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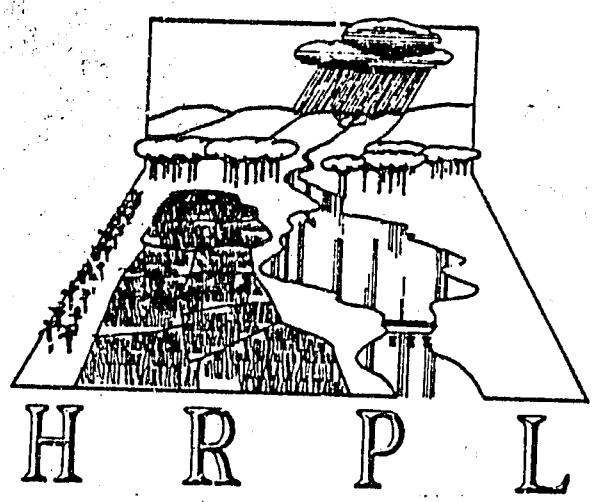
PROGRESS REPORT NO. 3

HYDROLOGY OF RAINFED PADDY LAND

A RESEARCH PROJECT

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



Submitted by

Amnat Apichatvullop
Acting Project Leader

Water Resources and Environment Institute
Faculty of Engineering
Khon Kaen University

December 1988

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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 Consultants	:	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	:	June - November 1988
Budget Allocation for this Period	:	฿ 842,098.-

1. Introduction

This research project aims to develop a mathematical model which is capable of simulating, for a given rainfall, the streamflow in small watersheds containing paddy land. The project selected several watersheds of varying land use and topography for monitoring rainfall, streamflow and groundwater flow.

Work achieved todate are instrumentation of selected watersheds, watershed survey, soil property study, development of daily water budget for paddy watershed and field experiment in infiltration.

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

2.1 Monitoring of water quantities in a subwatershed

A well-defined subwatershed of one of the study watersheds is to be thoroughly surveyed for exact land use and topography. Streamflow, diversion and storage in paddy land are to be measured continuously over one rainy season. This is to verify the daily water budget model that has been developed.

2.2 Establishing rating curves

Rating curves (stage-discharge relationships) are to be established for every stream gaging station. This will be done by measuring flows for various stages.

2.3 Field measurement of infiltration

On-site infiltration measurements will be carried out for 5 predominant soils, namely; Korat, Satuk, Ponepisai, Warin and Yosothorn soils. Measurements will be taken for three moisture conditions: wet season, beginning of dry season and end of dry season.

2.4 Visit to Israel

The project is to send a scientist to Israel for two weeks. The purpose is to consult with the Israeli collaborators, Professors Isaac Shainberg and Rami Keren on the development of the infiltration model. In addition the Thai scientist will look at watershed management practice in Israel.

3. Material and Methods

3.1 Monitoring water quantities in a subwatershed

The subwatershed selected is in Huai Khummum (see location in Fig.1). The stream section is between two concrete weirs. Ground reconnaisance was carried out in July 1988 by a student research assistant to determine the actual land use and general topography. All the paddy plots were surveyed for levels. Micro-staff gages were installed in sample paddy plots. And villagers were hired to record the water level, twice daily, on these paddy plots. The stream flows passing the two concrete weirs as well as water diverted from the upper weir were also recorded. With this information all water quantities entering, leaving and remaining in the subwatershed can be determined.

3.2 Establishing rating curves

For all the stream gaging stations when the streams are flowing, discharge measurements will be carried out using the Area-Velocity method. The flow cross-section is divided into vertical strips. The depth (d) of each strip is measured using sounding rod and the mean velocity is measured using Price current meter. The mean velocity is calculated as follows:

if $d < 0.6$ m $\quad \bar{V} = V_{.6d}$

if $0.6 \text{ m} \leq d \leq 3.05$ m $\quad \bar{V} = \frac{1}{2}(V_{.2d} + V_{.8d})$

if $3.05 \text{ m} \leq d \leq 6.1$ m $\quad \bar{V} = \frac{1}{4}(V_{.2d} + 2V_{.6d} + V_{.8d})$

if $d > 6.1$ m $\quad \bar{V} = \frac{1}{10}(V_0 + 3V_{.2d} + 2V_{.6d} + 3V_{.8d} + V_d)$

where $V_{.2d}$ is the velocity at depth 0.2d, etc. The discharge in each strip is

$$q_i = \bar{V}_i \cdot d_i \cdot b_i$$

where b_i is the width of strip i. The total discharge passing through the cross-section is

$$Q = \sum_{i=1}^{n} \bar{V}_i \cdot d_i \cdot b_i$$

3.3 Field measurement of infiltration

Double-ring infiltrometer tests will be performed for the five soils in the upland of Huai Khummum and Huai Yae. Two surface conditions will be selected: bare and covered (with grass).

3.4 Visit to Israel

Dr. Amnat Apichatvullop, the acting project leader, visited Israel in October, 1988. He met Professors Isaac Shainberg and Rami Keren at the Soils and Water Institute, Agricultural Research Organization (Volcani Center). They discussed the work and the results of the infiltration study on the soil samples from Thailand. The Thai scientist also performed infiltration experiments using a rain simulator (see Fig.6 & 7).

The Thai scientist visited runoff plots, small watersheds and several other forms of watershed management, from central Israel to the Golan Height in the north and the Negev Desert in the south. He also visited scientists at the Technion, the Soil Erosion Research Center and the Ben-Gurion University.

4. Results

4.1 Water quantities in subwatershed

Fig.12 shows the land use, topography, the water distribution system and the water monitoring network in the study subwatershed. Examples of water level reading are presented in Table 1. The inflow, outflow and storage in the paddy land can be calculated from these measurements.

4.2 Rating curves

The results of flow measurement are quite satisfactory. However, the range of stage is not wide enough. Four stream stations can be said to have an established rating curve (see Table 2). Fig.13 shows the rating curve for station KS1 of Huai Khummum.

4.3 Infiltration

Table 3 shows the infiltration experiments completed to date. Fig.14 presents a typical infiltration results.

4.4 Visit to Israel

The visit to Israel provided a good understanding for the Thai scientist in many areas including the basic hydrologic processes of infiltration, runoff, physical and chemical interaction between soil and water, surface moisture accumulation, and water harvesting techniques. Many things are readily applicable to engineering and agricultural use in Thailand. For example embankment stabilization and soil conservation using chemical (gypsum) treatment.

5. Remarks

During this reporting period another micro computer was procured. It is an IBM-compatible AT model with a 30-M byte hard disk. This will be used for mathematical modelling.

Other equipments procured prior to this period (not mentioned in Progress Report No.2) are five water level recorders, one Price current meter and three tipping bucket rain gages. The water level recorders and rain gages have been installed in the study watersheds and are now providing data continuously.

Professor Isaac Shainberg is to visit Thailand from January 3 to 12, 1989. He will meet with the Thai scientists at Khon Kaen University. The infiltration study and the model thus developed will be presented. In addition he will visit watersheds in northeastern and northern Thailand.

6. Work plan for the next period

6.1 Study of erosion and sediment deposition.

A student research assistant, Mr. Prachya Khamluemee, will develop a model for predicting erosion and sediment deposition in a small watershed. He will be supervised by Dr. Sanguan Patamatamkul.

6.2 Calibration of rainfall-runoff models.

In order to come up with an appropriate mathematical model of rainfall-runoff for Northeast Thailand several existing models will be calibrated using the data collected to date. Later on the model that can best simulate Northeast Thailand conditions will be modified in several areas, notably the data requirement will be made more appropriate.

TABLE 1 WATER LEVEL IN STUDY SUBWATERSHED
(See Fig.12 for station location)

Date 15 October 1988

Water level in paddy field

Station	Water level (cm.)	Station	Water level (cm.)	Station	Water level (cm.)
1	1	11	0	21	7
2	0	12	15	22	15
3	7	13	7	23	17
4	15	14	24	24	18
5	0	15	40	25	26
6	5	16	12	26	17
7	0	17	14	27	17
8	17	18	20		
9	40	19	0		
10	19	20	10		

Water level at inlet & outlet of conveyances

Station	A (culvert intet)	B (culvert outlet)	D (left main canal)	F (canal end)	G (culvert outlet)	H (culvert outlet)	I (culvert outlet)	J (culvert outlet)
Water level (cm.)	59	47	144	37	43	33	35	475

Water level at weir crest

Station	Height (Width) of stoplog (cm.)									Water level (cm.)
	No.1	No.2	No.3	NO.4	NO.5	NO.6	NO.7	NO.8	No.9	
C (Upper Weir)	37 (153)	44 (164)	45 (162)	40 (160)	37 (164)	32 (137)				186
E (Lower Weir)	35 (153)	40 (145)	45 (144)	61 (147)	60 (143)	54 (144)	57 (144)	34 (154)	44 (96)	167

TABLE 2 STATIONS WITH ESTABLISHED RATING CURVE

STREAM (HUAI)	STA.	STAFF GAGE READING (M.)	DISCHARGE (M**3/SEC)
RIN	RS1	0.60	0.3152
		0.63	0.3525
		0.73	0.7665
		0.83	1.2068
BO	BS1	1.27	2.6647
		1.41	3.1722
		1.52	3.9436
		1.62	5.3783
		1.82	8.3785
YANG	YS1	1.50	0.3732
		1.55	1.8249
		1.65	1.9229
		1.80	7.4785
		1.95	8.9582
KHUMMUM	KS1	1.77	0.1529
		2.23	0.6909
		2.28	1.7463
		2.33	2.2695
		2.35	2.6034
		2.42	2.9743

TABLE 3 FIELD INFILTRATION EXPERIMENTS

Location	Soil Type	Land Use	Surface Condition	Initial Moisture Condition	Remark
Huai Khummum	Korat (Kt)	Upland	Bare	Wet Season	Completed
				Before Dry Season	-
				Dry Season	-
			Covered	Wet Season	Completed
				Before Dry Season	-
				Dry Season	-
	Satuk (Suk)	Upland	Bare	Wet Season	Completed
				Before Dry Season	-
				Dry Season	-
			Covered	Wet Season	Completed
				Before Dry Season	-
				Dry Season	-
	Phon Phisai (Pp)	Upland	Bare	Wet Season	Completed
				Before Dry Season	-
				Dry Season	-
			Covered	Wet Season	Completed
				Before Dry Season	-
				Dry Season	-
	Nam Phong (Ng)	Upland	Bare	Wet Season	Completed
				Before Dry Season	-
				Dry Season	-
			Covered	Wet Season	-
				Before Dry Season	-
				Dry Season	-
Huai Yae	Warin (Wn)	Upland	Bare	Wet Season	Completed
				Before Dry Season	-
				Dry Season	-
			Covered	Wet Season	Completed
				Before Dry Season	-
				Dry Season	-
	Yasothon (Yt)	Upland	Bare	Wet Season	Completed
				Before Dry Season	-
				Dry Season	-
			Covered	Wet Season	Completed
				Before Dry Season	-
				Dry Season	-

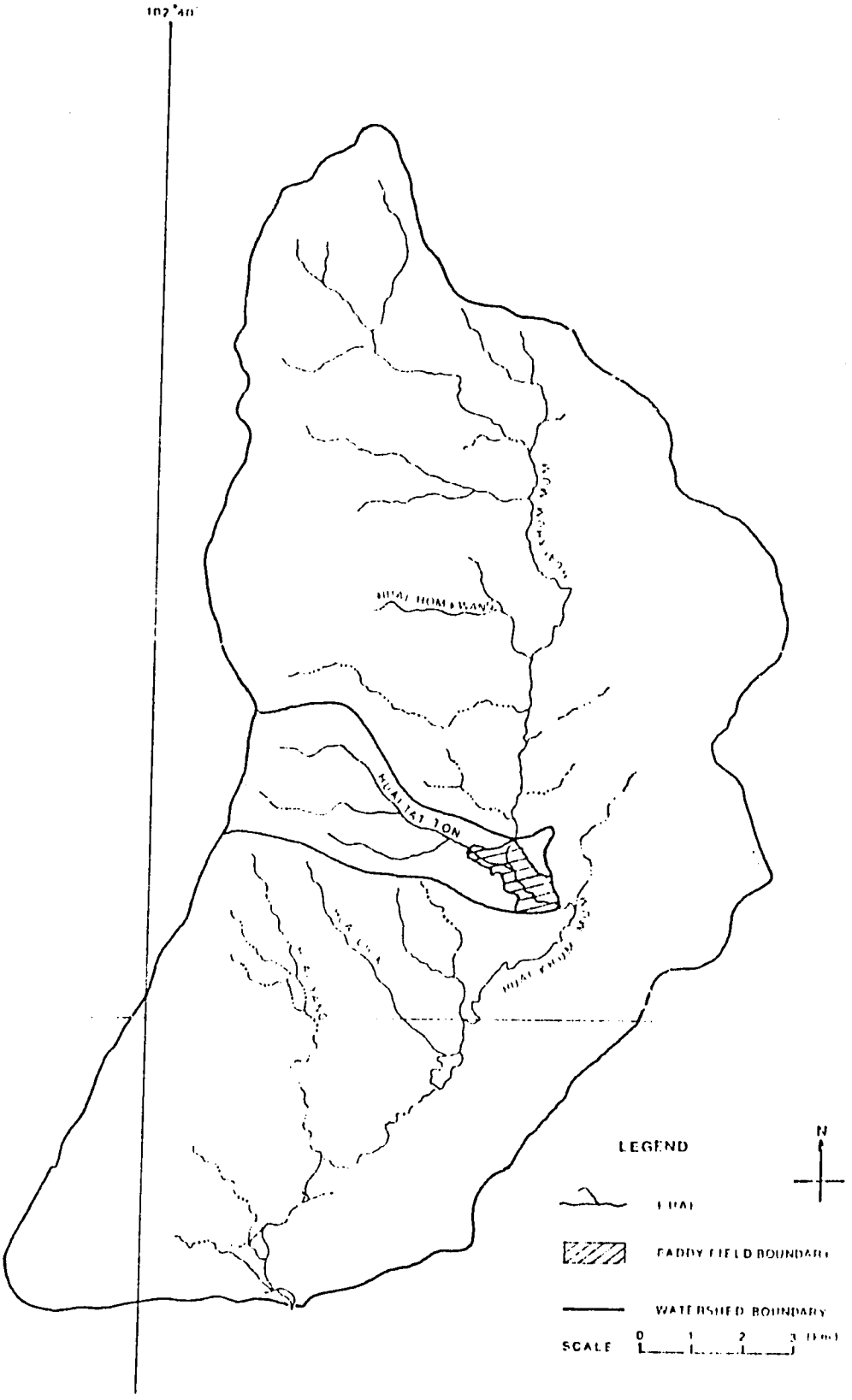


Fig.1 Study Subwatershed of Huai Khummum

Fig.2 Land Use and General Topography of Study Subwatershed

Fig.3 Micro-Staff Gage in Paddy Land

Fig.4 Measurement of Stream Cross Section

Fig.5 Velocity Measurement

Fig.6 Rain Simulator at Volcani Center

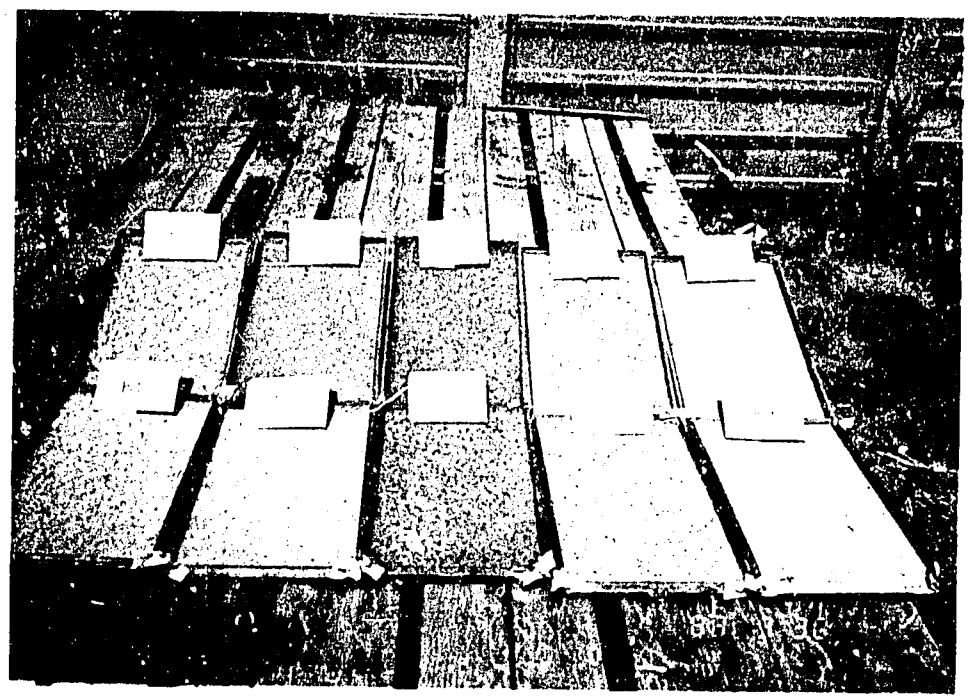


Fig.7 Soil Surfaces after Subjected to Simulated Rain

Fig.8 Small Runoff Plots in the Field

Fig.9 An Instrumented Water Harvesting Plot

Fig.10 Plastic-Lined Pond at the Soil Erosion Research Center, Emeq Hefer

Fig.11 Water Harvesting Technique at Avdat

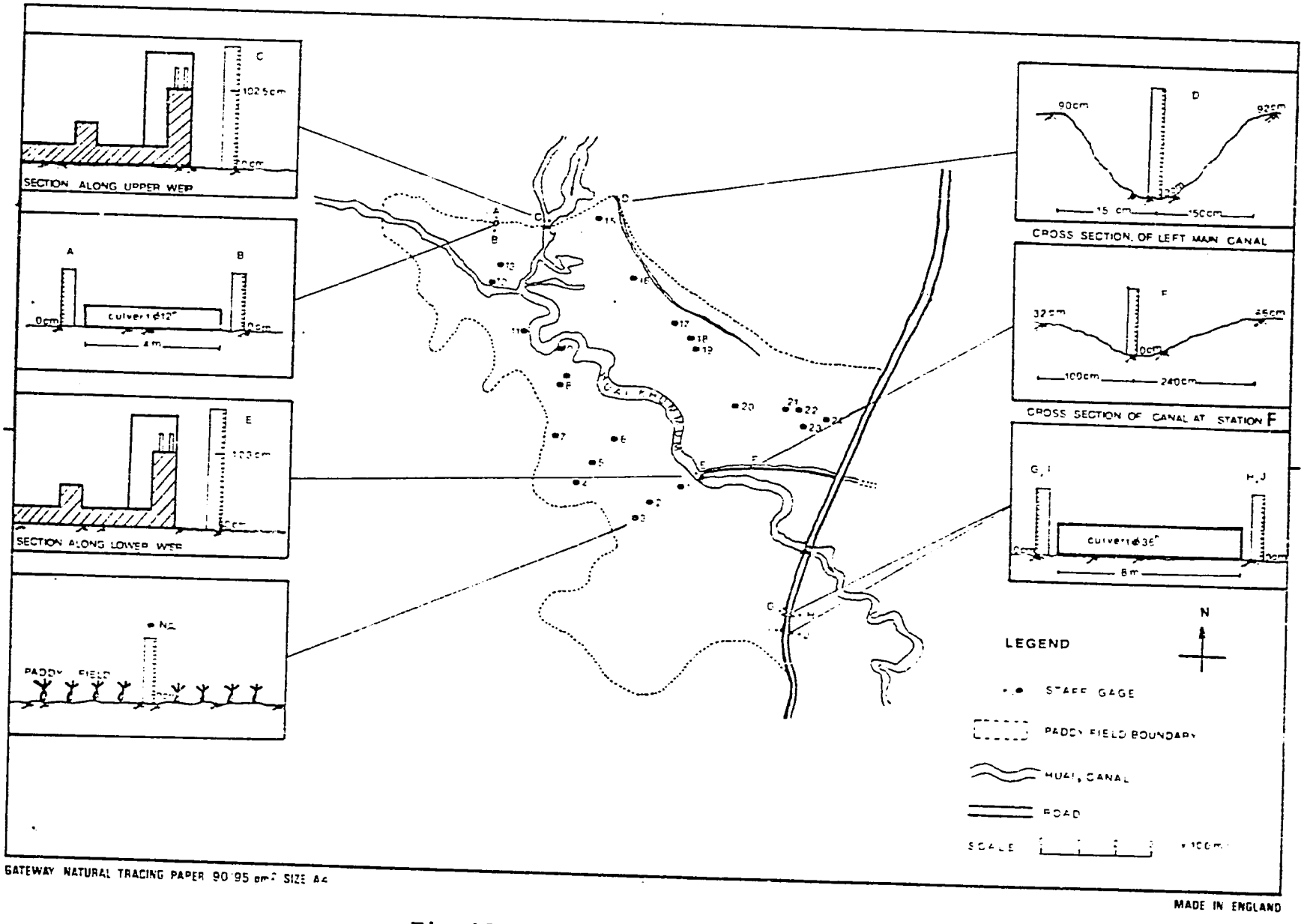


Fig.12 Detail of Study Subwatershed

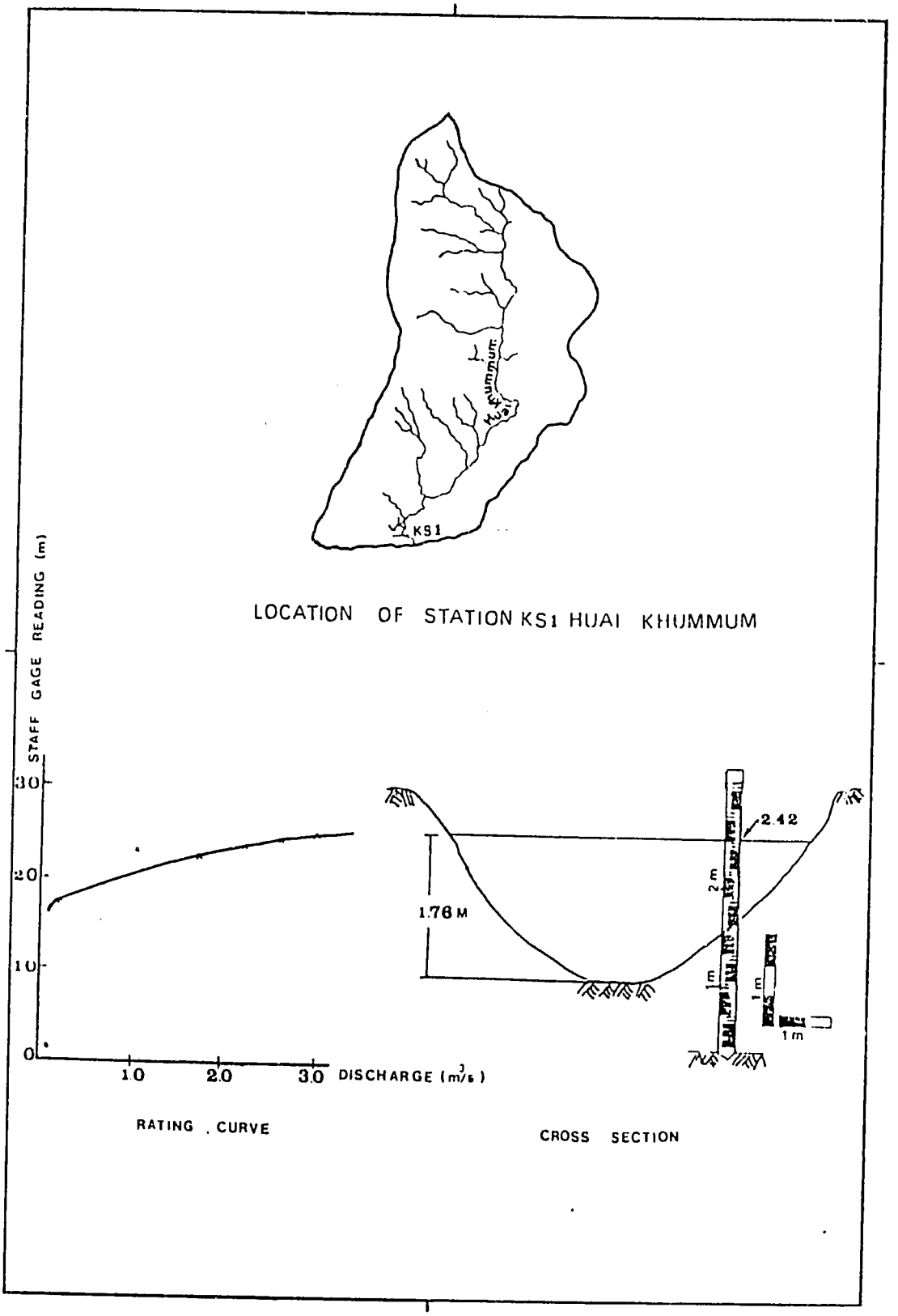
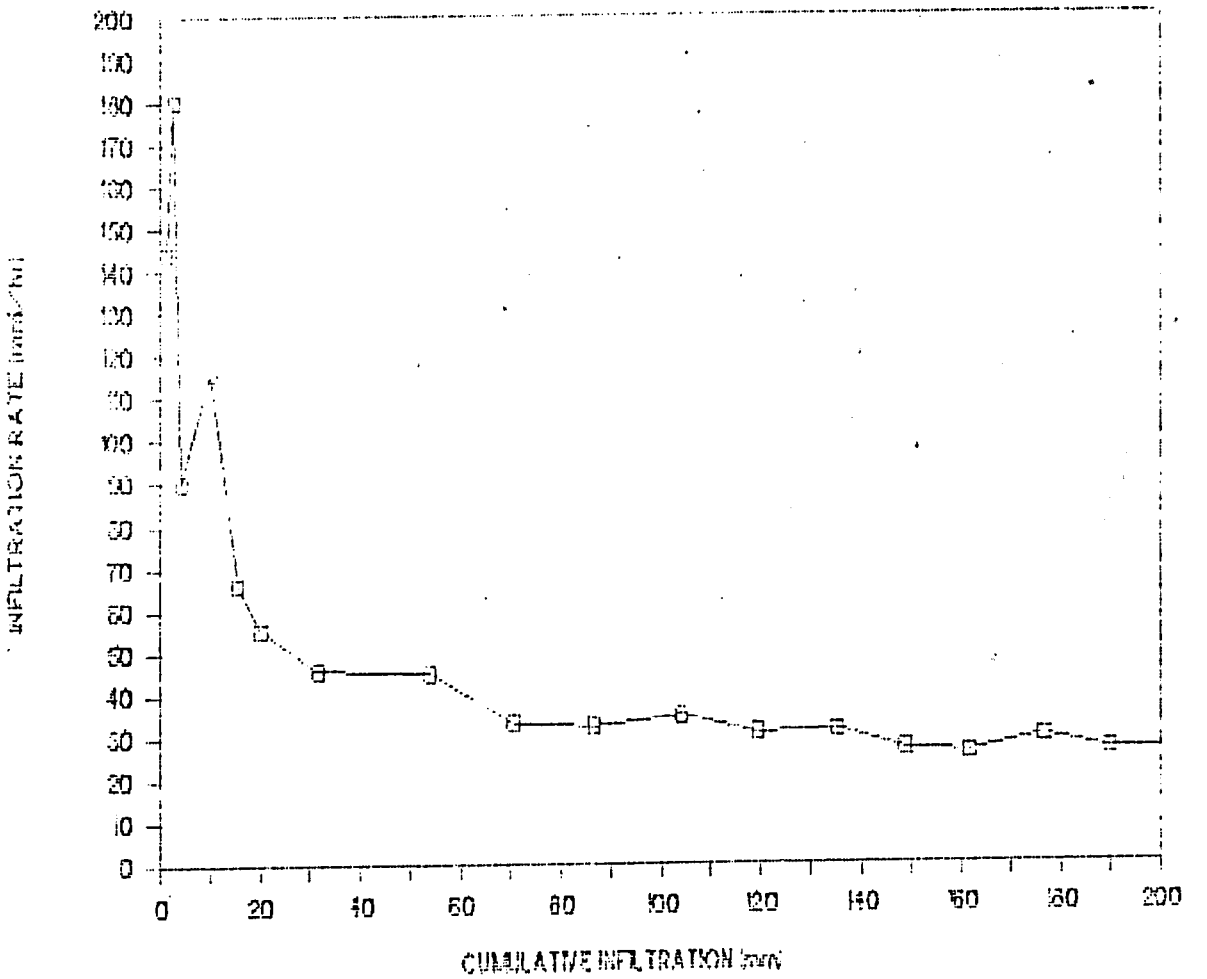


Fig.13 Rating Curve for Station KS1

SOIL TYPE Kt.SAMPLE 1

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