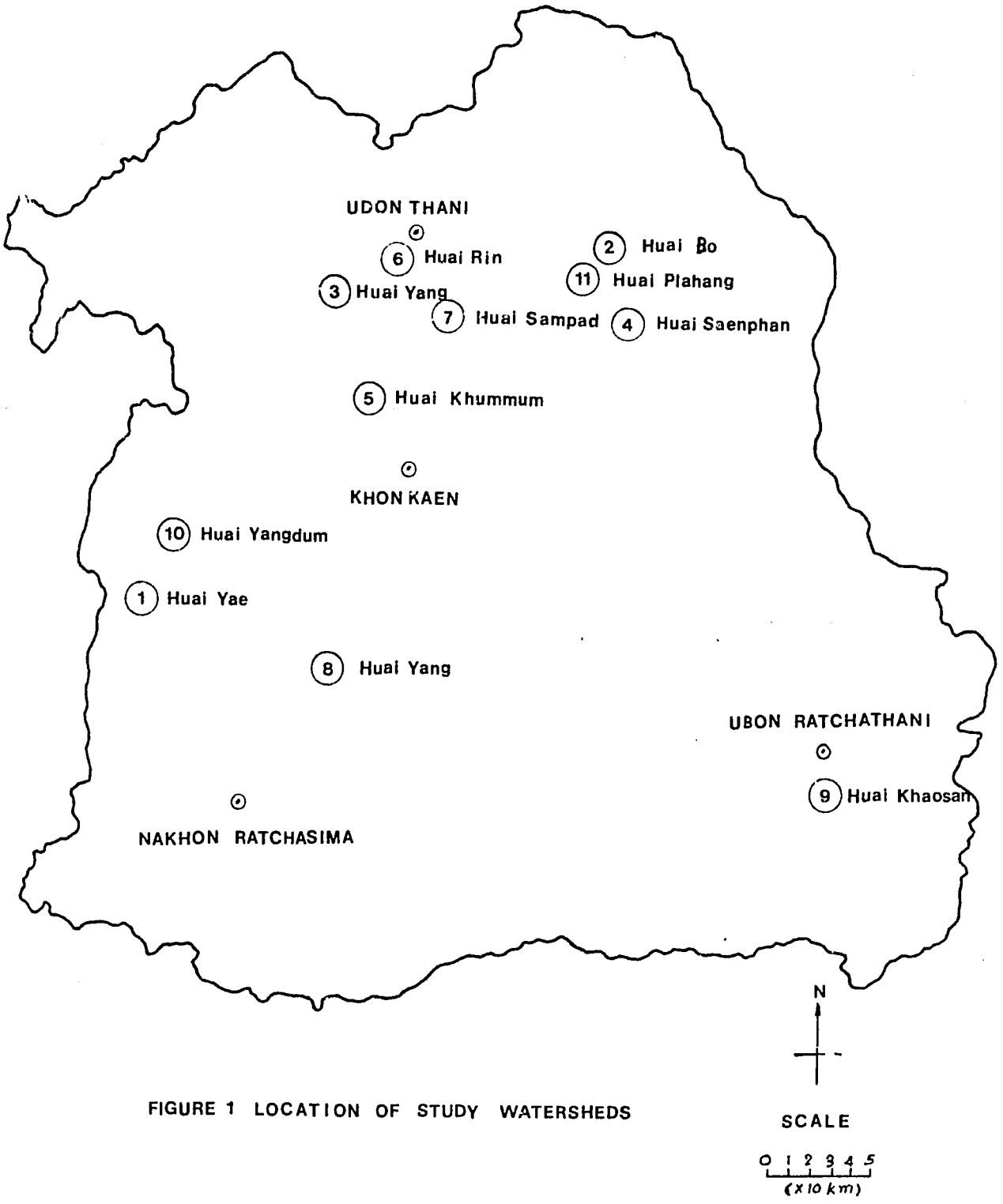

FIGURE 1 LOCATION OF STUDY WATERSHEDS

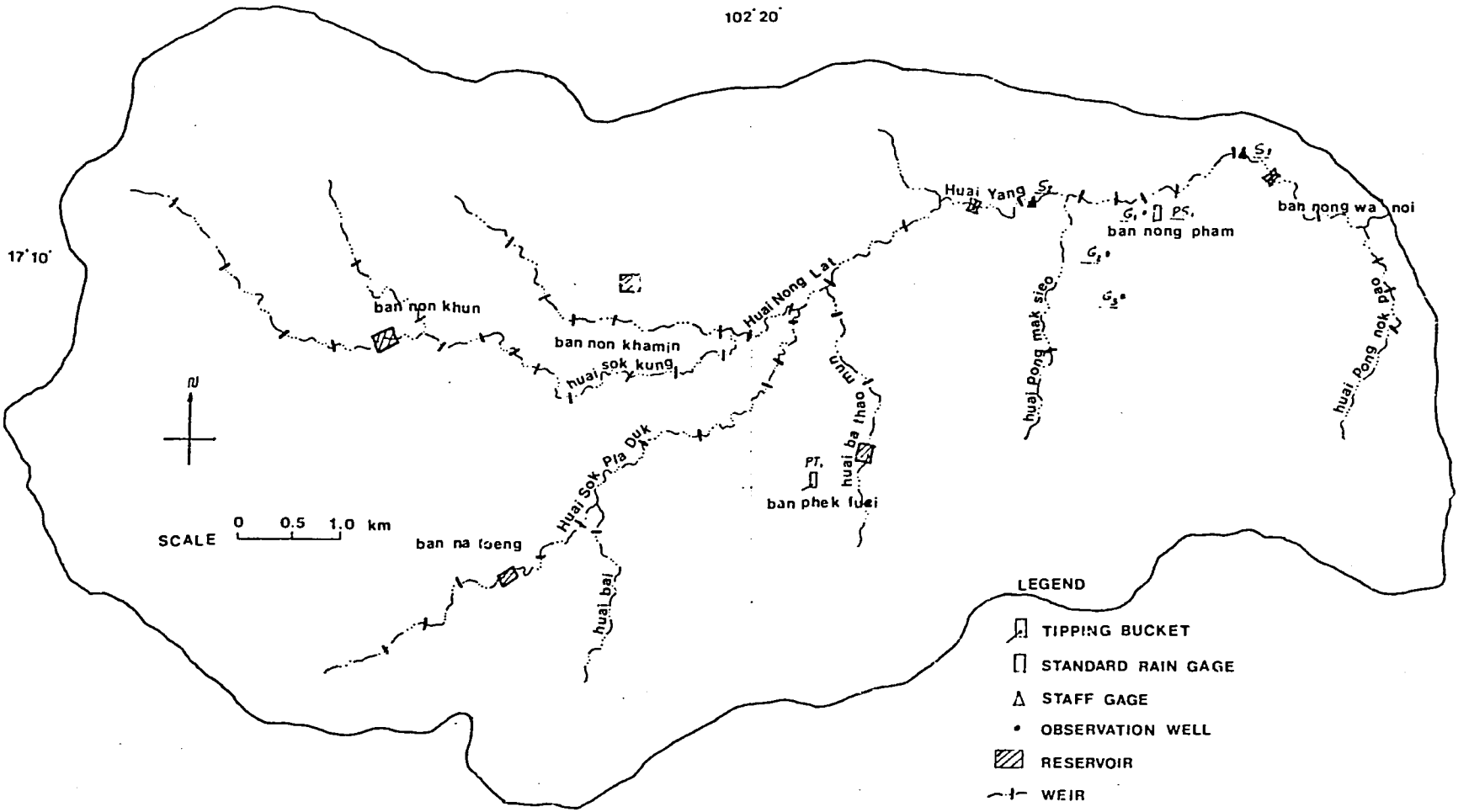

FIGURE 2 HUAI YANG WATERSHED

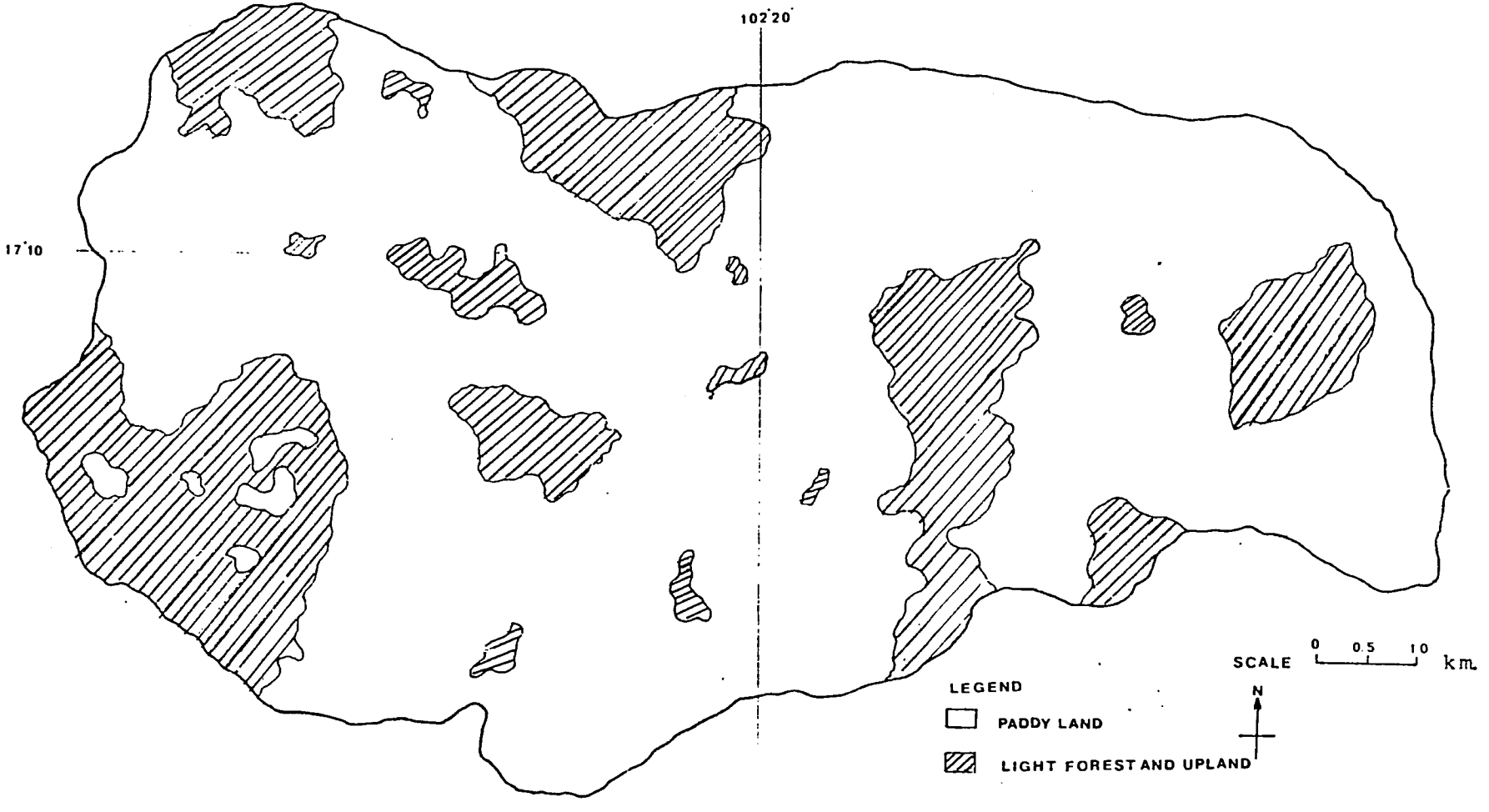

FIGURE 3 LAND USE , Huai Yang Watershed

Fig.4 Upper Part of Huai Yang

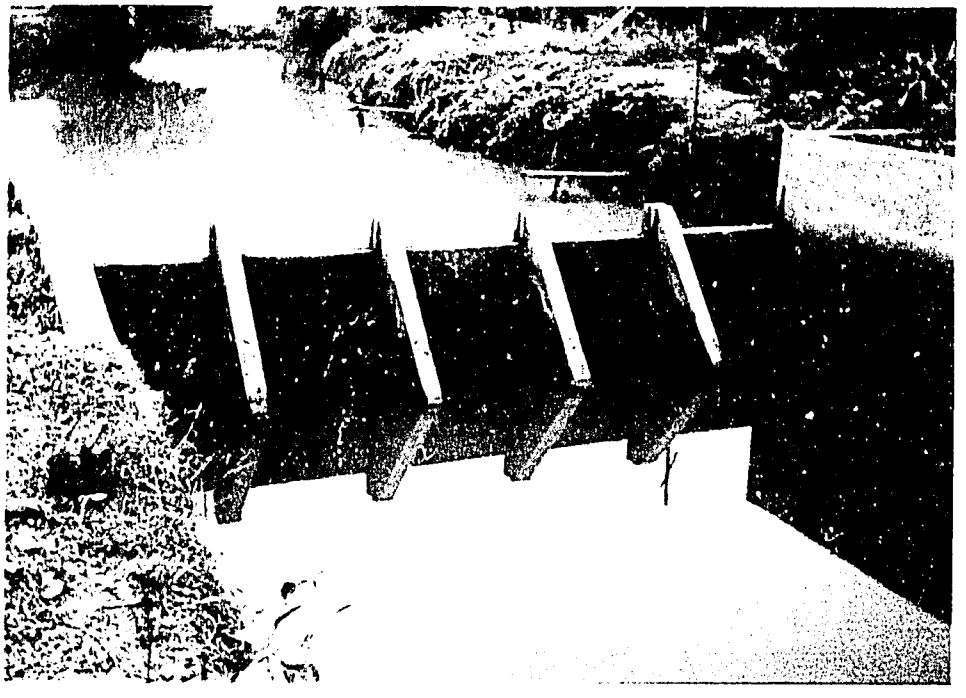

Fig.5 A Concrete Weir in the Lower Part of Huai Yang

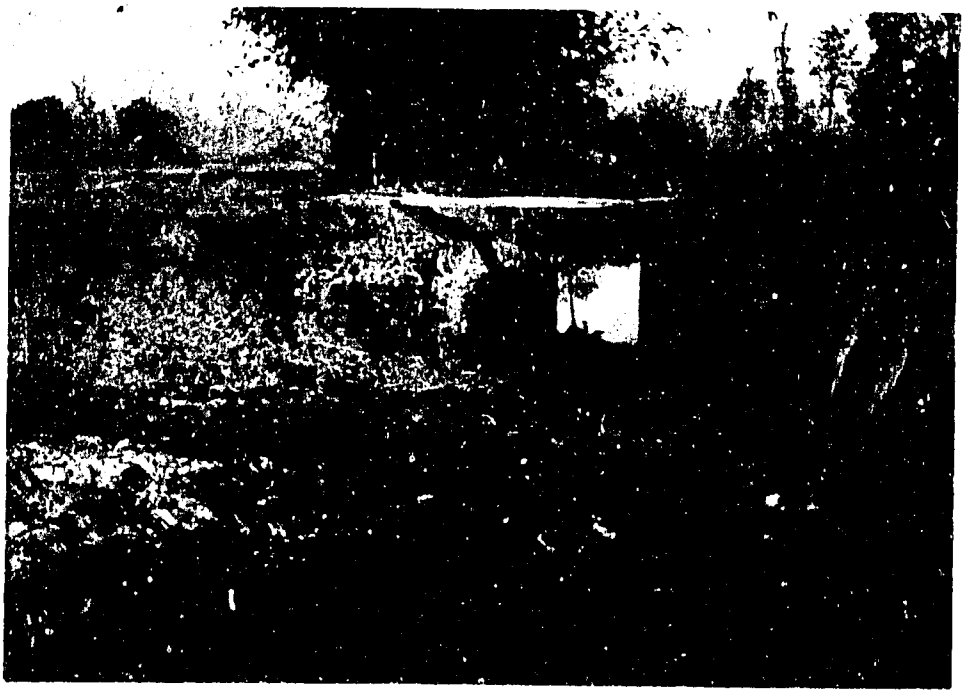

Fig.6 Earth Weir with Concrete-Lined Channel

Annex 2

Allocation of Water in a Small Watershed

Allocation of Water in a Small Watershed

Chuchoke Aryupong

Amnat Apichatvullop

Paper presented at Seminar on
Crop Production in Problem Soils in Northeast Thailand

May 23 - 27, 1988

Agricultural Development Research Center

Khon Kaen

Allocation of Water in a Small Watershed

Chuchoke Aryupong[1]
Amnat Apichatvullop[2]

Abstract

At present the Royal Thai Government is accelerating the development of the Northeast, especially in water resources. The number of small water resources projects such as weirs and small reservoirs (usually for supplementary irrigation of wet season paddy) is increasing very rapidly. This rapid increase could result in competition for water among adjacent projects in the near future. To prevent such a problem, an overall water allocation to all the potential projects within a watershed is called for. This paper presents a model capable of simulating the total watershed performance for a given number of weir projects in the watershed. For a development scenario the model simulates streamflow from rainfall using an SCS approach and calculates the daily soil moisture in the paddy field served by every weir project. The total number of water-stress days experienced by the paddy would provide a basis for selecting the desired development scenario.

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[1] Master's Student, Water Resources Engineering Program, Khon Kaen University
[2] Lecturer, Faculty of Engineering, Khon Kaen University

Introduction

Agricultural land use in the Northeast is the most extensive in all of Thailand. Of the 106 million rai of land, 62 million rai is being used for agricultural production.[1] Such extensive agriculture requires a lot of water. However, the region is a plateau with mostly undulating terrain which makes it uneconomical to provide irrigation by building large reservoirs and distribution systems. It is estimated that 80 % of area of the Northeast will have to rely on small water resources projects such as weirs and small reservoirs.[2]

The Royal Thai Government has given high priority to small scale water resources projects in the Northeast for the last ten years. At present there are about 10,000 such projects in the region and the number is still increasing.[3]

As for small weirs, they are used primarily for diverting streamflow into paddy land to supplement the rain during wet season paddy cultivation (only one crop of rice per year is possible for area served by a weir). As the number of projects increases, they will have to compete for the limited streamflow. This would effectively reduce the service area of a weir project, resulting in low economic returns. Incidences of water use conflict among adjacent projects have been reported in northern Thailand.[4] To prevent such a problem, a careful planning of weir projects over the entire watershed is required. This paper present a simple model which is capable of simulating the water use condition for a given development scenario.

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(1) 1985's figure from Thailand Natural Resources Profile, Thailand Development Research Institute. 1987.

(2) Water for the Northeast, AIT. 1978.

(3) Potential for Small Weir and Reservoir Development in the Northeast, Pattamathamkul and Wirojanagud, 1987.

(4) Tankimyong, U., 1986, personal communication.

Land use and the weir project

The land use in a watershed may be categorized into 3 types : forest land, upland and paddy land. From the viewpoint of harvesting surface water, forest land and upland are runoff contributive areas while paddy land stores the rain and intercepts runoff from higher area.

Most weir projects are intended to provide supplementary irrigation for wet season paddy. Usually only a small area of paddy land adjacent to the weir can be served by each weir. An average of 400 rai service area has been observed. The rest of the paddy land and all the upland are rainfed. This study only considers wet season water use by the service area of each weir.

Hydrology of the watershed

We shall confine our study to small watersheds of size around 100 square kilometers. A watershed can be divided into subwatersheds, each contains a weir through which all the water within it drains (see Fig. 1). That is, given a weir to be located at a particular site, we can draw the subwatershed boundary.

For a subwatershed as shown in Fig. 2, the runoff resulting from a given rainfall onto the subwatershed can be computed using the model developed by Noparit (1986) which was adapted from the SCS model (1964).

Water balance in paddy land

Water budget analysis within the service area (see Fig. 3) of the subwatershed can be carried out using the water balance equation:

$$(I_t + P_t - ET_t - O_t - L_t)\Delta t = A(h_{t+1} - h_t)$$

where I_t = rate of diversion from the weir

P_t = rate of rain fall over the service area

ET_t = rate of evapotranspiration of the paddy

O_t = rate of spill and outflow from the service area

L_t = rate of seepage and percolation from the service area

$\triangle t$ = time period under consideration(usually 1 day)

A = size of service area

h_{t+1} = soil moisture, expressed in depth over service area at time $t + \triangle t$

h_t = soil moisture at time t

The day-to-day soil moisture can be calculated from:

$$h_{t+1} = h_t + P_t - ET_t - L_t + \frac{I_t}{A} - \frac{O_t}{A}$$

Calculation of related water quantities

P_t is an input daily rainfall at the weir site or nearby weather station

ET_t is calculated using the pan evaporation method together with the coefficients proposed by Doorenbos and Pruitt (1977):

$$ET_t = \begin{cases} k_c \cdot k_p \cdot E_{pan} & \text{if } h_t \geq h_{sat} \text{ (saturated soil moisture)} \\ \dfrac{h_t - 0.2\, h_{sat}}{0.75\, h_{sat} - 0.2\, h_{sat}} \cdot k_c \cdot k_p \cdot E_{pan} & \text{if } 0.2\, h_{sat} \leq h_t \leq 0.75\, h_{sat} \\ 0 & \text{if } h_t \leq 0.2\, h_{sat} \end{cases}$$

Lt, for soils in the Northeast, Adhikary (1979) suggested a value of 3 mm/day when there is standing water, therefore Lt can be calculated as follows

$$L_t = \begin{cases} 3 \text{ mm} & \text{if } h_t \geq h_{sat} \\ 3 \cdot \dfrac{h_t - h_{fc}}{h_{sat} - h_{fc}} & \text{if } h_{fc} \leq h_t \leq h_{sat}, \quad h_{fc} = \text{soil moisture at field capacity} \\ 0 & \text{if } h_t \leq h_{fc} \end{cases}$$

I_t is calculated from the streamflow and water level.

O_t is the excess of soil moisture over 150 mm. + saturated soil moisture.

Application of the model

The model is tested using the Huai Yang Watershed in Amphur Nong Bua Lampu, Udornthani. It has an area of 75 sq.km. (47000 rai) of which 35000 rai is paddy land, 6000 rai upland. The remaining area is light wooded area. There are two concrete weirs (see Fig. 4) and a lot of earth weirs which are privately owned.

Daily soil moisture is calculated beginning May 1, but transplanting of the paddy will not take place until soil moisture reaches 200 mm. (40 mm. standing water, the soil having a moisture capacity of 160 mm). Calculation of soil moisture will proceed until the paddy is harvested, i.e. 120 days after transplant. Days on which soil moisture is below a recommended value are called water-stress days. The number of water-stress days experienced by the crop can be related to the crop yield, or it can be used directly as an index for project performance. By simulating for a long period, say 30 years, and averaging this index, the result can be used as a basis for selecting the appropriate number of weir projects and their location.

Fig. 5 shows the longterm average number of water-stress days as a function of number of weir projects. It can be concluded that to avoid conflicting water use among weir projects, Huai Yang watershed should not have more than 7 weir projects.

Conclusion

The need for an overall watershed planning for water allocation and weir project siting is becoming more urgent as more and more weirs are constructed each year. This paper presented a simulation model capable of producing results which will be useful for planning of weir projects in a watershed. The model can simulate the performance of the entire watershed for a given number of weirs.

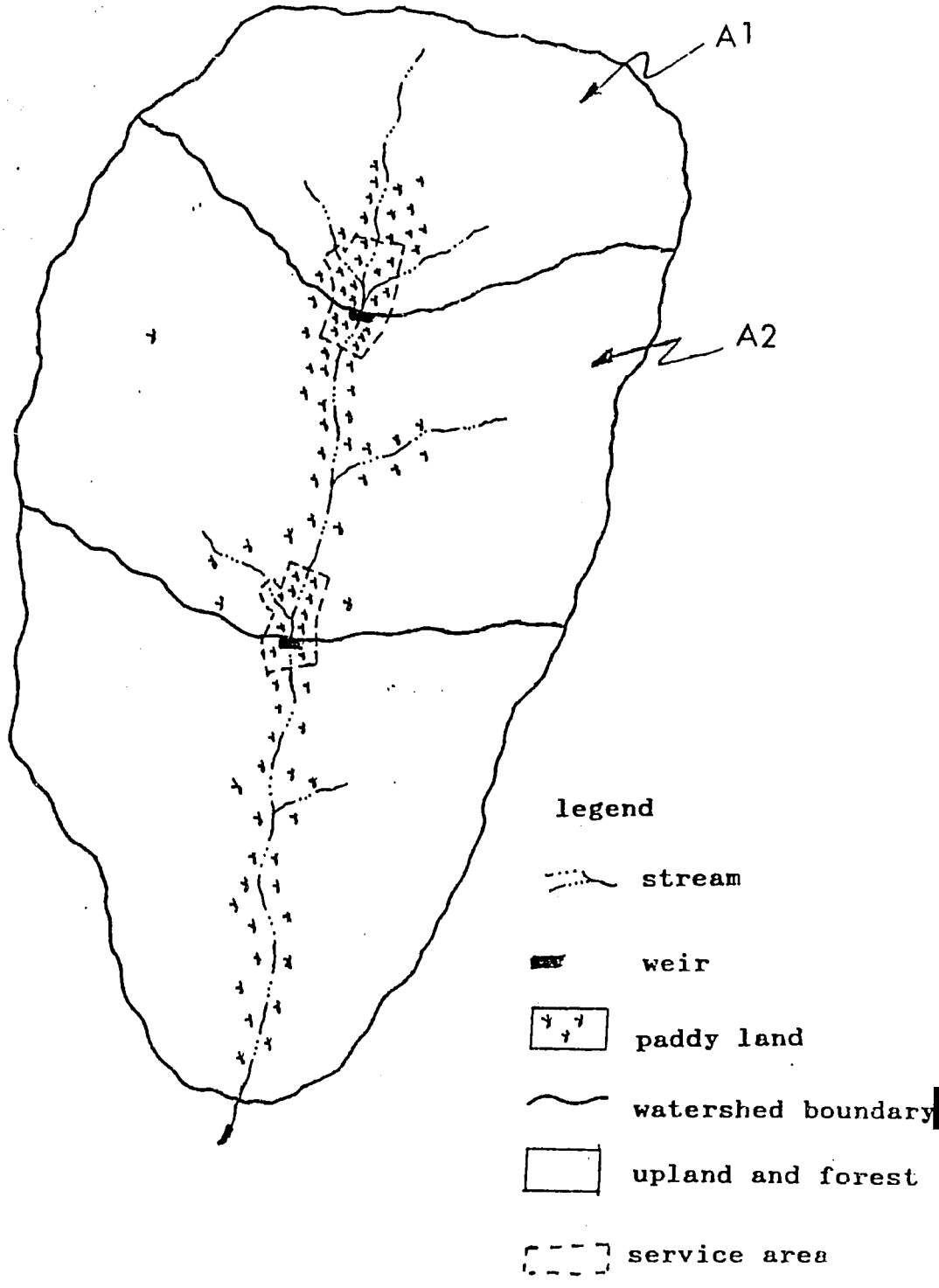

Fig.1 Definition of subwatershed

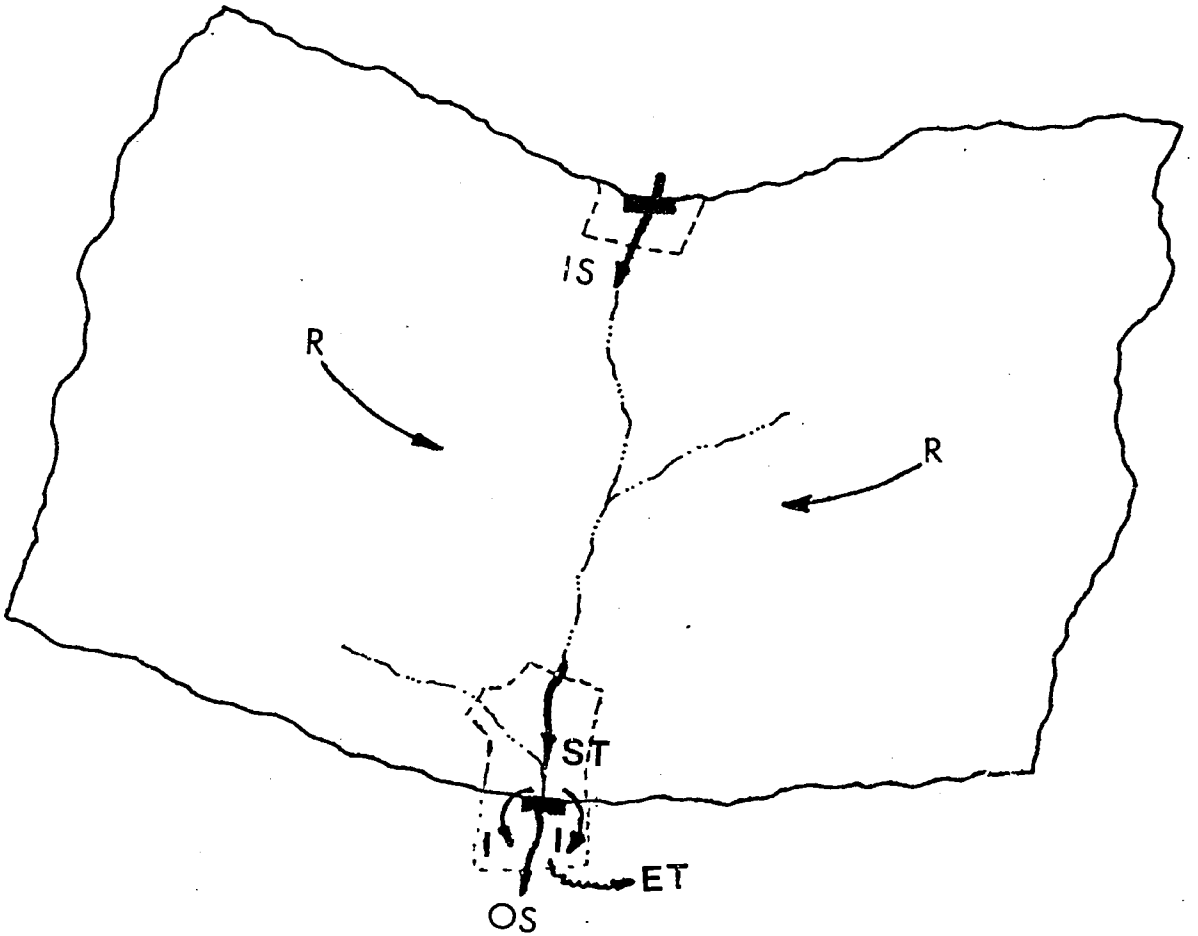

Fig.2 Components of water budget in subwatershed

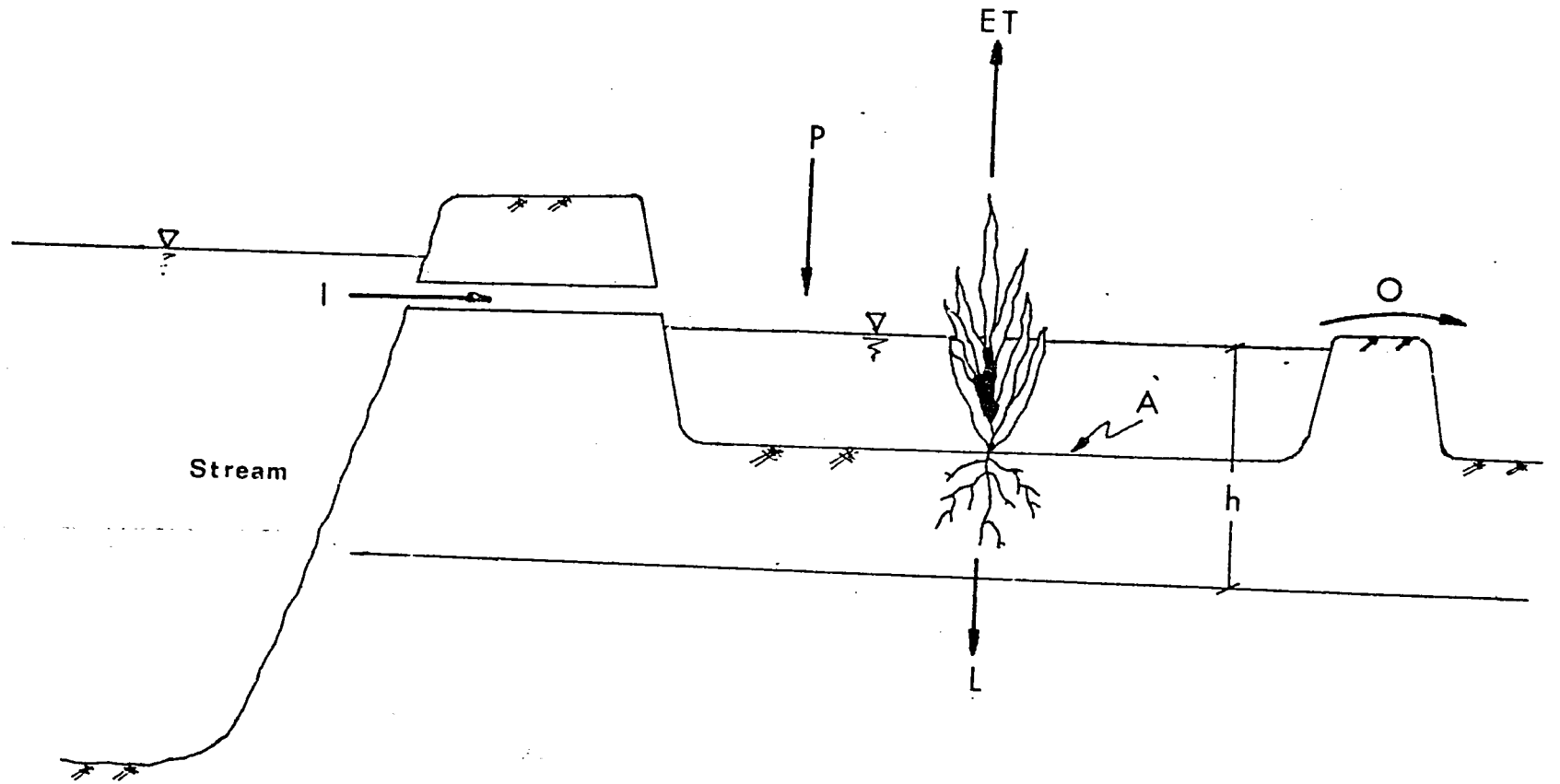

Fig.3 Components of water budget in service area

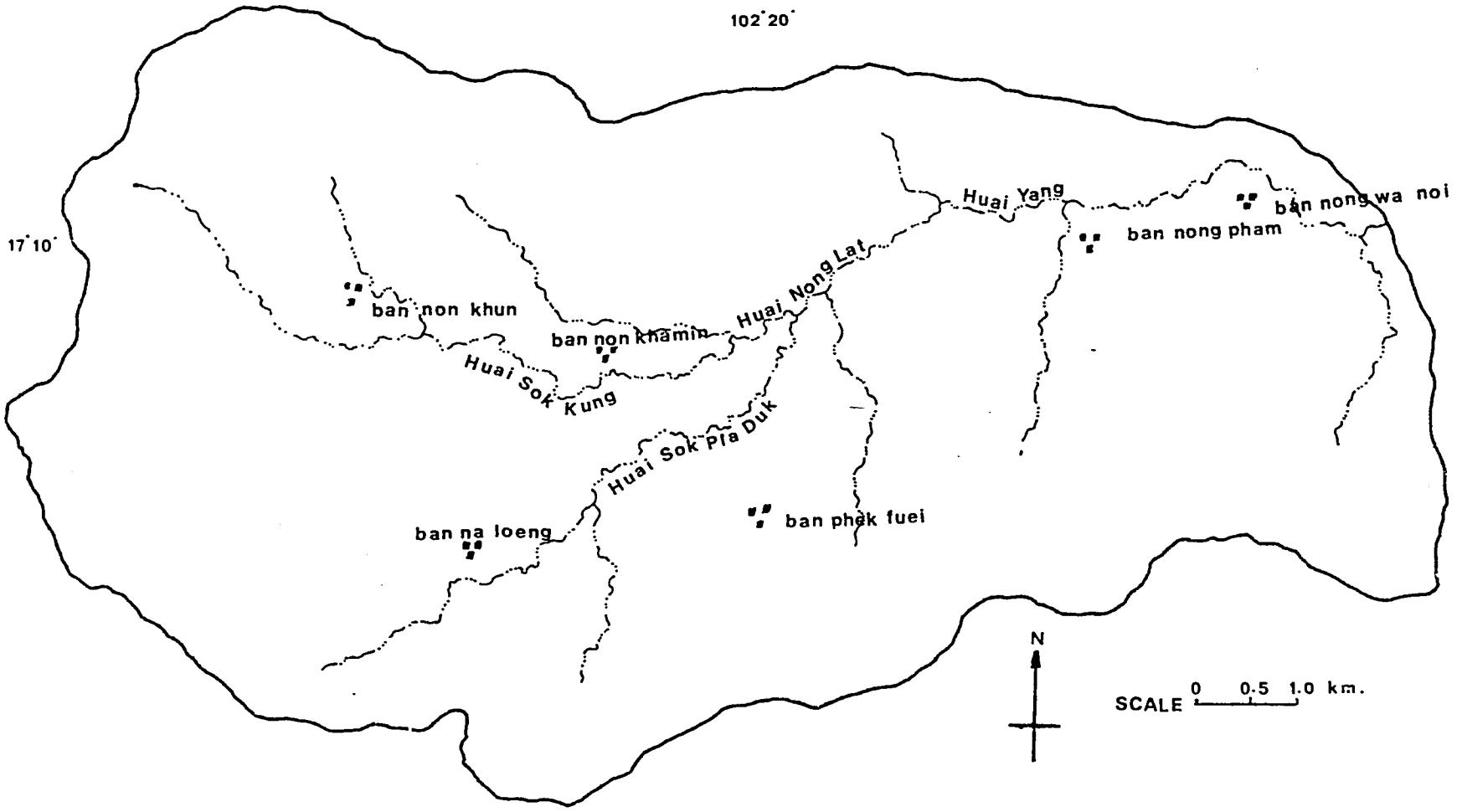

Figure 4 Huai Yang watershed

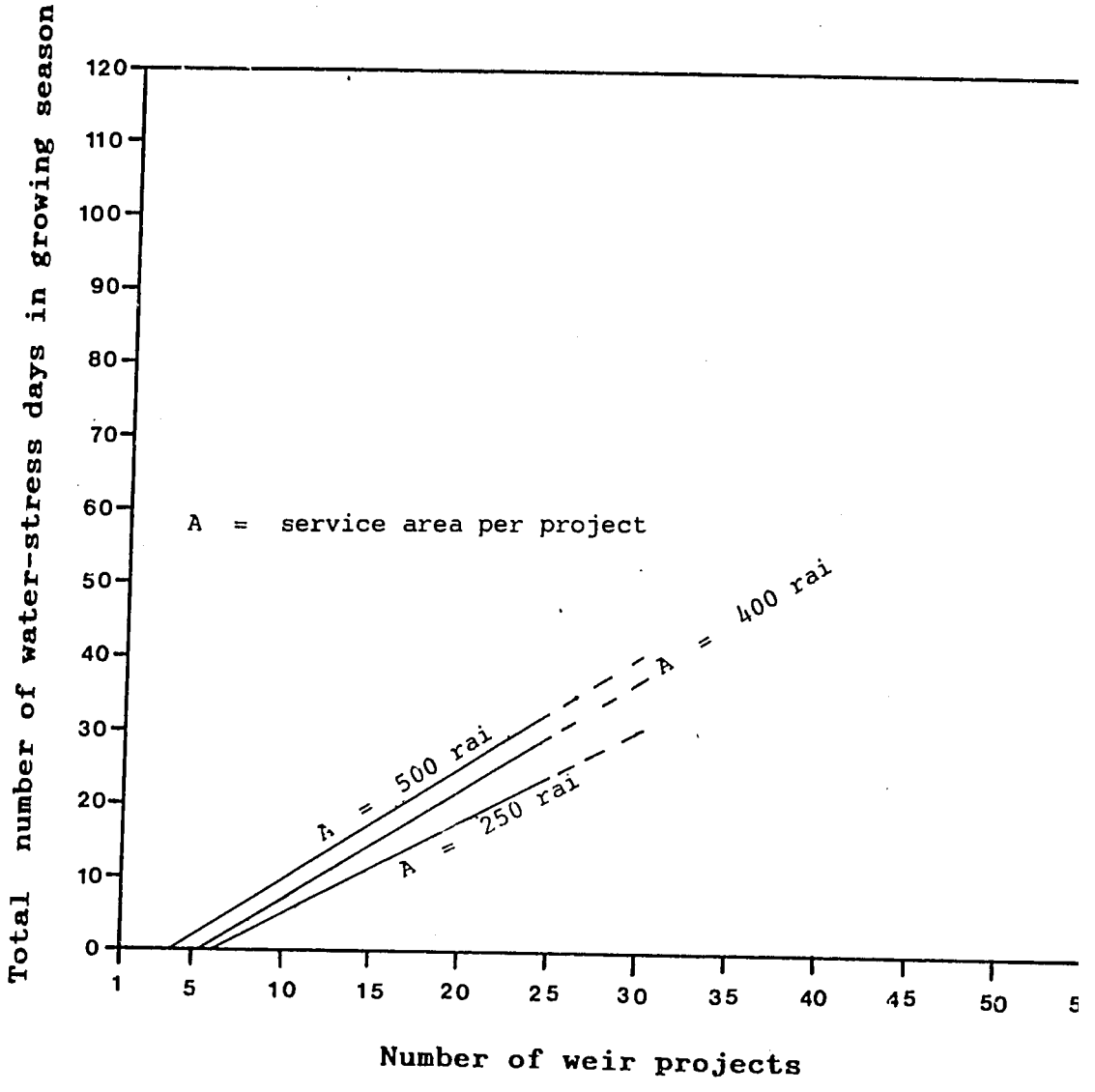

Fig.5 Effect of number of weir projects on project performan

Huai Yang watershed, Amphur Nong Bua Lampu, Udonthani.

References

Chuchoke Aryupong (1988), Water Balance Study of Weir Dominated Small Watershed in Northeast Thailand. Master Thesis, Graduate School, Khon Kaen University (in Thai).

Noparit Phadungsri (1986), Watershed Runoff Responses to Spatial Variability of Land Use Soil Type, and Topography. Master Thesis, Graduate School, Khon Kaen University (in Thai).

Sanguan Pattamatamkul and Prakob Wirojanagud (1987), Potential for Development of Small Weirs and Reserviors in Northeast Thailand. Research Report, Faculty of Engineering, Khon Kaen University (in Thai).

Uraiwan Tankimyong (1986), personal communication.

Adhikary, U. (1979), Prediction of Seepage and Percolation Rate from Some Irrigated Areas of N.E. Thailand. Master Thesis, AIT. Bangkok.

AIT (1978), Water for the Northeast : A Strategy for the Development of Small-Scale Water Resources. Report prepared for the Water Resources Subcommittee, NESDB, Bangkok.

Doorenbos, J. and W.O. Pruitt (1977), Guidelines for Predicting Crop Water Requirements. FAO Irrigation and Drainage Paper no. 24. Rome.

USDA Soil Conservation Service (1964), Hydrology. National Engineering Handbook, Section 4, Part I : Watershed Planning. Washington, D.C.

Annex 3

Israelis' Activities in HRPL Project

HYDROLOGY OF RAINFED PADDY LAND

CDR Research Project C7-187
Grant No. 936-5544-G-00-7017-00
Israeli part : R.Keren and I.Shainberg

Objectives To study crust formation and runoff of upland soils from watersheds of northeast Thailand.

Research Plan

The laboratory experiments will be carried out in Israel on soils from a few sites in watersheds of northeast Thailand on which the future field experiments will take place. The physical and chemical properties of the soils will be studied (mechanical analysis, clay mineral composition, cation exchange capacity, adsorbed ion composition). The hydraulic conductivity of the soils for distilled water (simulating rain) as a function of the composition of adsorbed ions (Na^+, K^+, $Ca2^+$ and $Mg2^+$)will be studied.

Dry soil (aggregates smaller than 4 mm) will be exposed to rain of distilled water. Crust formation, water runoff and soil erosion of the selected soils will be studied, using a rainfall simulator.

The effect of the kinetic energy of raindrops on soil erosion will be determined by a drip type rain simulation. Either fall height or drop size can be selected while total volume of rainfall applied remains the same.

The relationship between infiltration/runoff ratio and the physical and chemical properties of the soils will be evaluated.

A model for water infiltration for the studied soils will be developed to predict water runoff from soil surfaces of small sites at various kinetic energy of raindrops.