インドネシア共和国
メラピ火山砂防基本計画策定調査
（図　面　集）

昭和53年３月

国　際　協　力　事　業　団

STUDY FOR MAKING MASTER PLAN

FOR LAND EROSION AND VOLCANIC DEBRIS CONTROL

IN THE AREA OF MT. MERAPI

THE REPUBLIC OF INDONESIA

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MARCH 1978

JAPAN INTERNATIONAL COOPERATION AGENCY

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Fig. 1 Map of Study Area

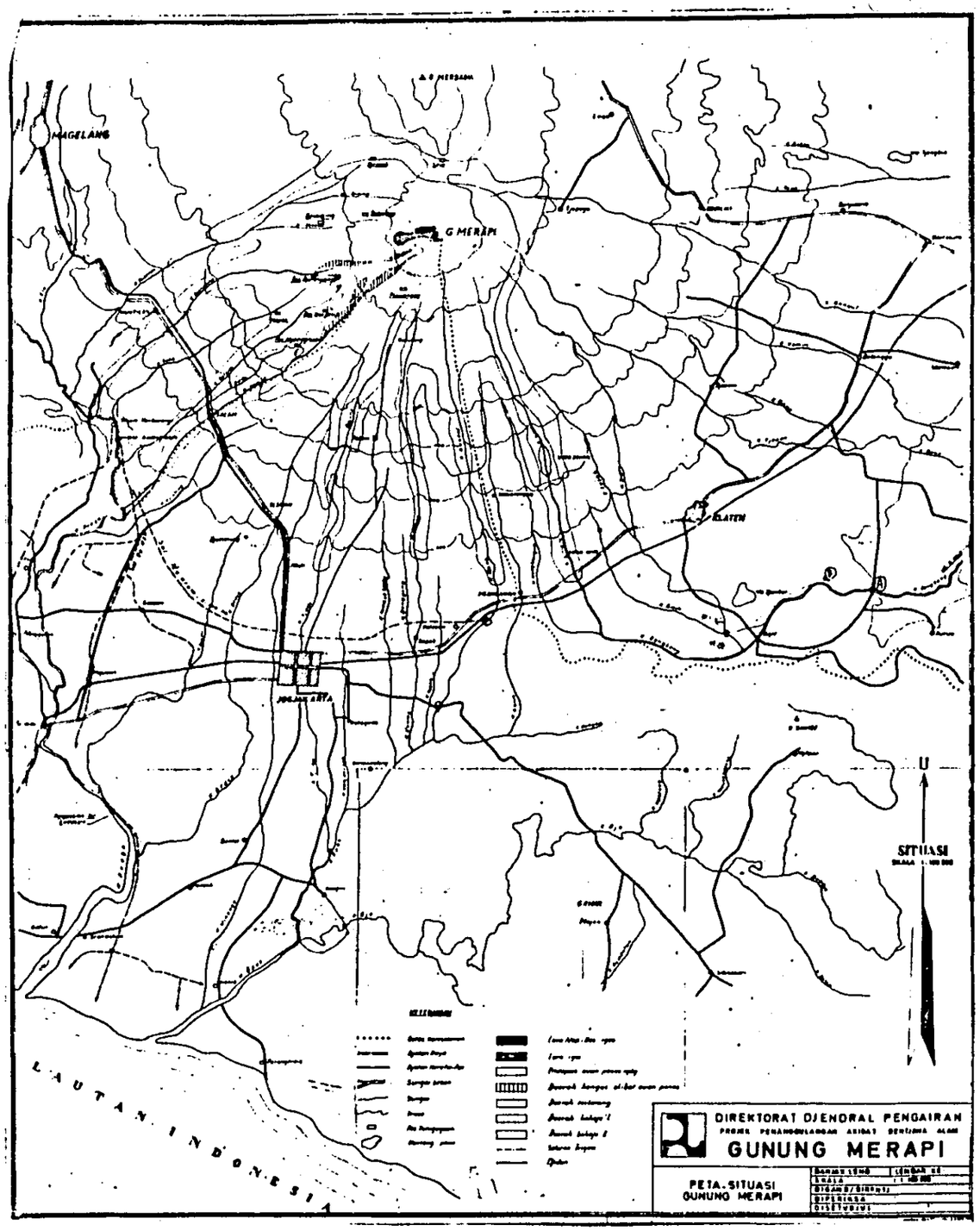
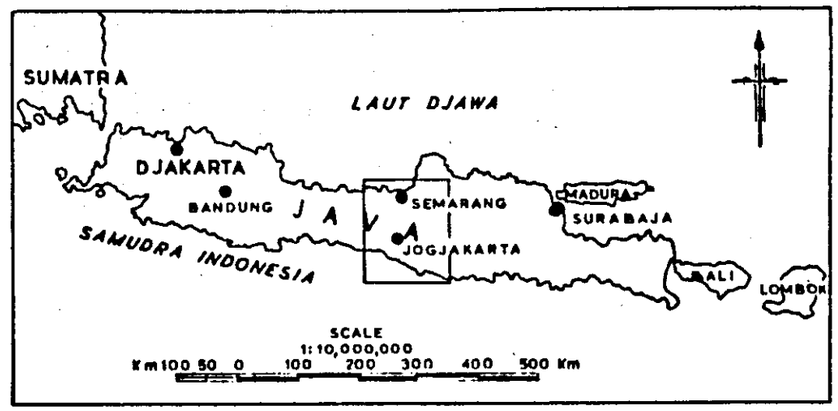


FIG. 2 STUDY AREA



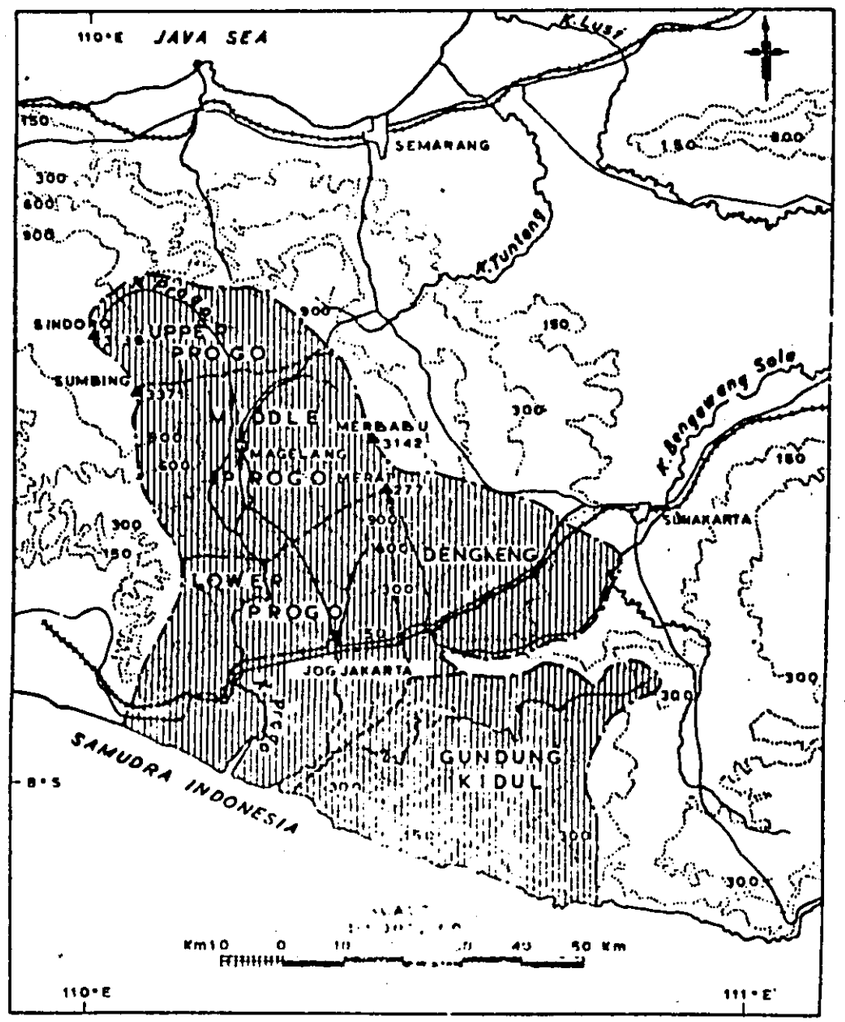


FIG. 3 MAJOR LAND USE

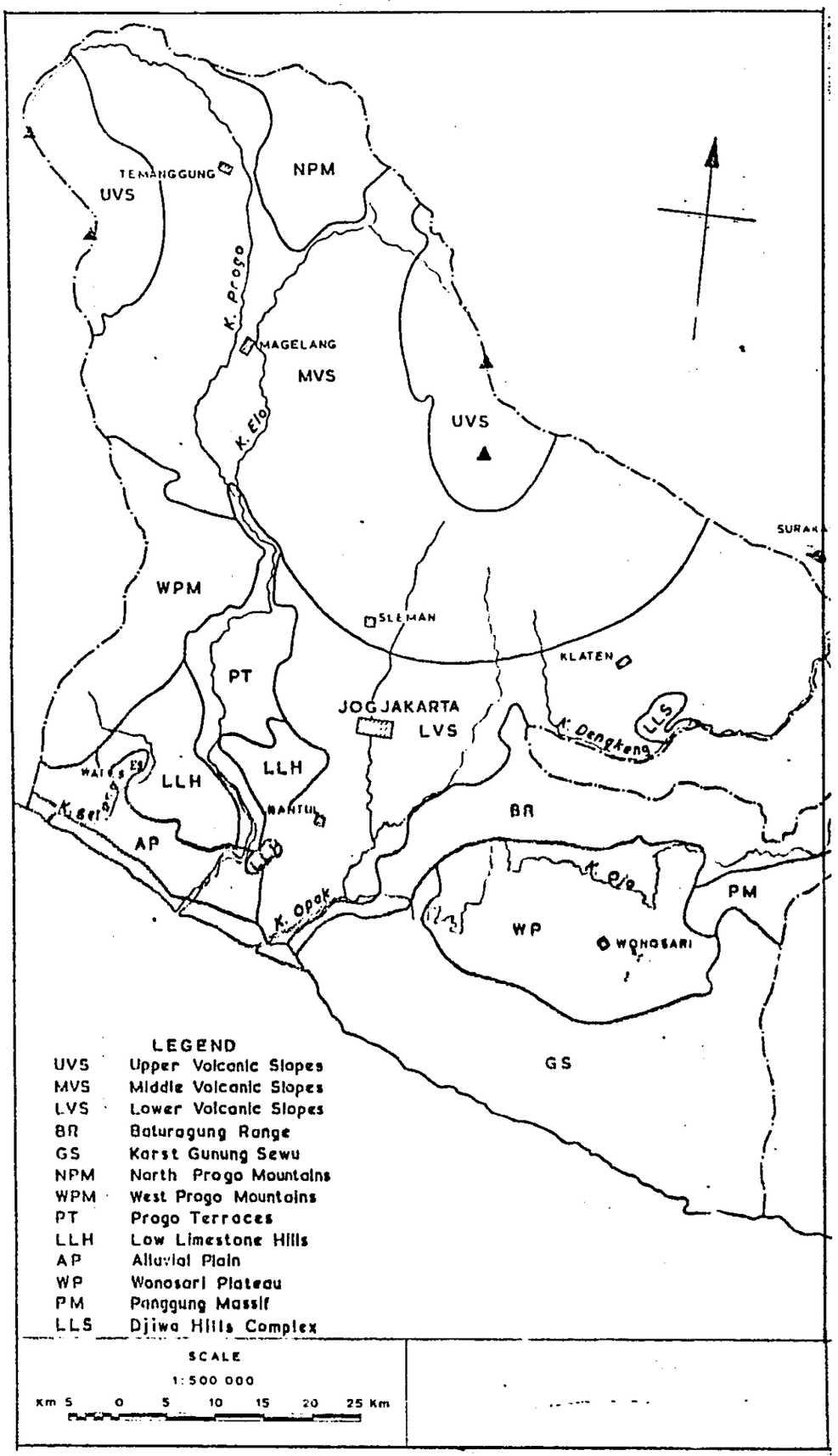


FIG. 4 POPULATION DENSITY (1969)

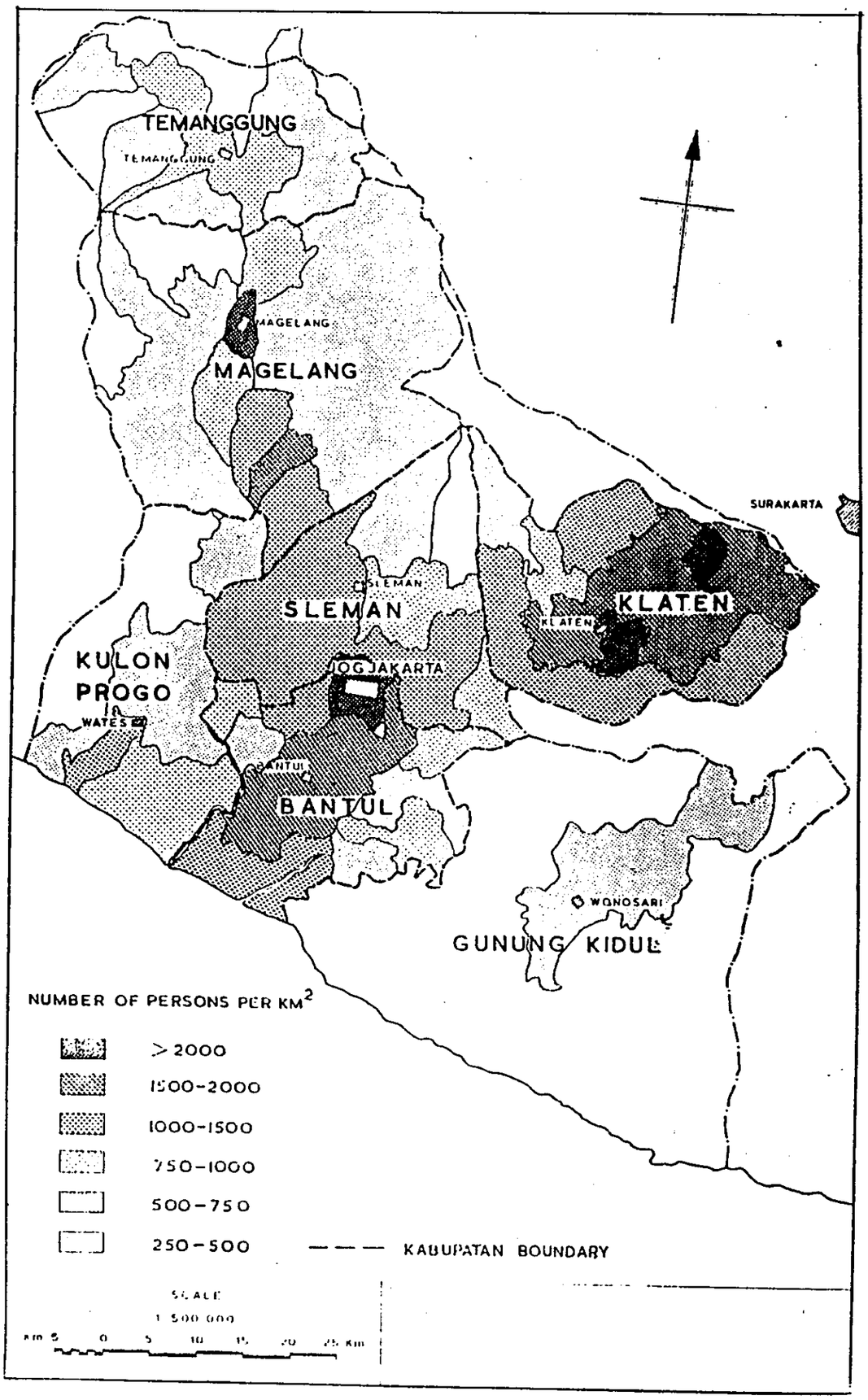


FIG. 5 POPULATION INCRESE RATIO

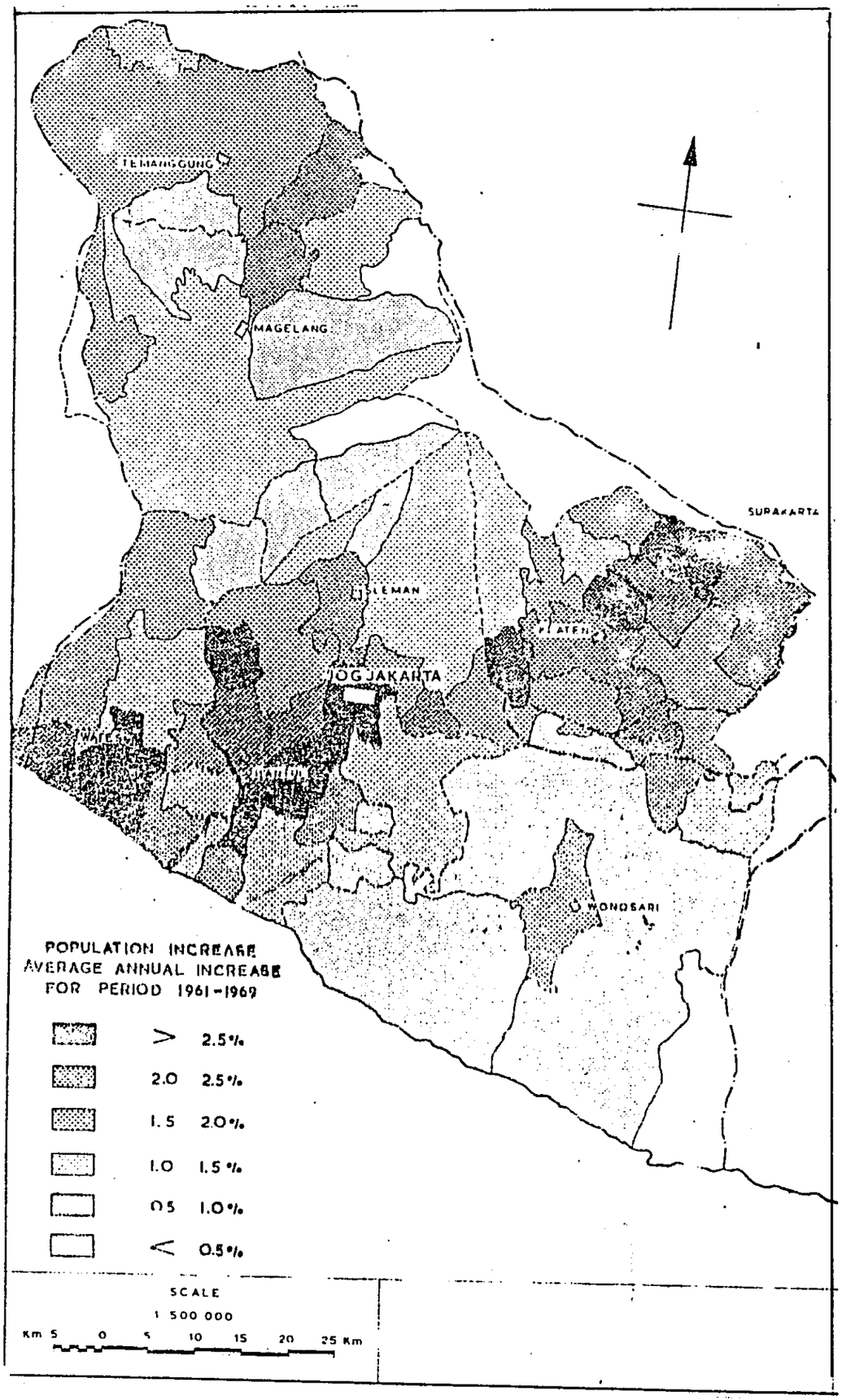


FIG. 6 LAND USE

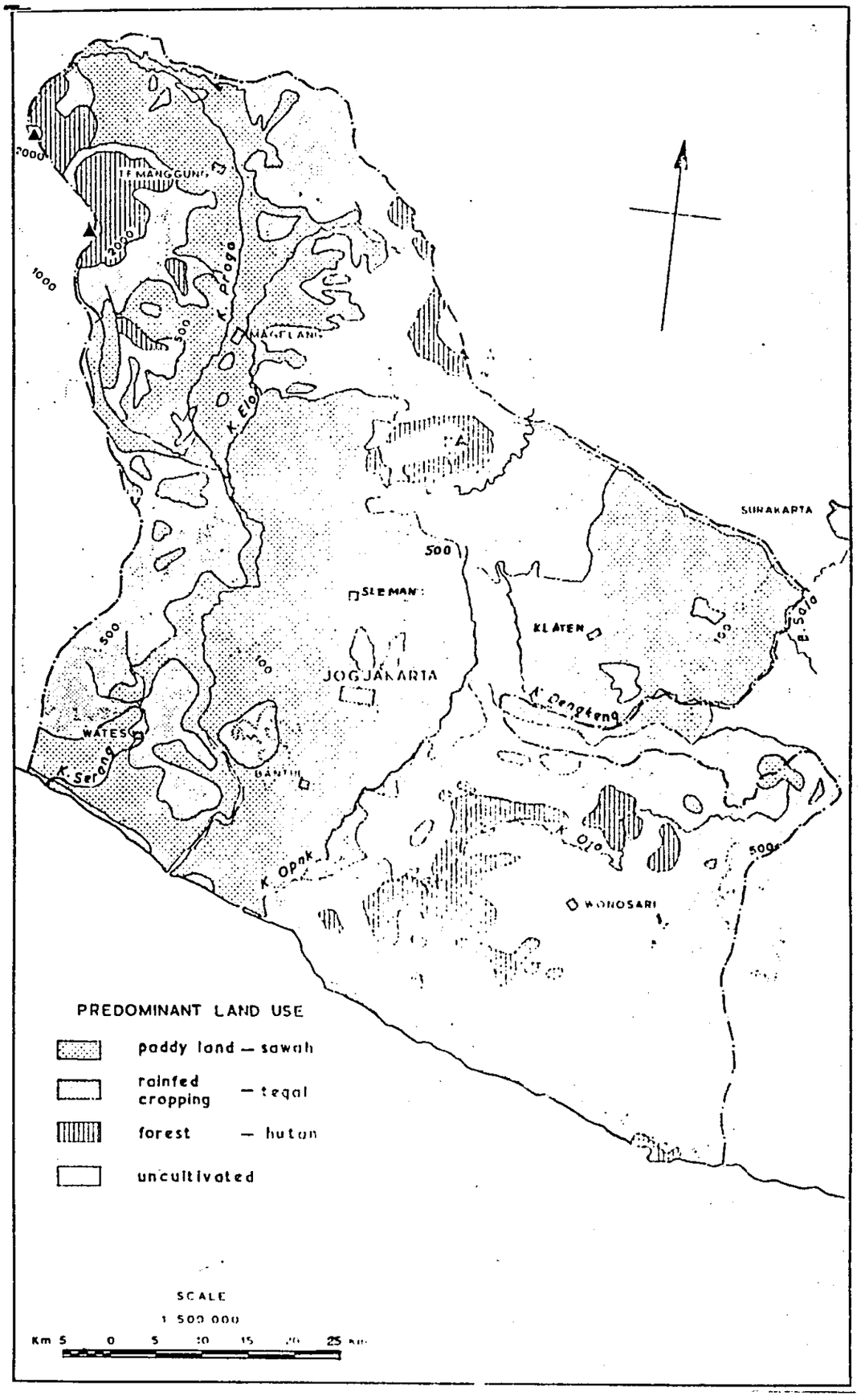


FIG. 7 DAILY RAINFALL CORRELATION (1)

NGEPOS . vs . YOGYAKARTA

(1975 – 1977)

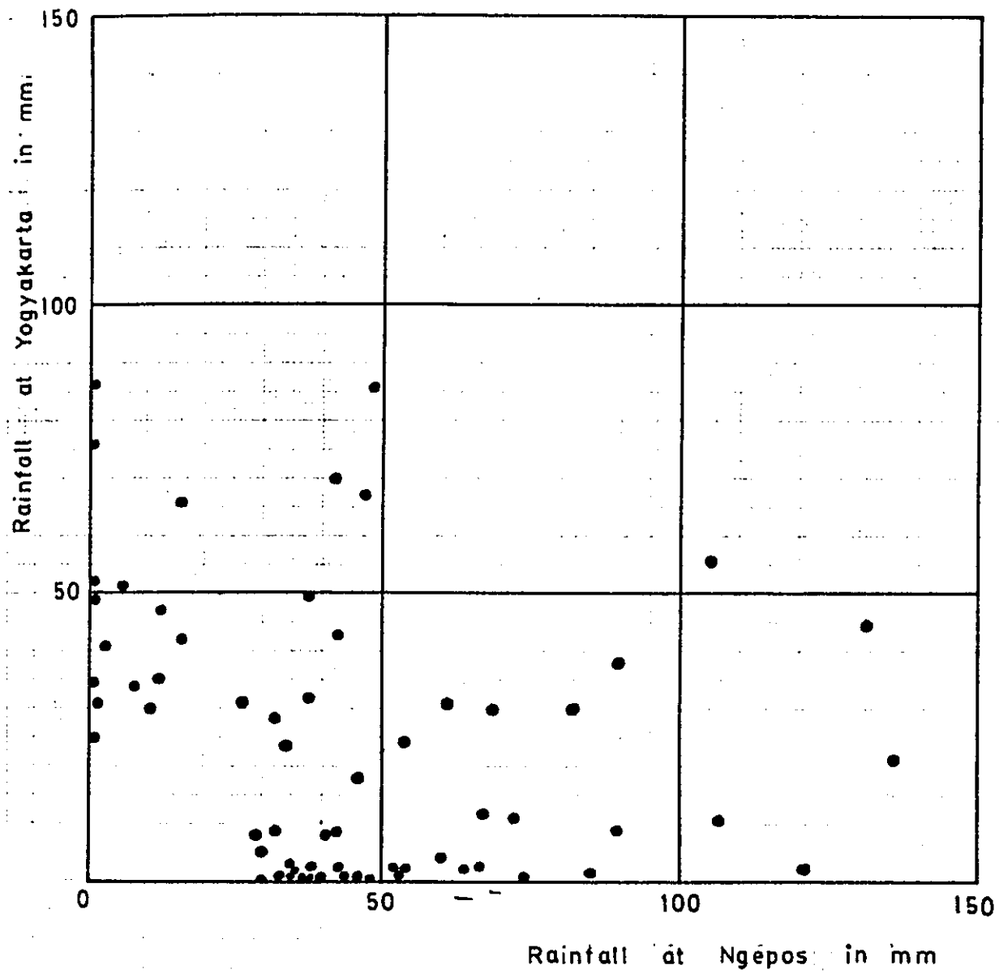


FIG. 7 DAILY RAINFALL CORRELATION (2)

NGEPOS . vs . SALAM .

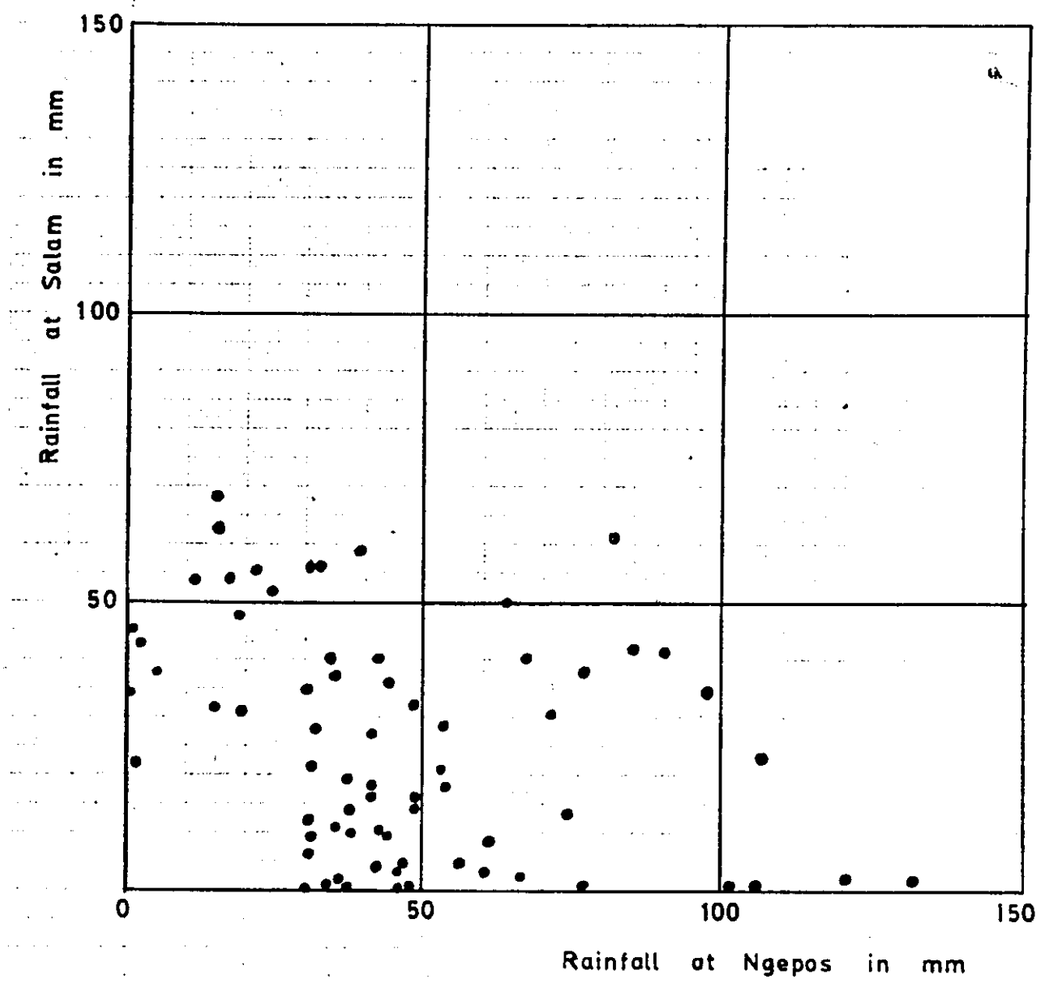


FIG. 7 DAILY RAINFALL CORRELATION (3)

NGEPOS .vs. KALIGESIK

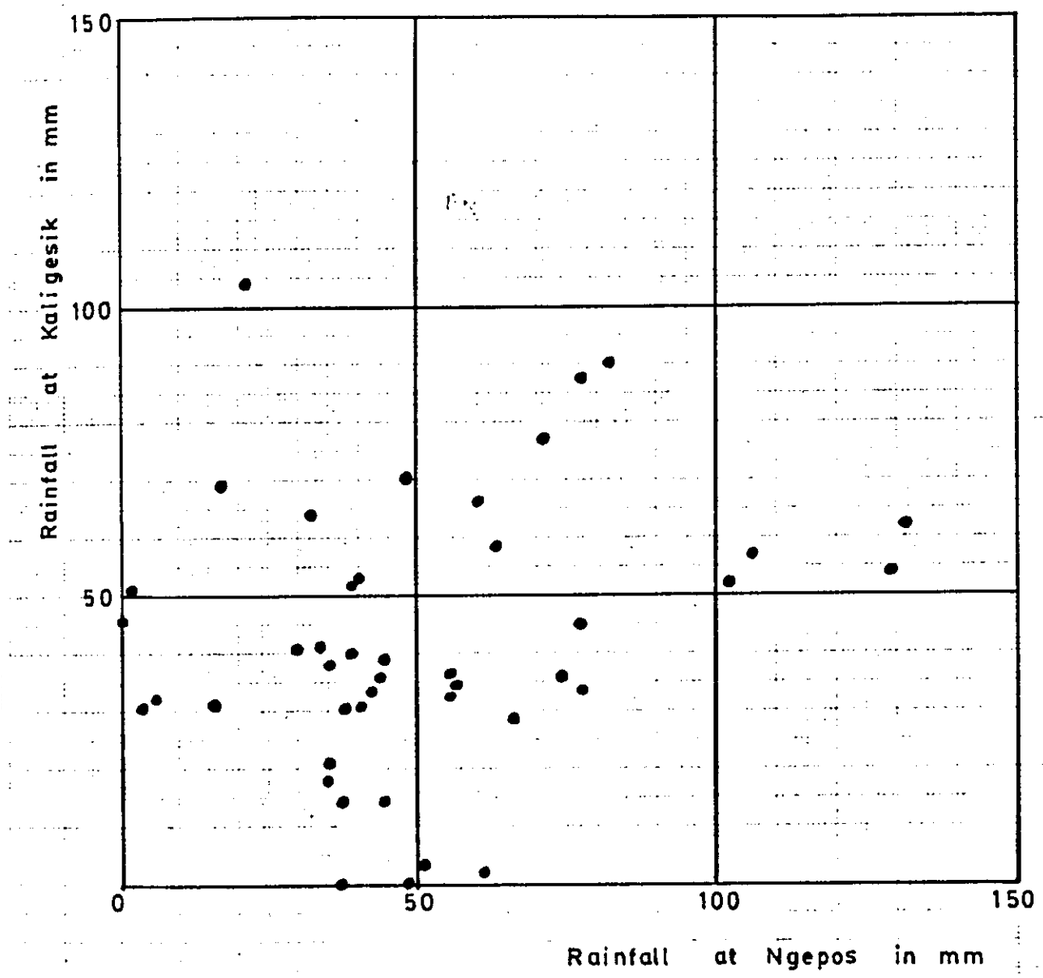


FIG. 7 DAILY RAINFALL CORRELATION (4)

NGEPOS .vs. TALUN

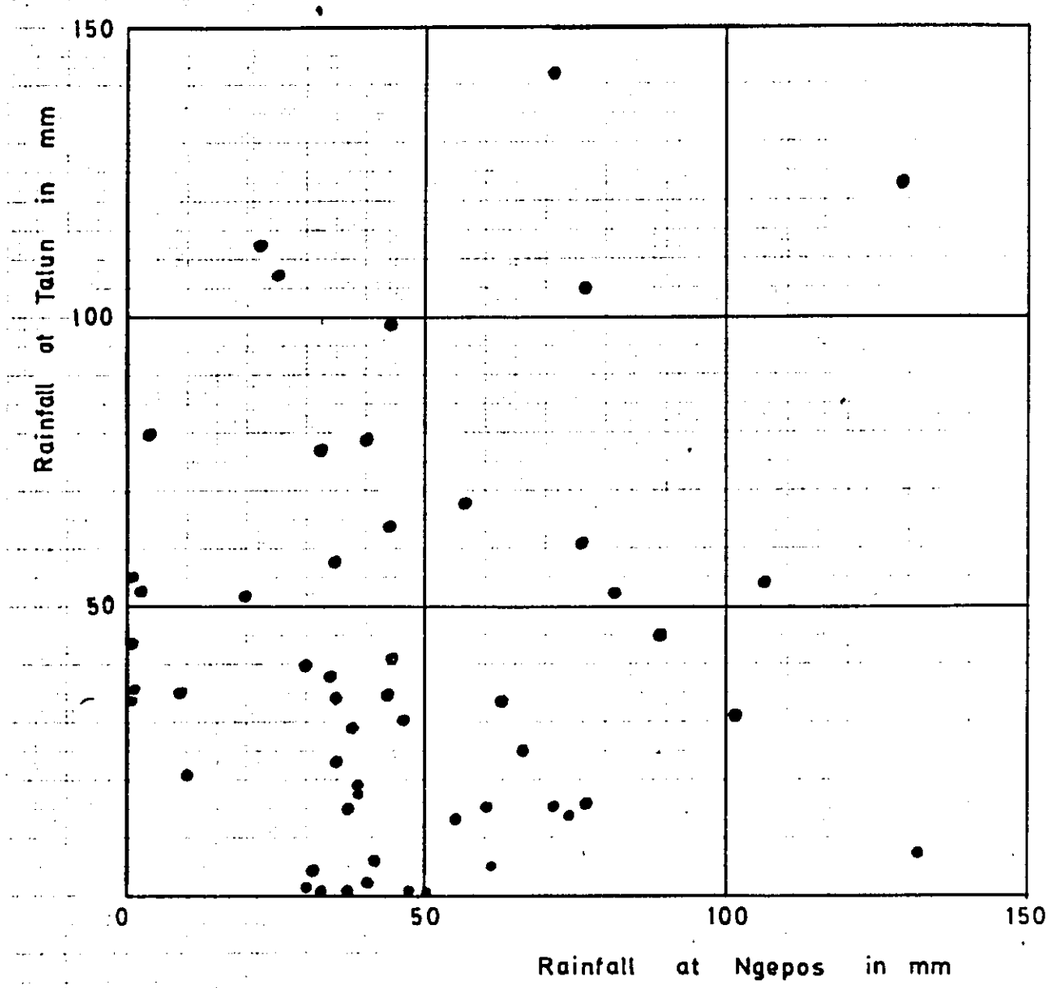


FIG. 7 DAILY RAINFALL CORRELATION (5)

NGEPOS .vs. GIRIKERTO

(1976 — 1977)

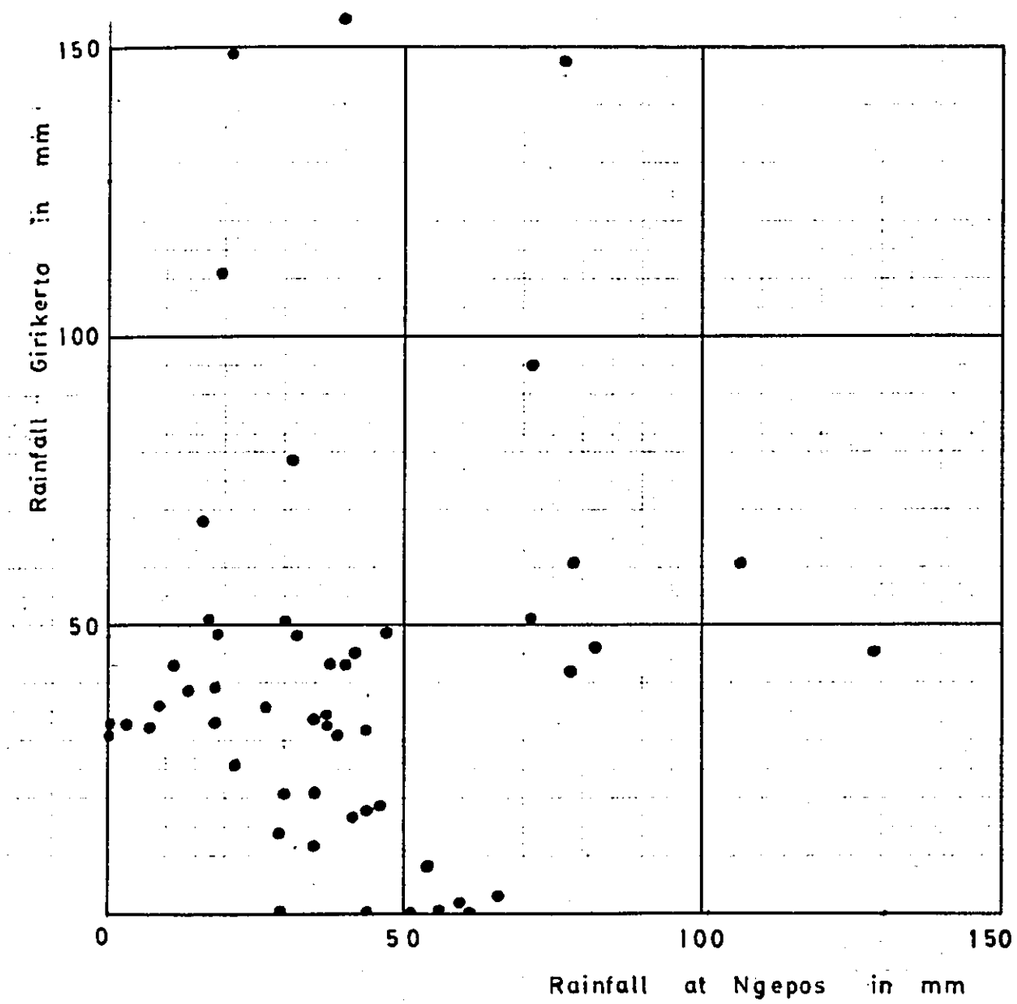


FIG. 7 DAILY RAINFALL CORRELATION (6)

NGEPOS . vs. PLAWANGAN

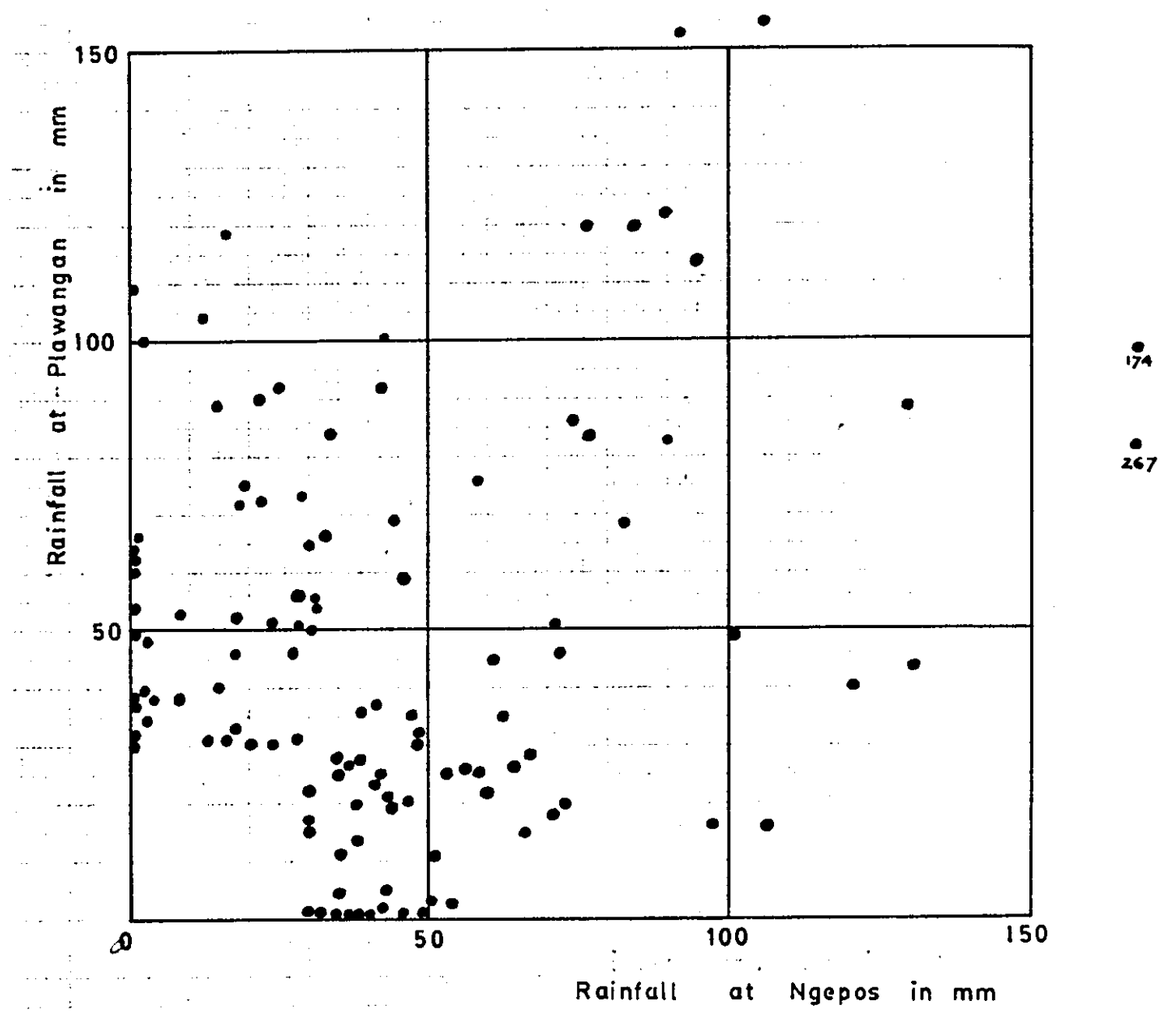
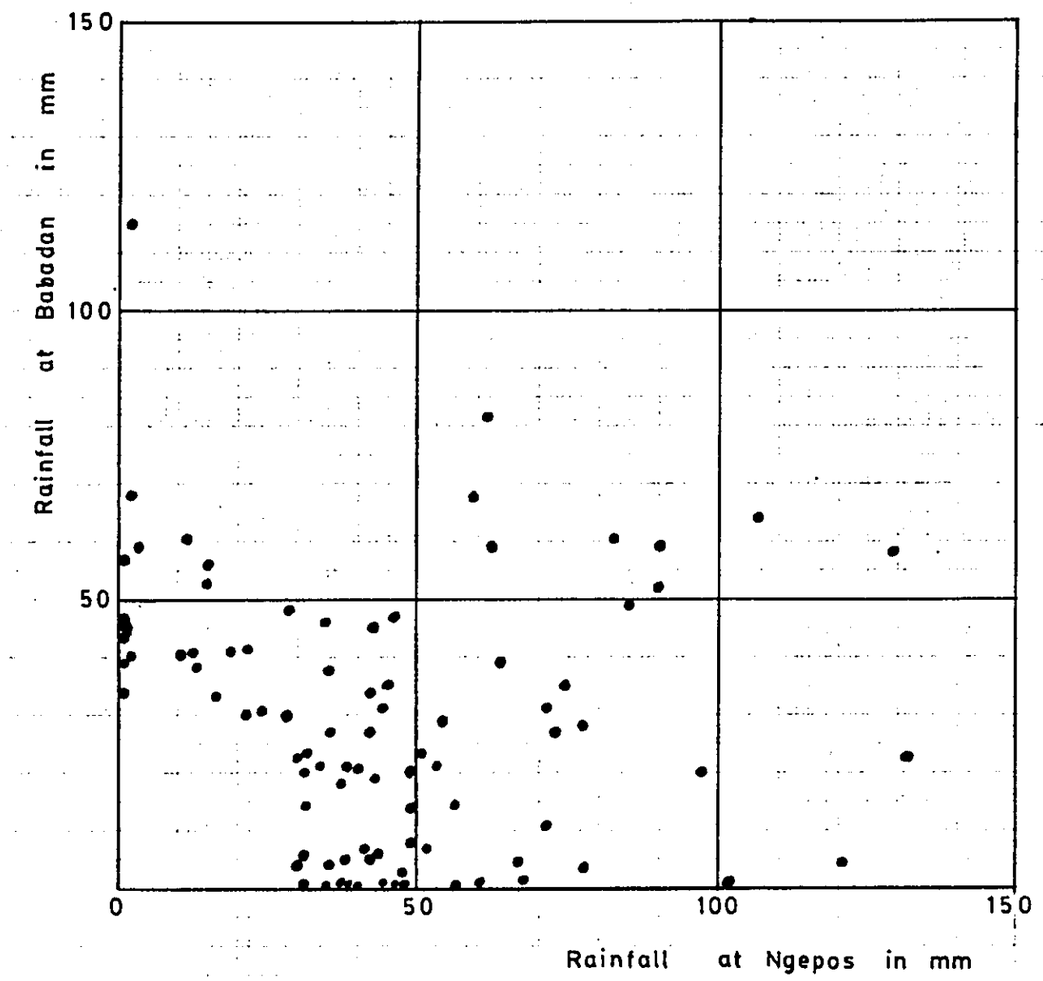


FIG. 7 DAILY RAINFALL CORRELATION (7)

NGEPOS vs. BABADAN



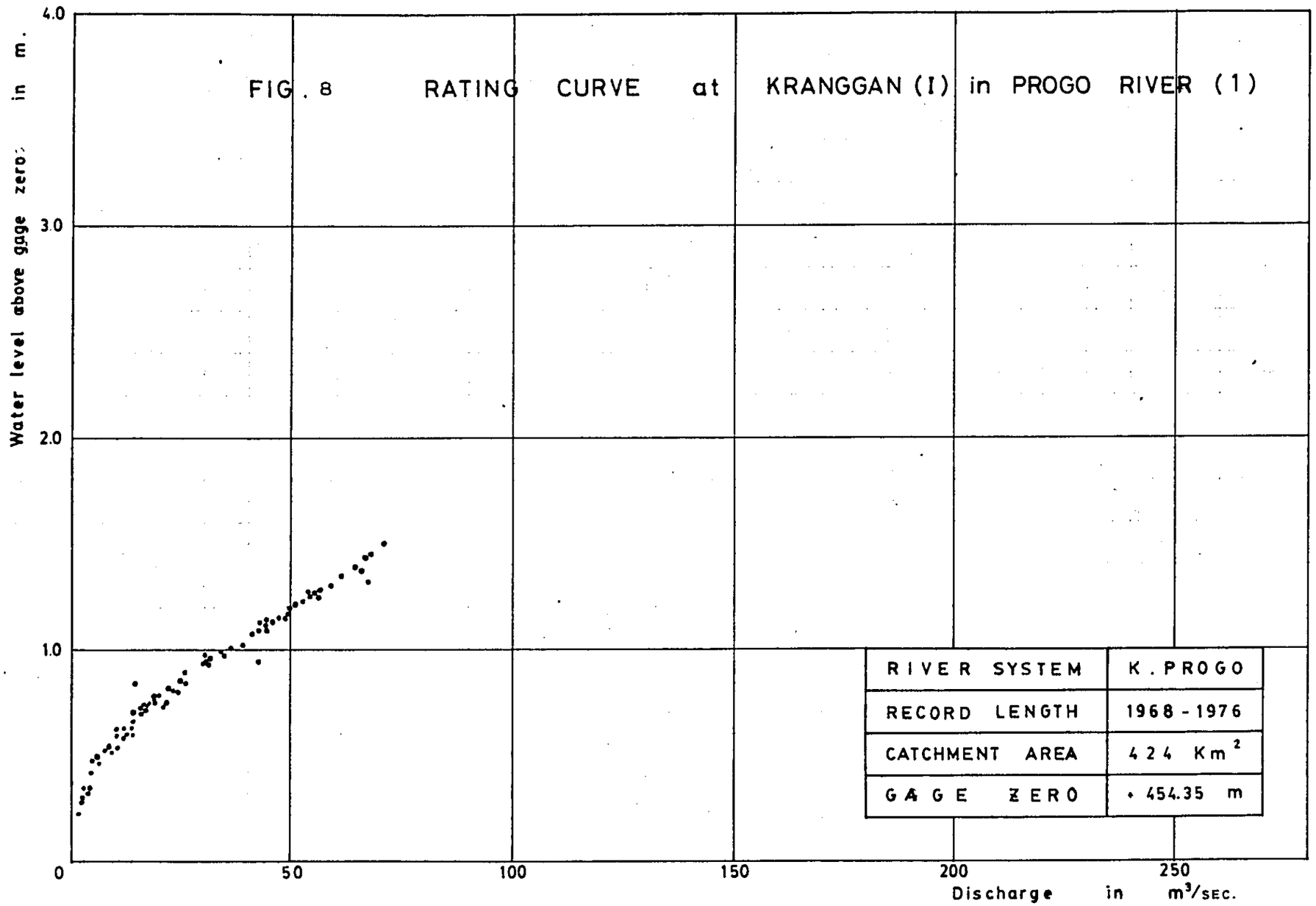


FIG. 8 RATING CURVE at KRANGGAN (I) in PROGO RIVER (1)
Water level above gage zero in m.
4.0
3.0
2.0
1.0
0
50
100
150
200
250
Discharge in m³/sec.
RIVER SYSTEM
K. PROGO
RECORD LENGTH
1968 - 1976
CATCHMENT AREA
424 Km²
GAGE ZERO
+ 454.35 m

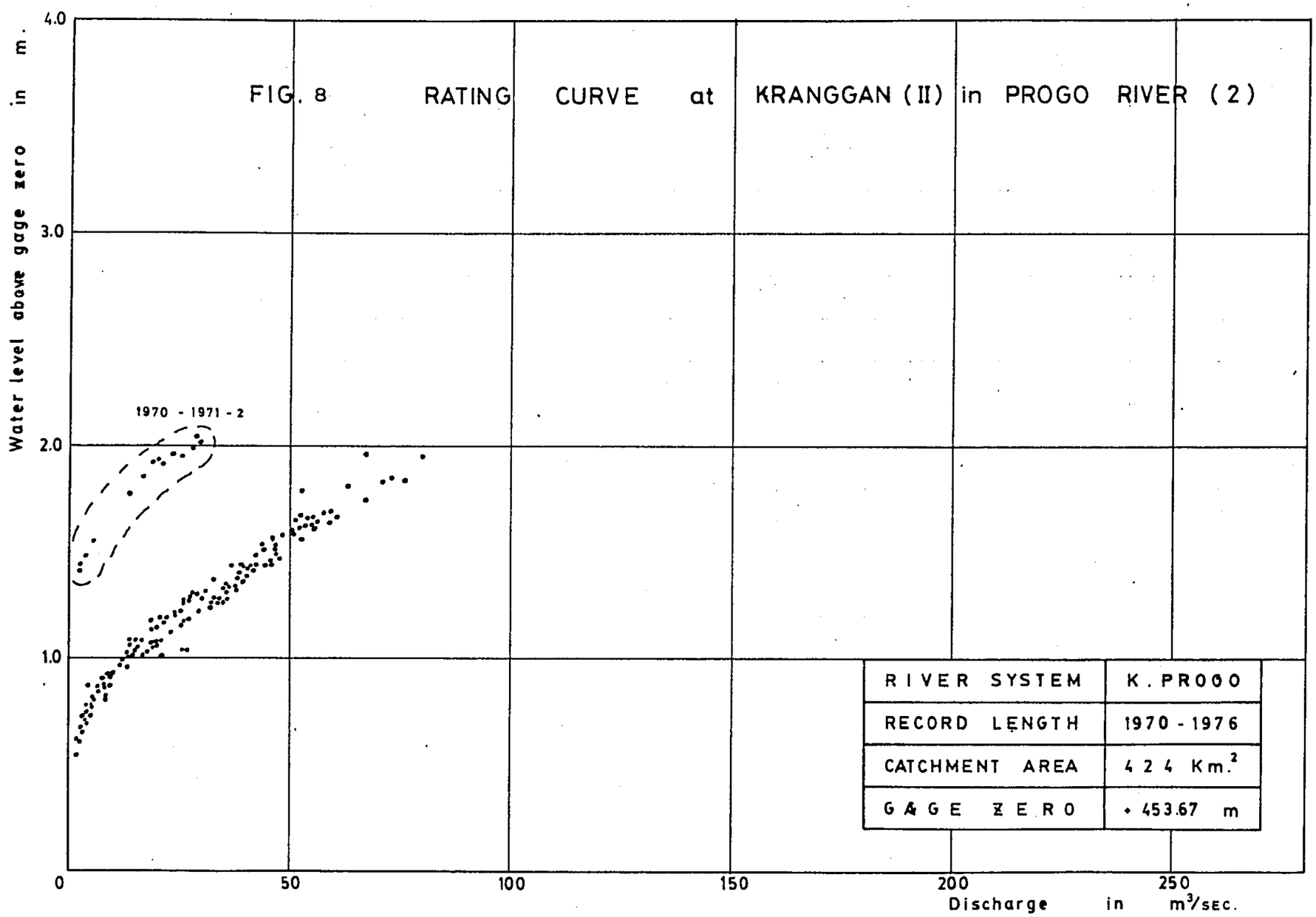


FIG. 8 RATING CURVE at KRANGGAN (II) in PROGO RIVER (2)
Water level above gage zero in m.
4.0
3.0
2.0
1.0
0
50
100
150
200
250
Discharge in m³/sec.
1970 - 1971 - 2
RIVER SYSTEM
K. PROGO
RECORD LENGTH
1970 - 1976
CATCHMENT AREA
424 Km.²
GAGE ZERO
+ 453.67 m

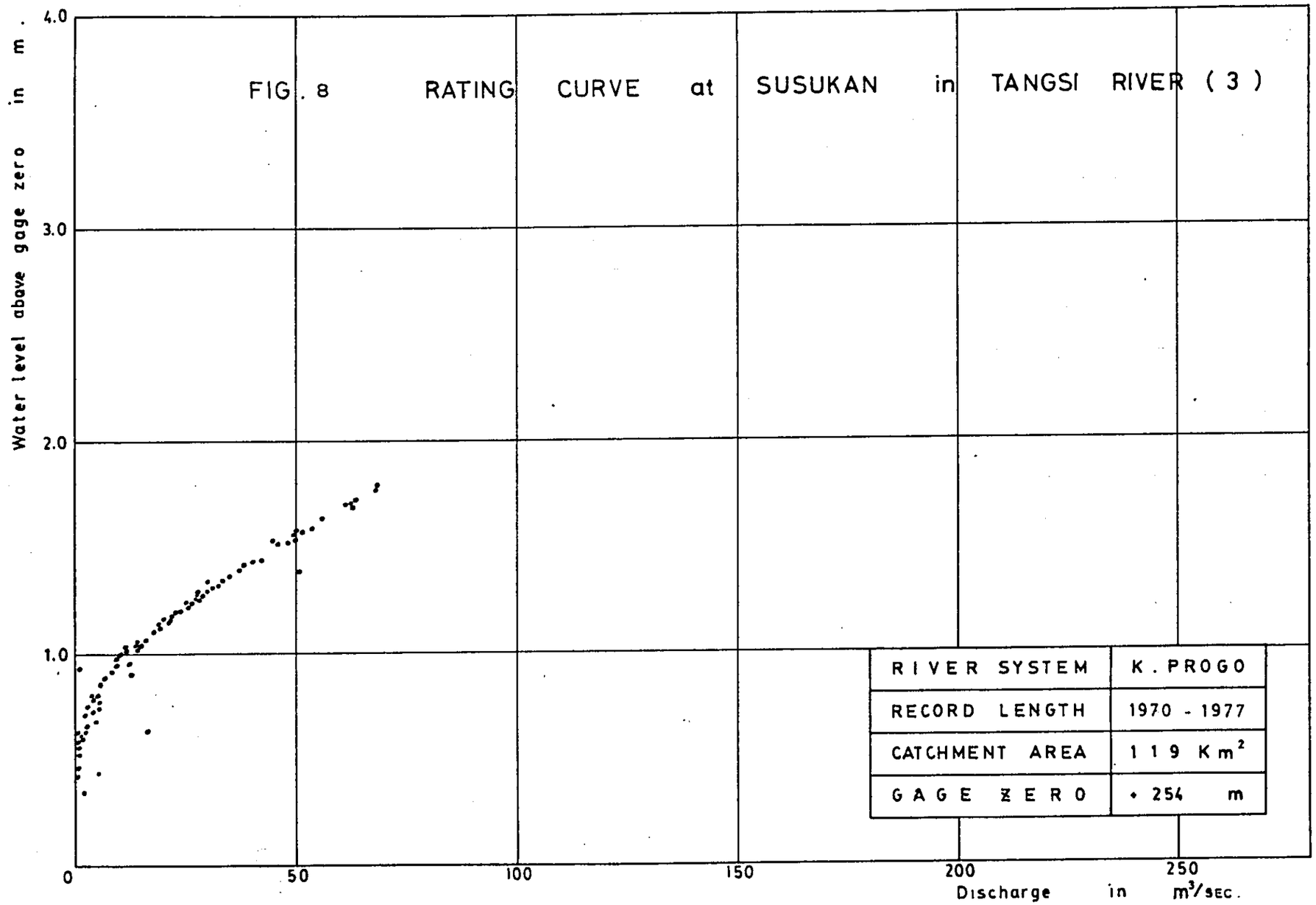


FIG. 8 RATING CURVE at SUSUKAN in TANGSI RIVER (3)
Water level above gage zero in m.
4.0
3.0
2.0
1.0
0
50
100
150
200
250
Discharge in m³/sec.
RIVER SYSTEM
K. PROGO
RECORD LENGTH
1970 - 1977
CATCHMENT AREA
119 Km²
GAGE ZERO
+ 254 m

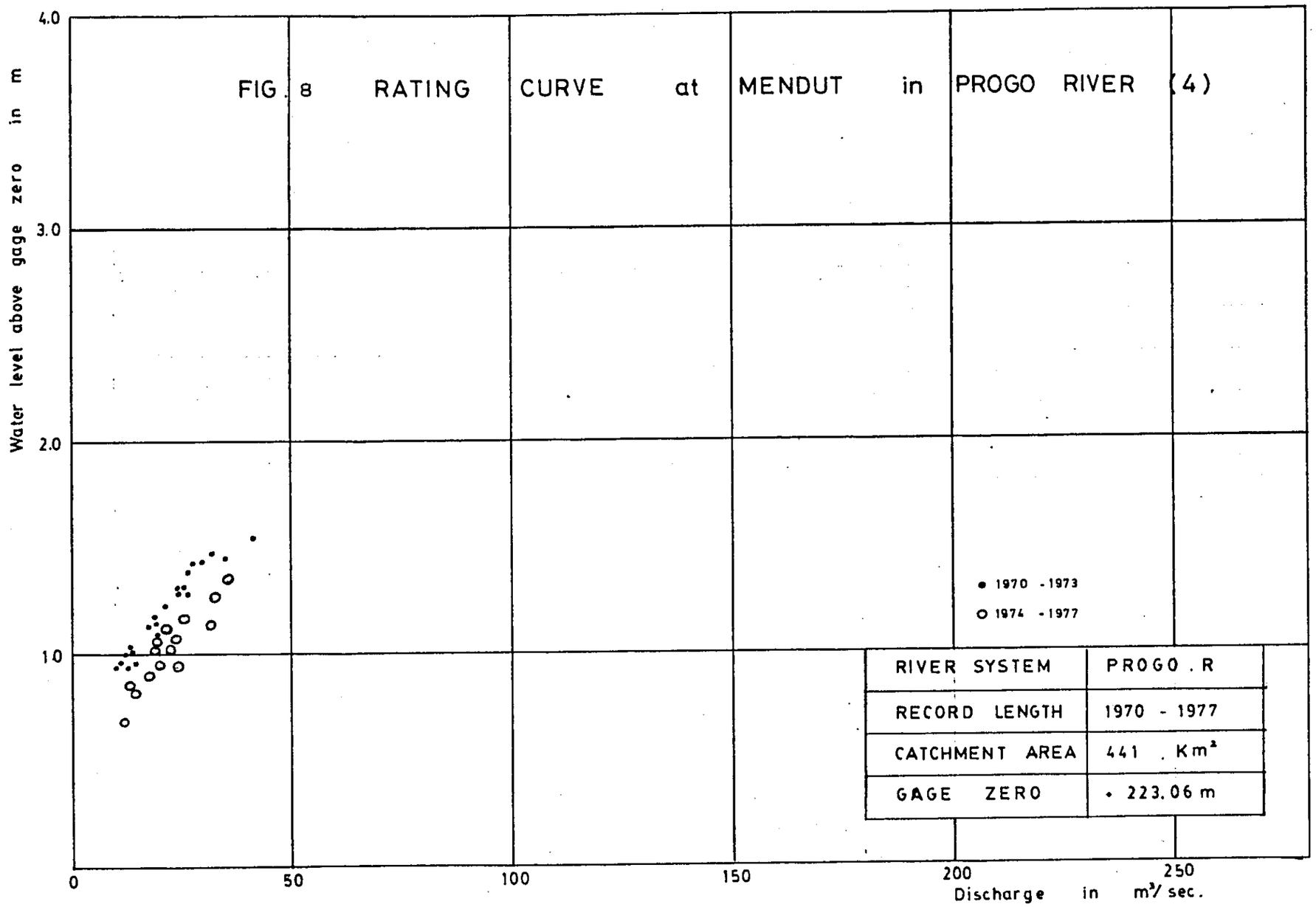


FIG. 8 RATING CURVE at MENDUT in PROGO RIVER (4)
Water level above gage zero in m
4.0
3.0
2.0
1.0
0
50
100
150
200
250
Discharge in m³/sec.
● 1970 - 1973
○ 1974 - 1977
RIVER SYSTEM
PROGO . R
RECORD LENGTH
1970 - 1977
CATCHMENT AREA
441 . Km²
GAGE ZERO
+ 223.06 m

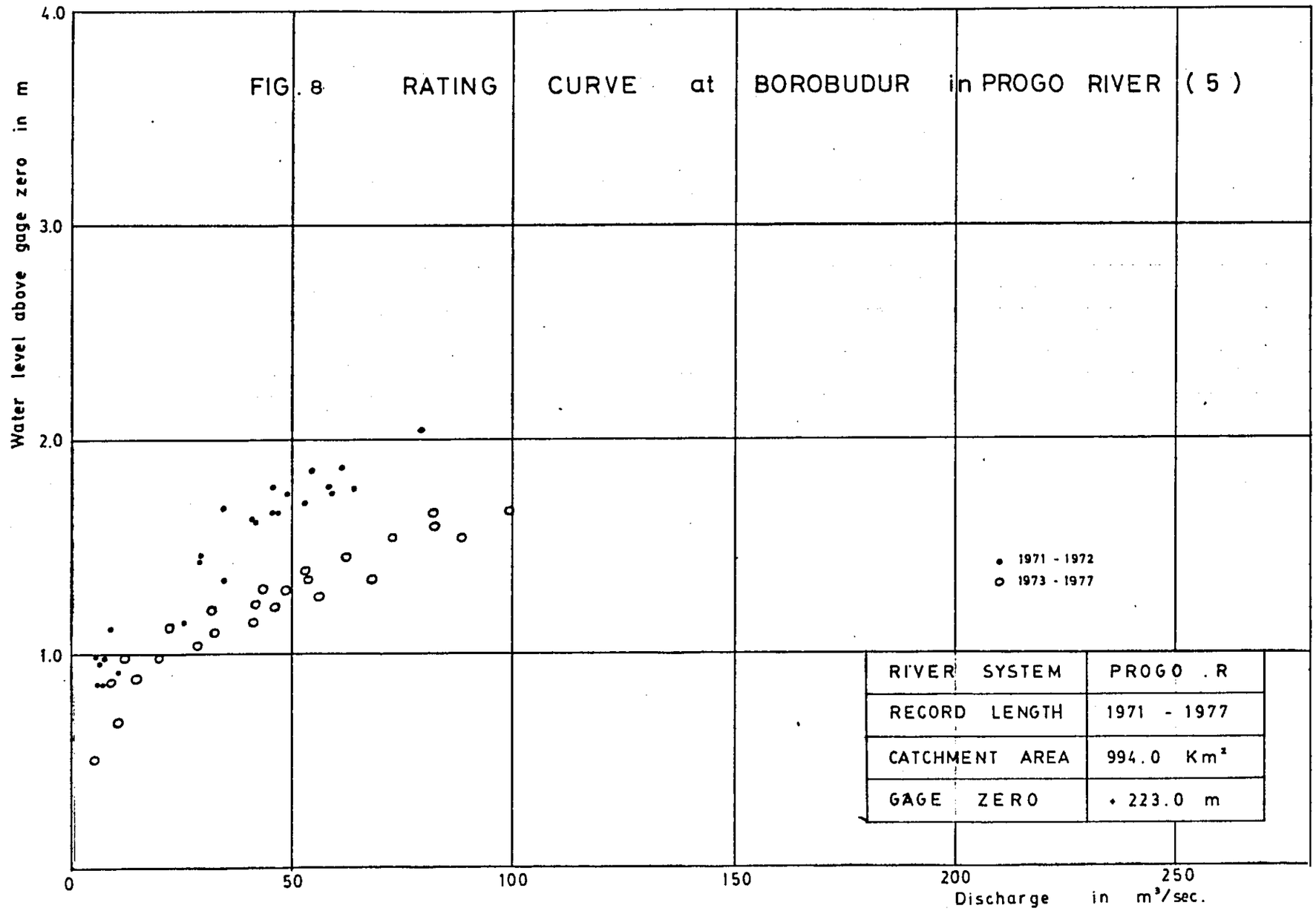


FIG. 8 RATING CURVE at BOROBUDUR in PROGO RIVER (5)
Water level above gage zero in m
4.0
3.0
2.0
1.0
0
50
100
150
200
250
Discharge in m³/sec.
1971 - 1972
1973 - 1977
RIVER SYSTEM
PROGO . R
RECORD LENGTH
1971 - 1977
CATCHMENT AREA
994.0 Km²
GAGE ZERO
+ 223.0 m

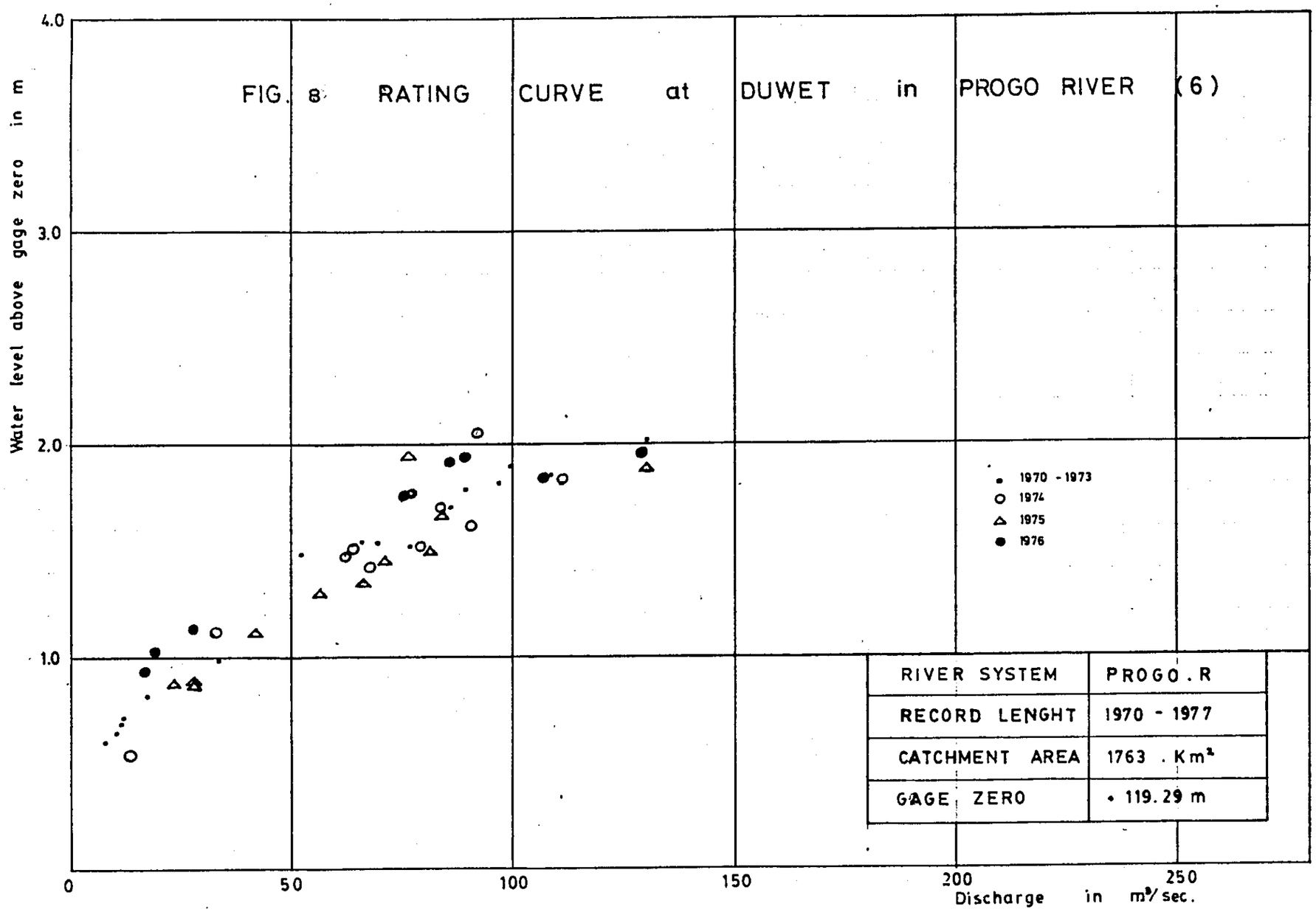


FIG. 8 RATING CURVE at DUWET in PROGO RIVER (6)
Water level above gage zero in m
4.0
3.0
2.0
1.0
0
50
100
150
200
250
Discharge in m³/sec.
1970 - 1973
1974
1975
1976
RIVER SYSTEM
PROGO . R
RECORD LENGHT
1970 - 1977
CATCHMENT AREA
1763 . Km²
GAGE ZERO
+ 119.29 m

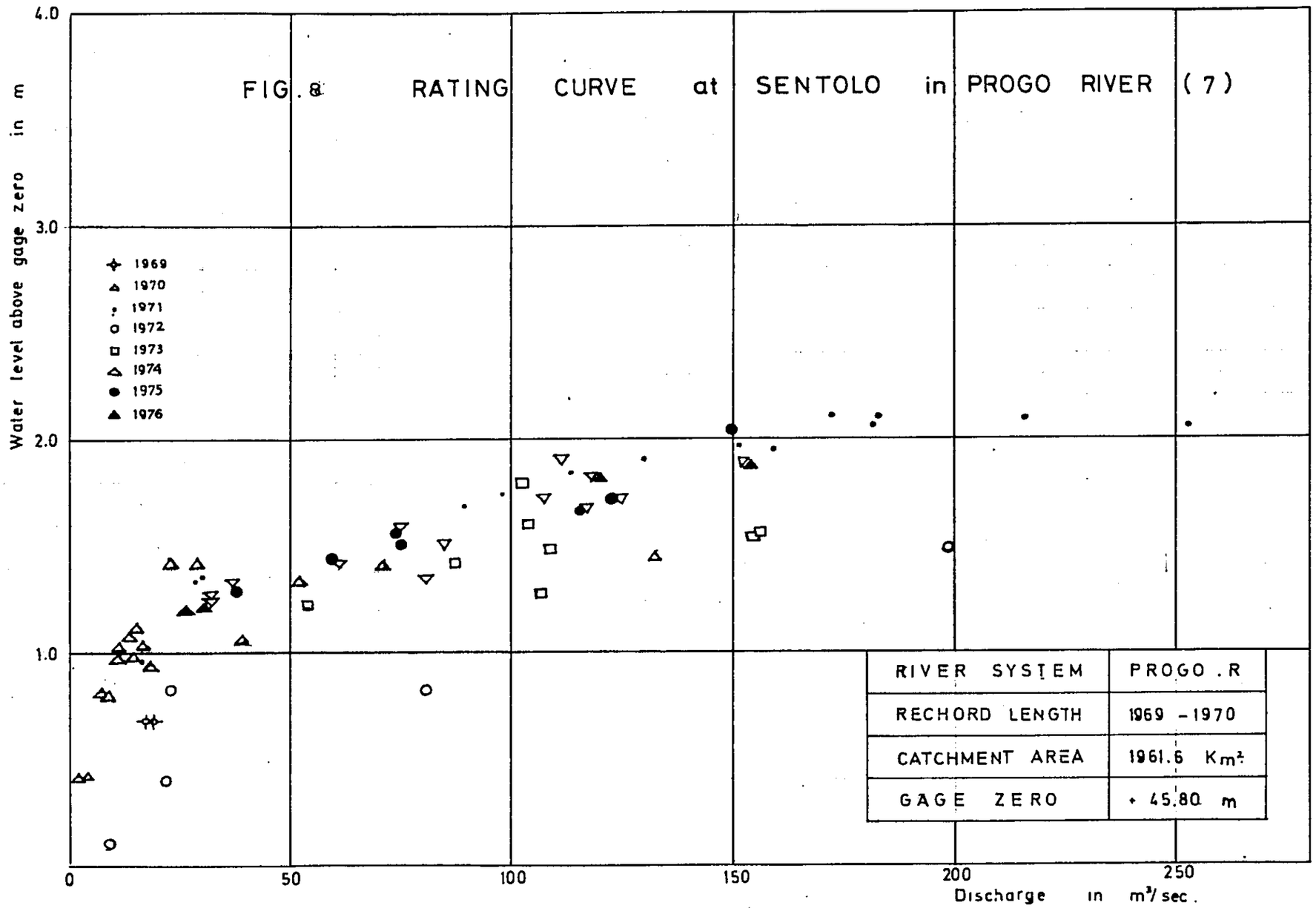


FIG. 8 RATING CURVE at SENTOLO in PROGO RIVER (7)
Water level above gage zero in m
4.0
3.0
2.0
1.0
0
50
100
150
200
250
Discharge in m³/sec.
1969
1970
1971
1972
1973
1974
1975
1976
RIVER SYSTEM
PROGO .R
RECHORD LENGTH
1969 - 1970
CATCHMENT AREA
1961.6 Km²
GAGE ZERO
+ 45.80 m

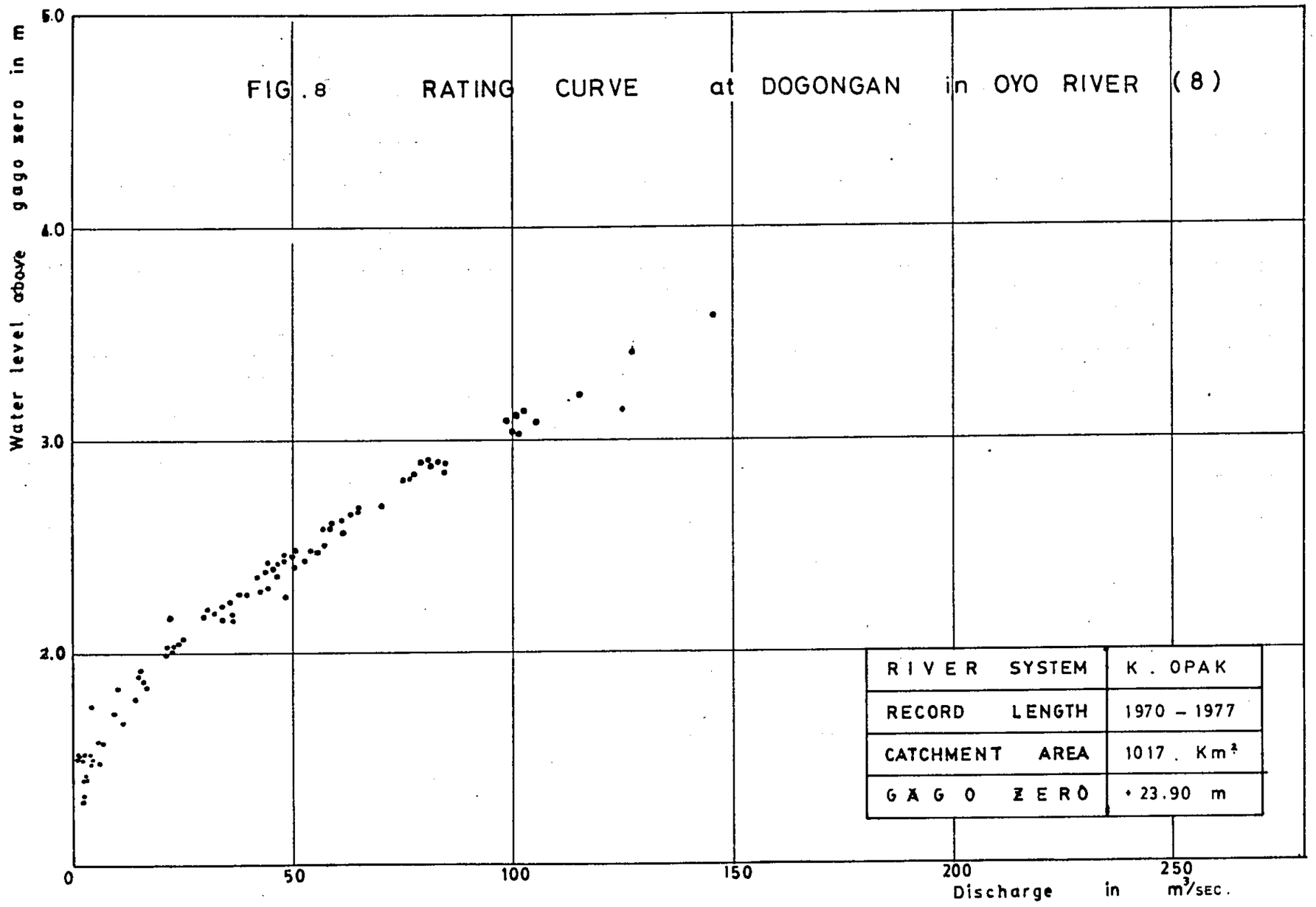


FIG. 8 RATING CURVE at DOGONGAN in OYO RIVER (8)
Water level above gago zero in m
5.0
4.0
3.0
2.0
0
50
100
150
200
250
Discharge in m³/sec.
RIVER SYSTEM
K. OPAK
RECORD LENGTH
1970 – 1977
CATCHMENT AREA
1017. Km²
GAGO ZERO
+ 23.90 m

FIG. 9 WARNING SYSTEM OF LAHAR

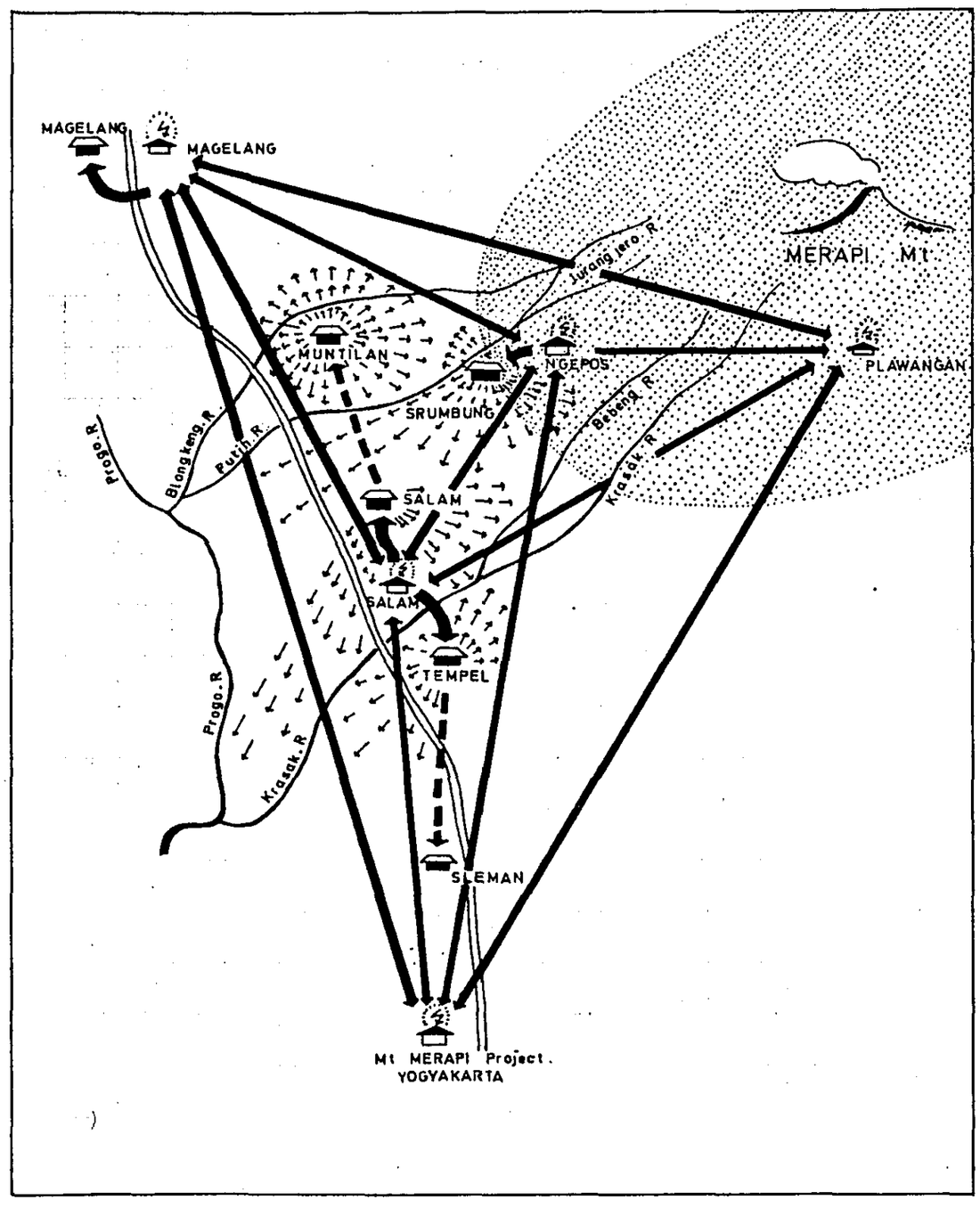


FIG. 10 TYPICAL HIDROGRAPH OF WATER LEVEL IN RAINY SEASON

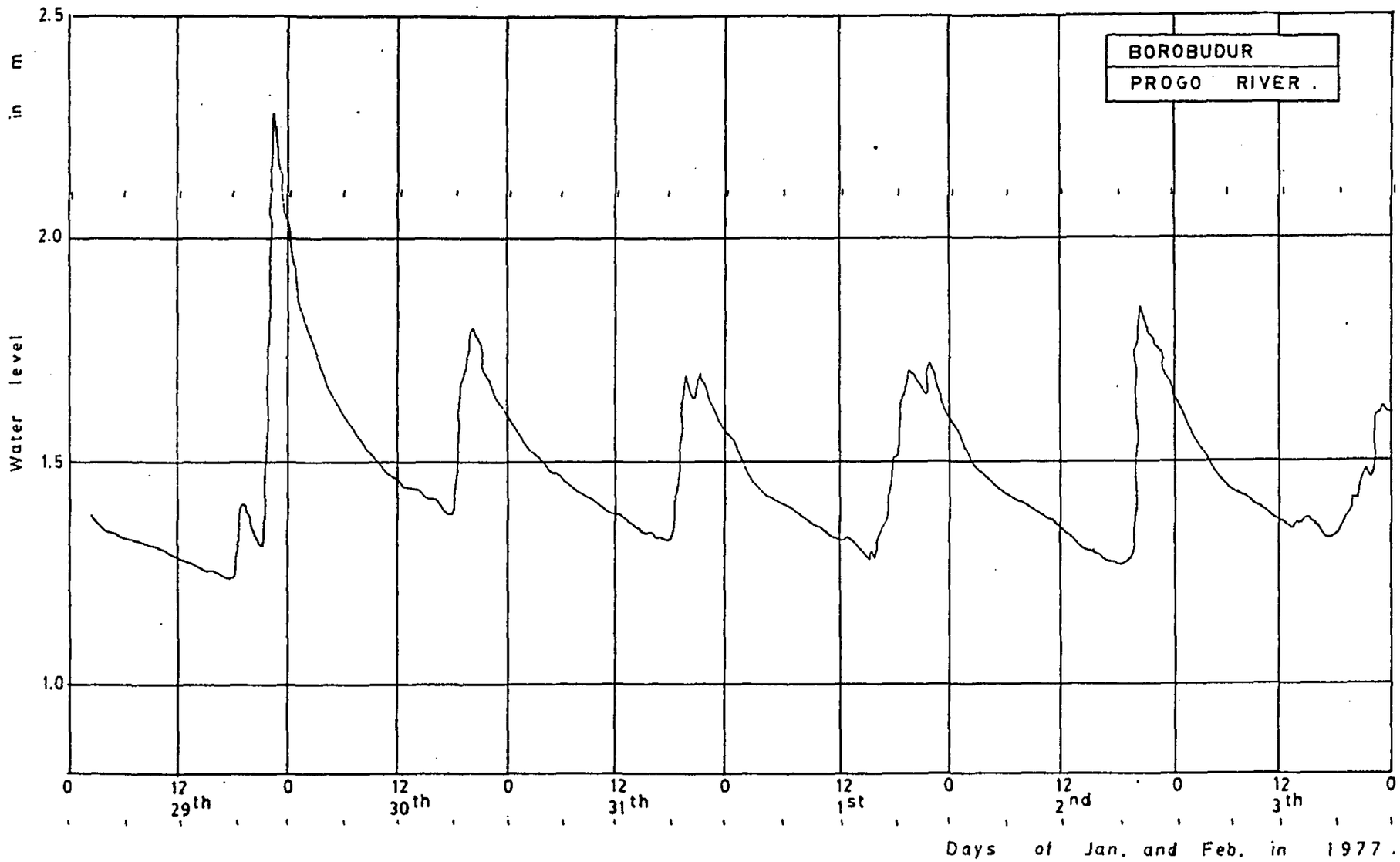


FIG. 11 PROBABLE DISCHARGE AT BLAWANG WEIR IN OPAK RIVER

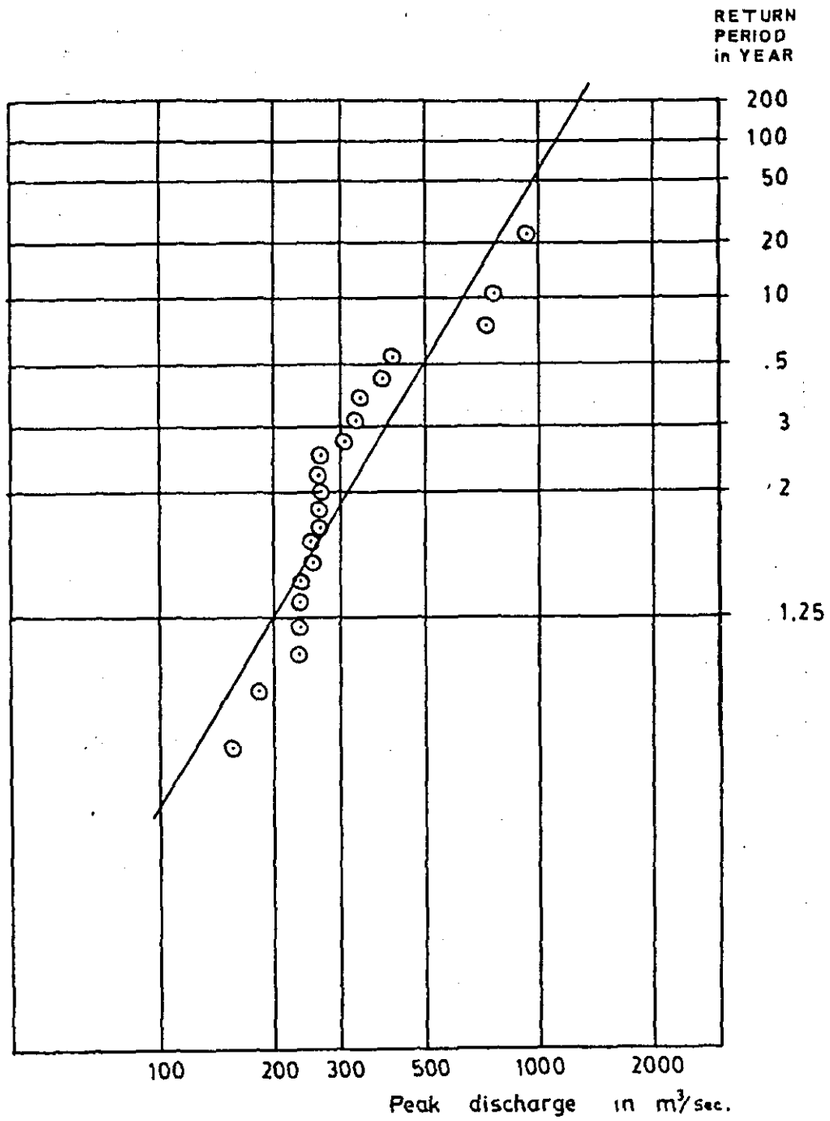
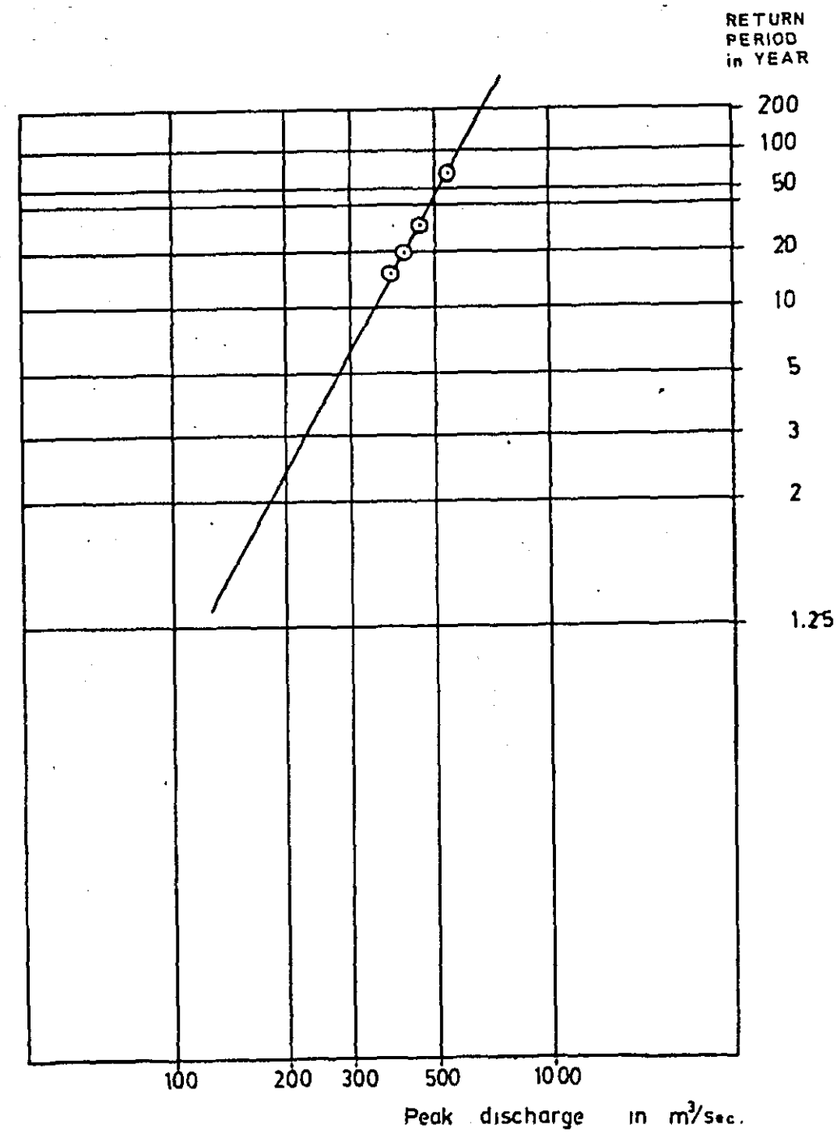


FIG 12 PROBABLE DISCHARGE AT KRASAK WEIR IN KRASAK RIVER.



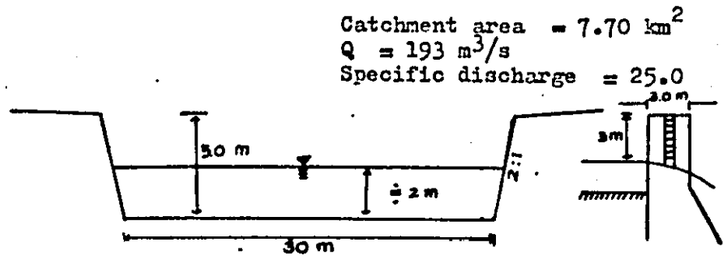


Fig. 13 Estimated peak stage at Jurang jero check dam on 25th Nov.1976.

FIG 14 DIUNAL DISTRIBUTION OF RAINFALL

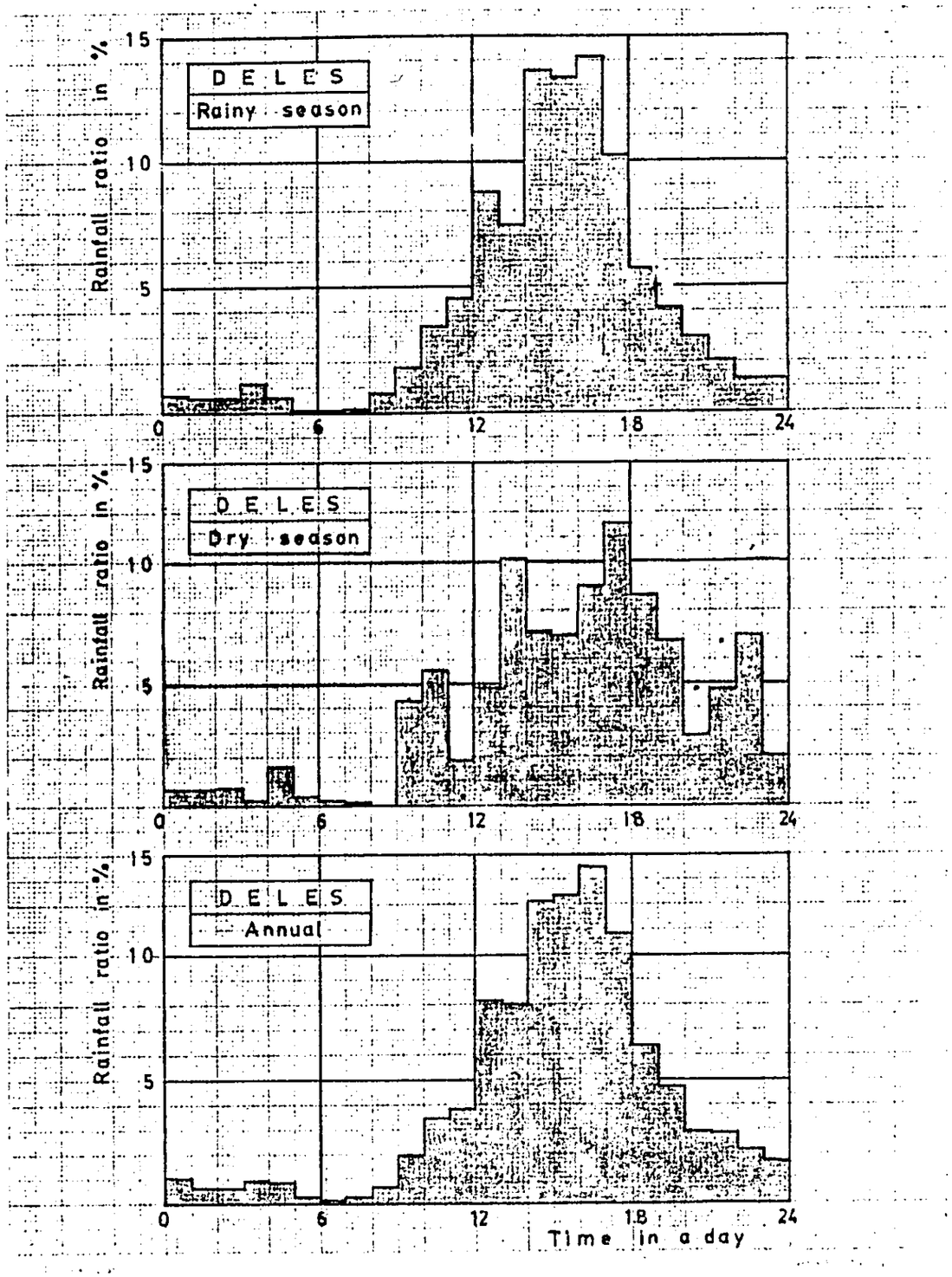


Fig 15 FLOOD DISCHARGE FREQUENCY CURVES FOR PROGO AND OPAK BASINS

(After Kali Progo · Basin study")

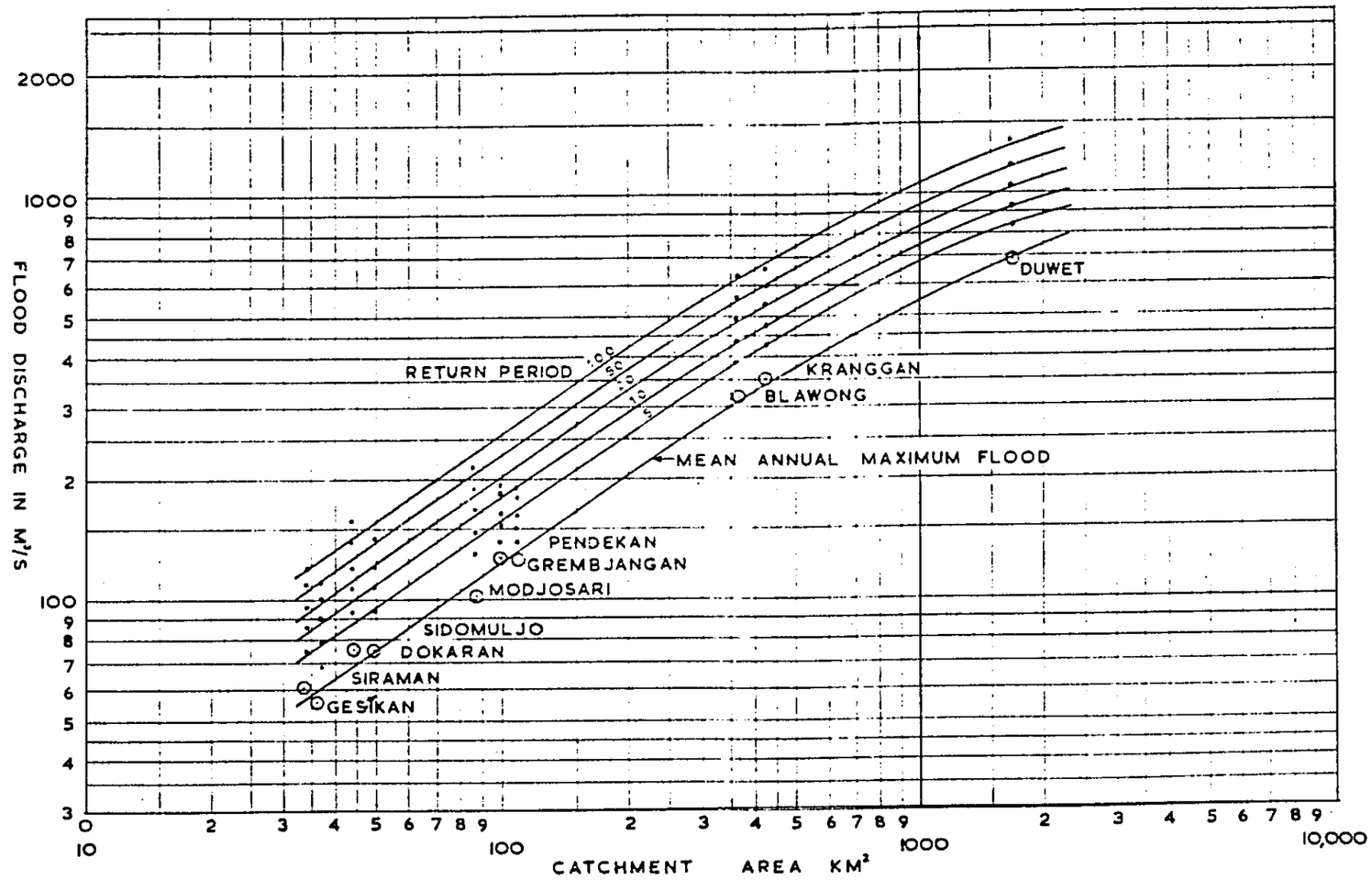


Fig 16 Influence of Inundation on Peak Discharge

(Bengawan Solo Basin , Probable year = 40)

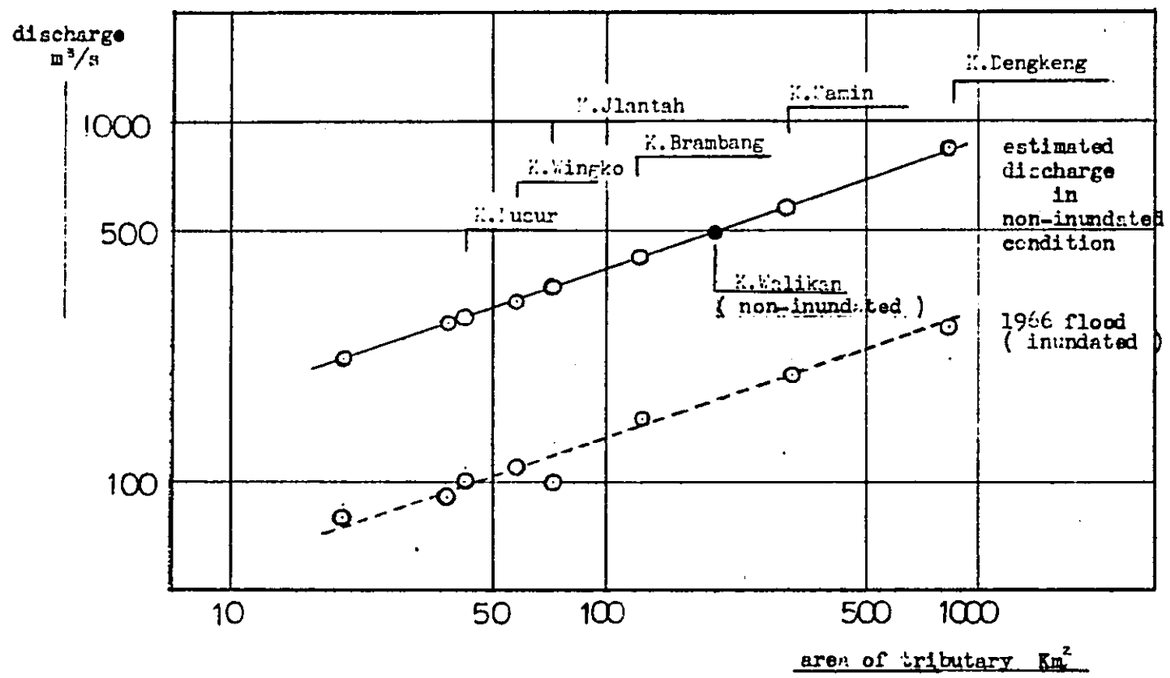


Fig 17 Specific Discharge versus Catchment area in Indonesia

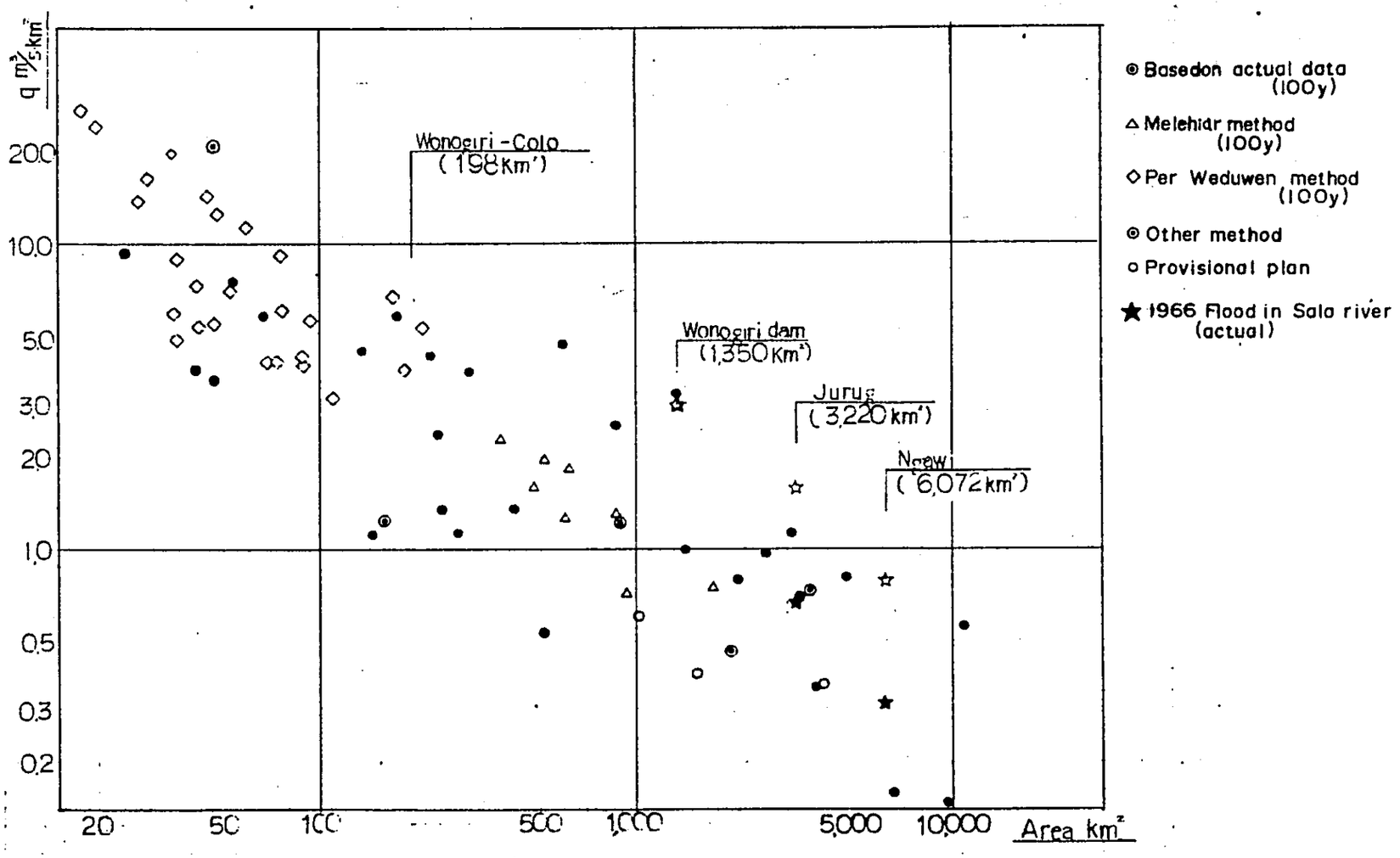
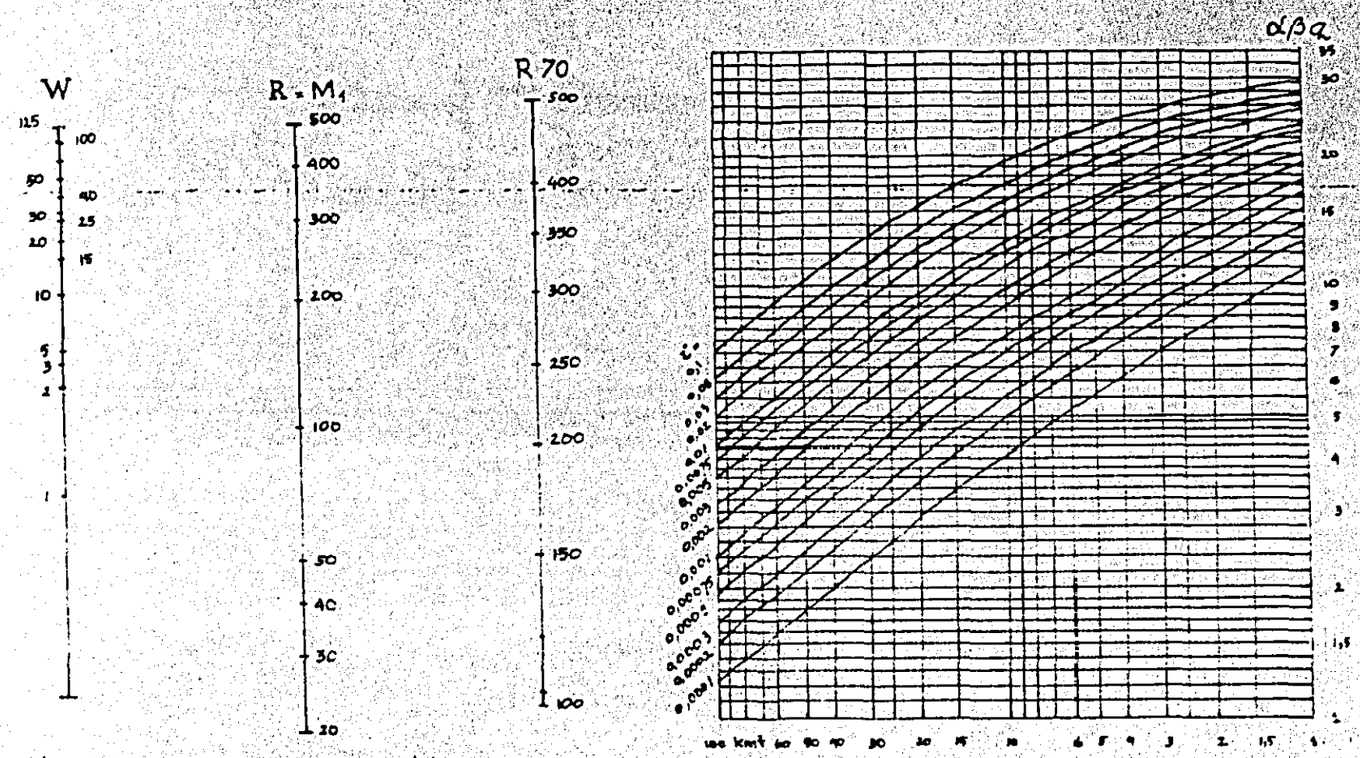


Fig 1.8 Weduwent's method on Peak Discharge Estimation



M_1 = air hujan terbesar yang diselidiki dalam waktu tertentu ($R = M_1$).

W = banyaknya tahun selama penyelidikan.

Untuk daerah mengaliran < 1 km², αβq diambil = 1 km²

αβq = banyaknya air yang mengalir dalam m³/dt tiap² km², dengan air hujan sebesar 240 mm. selama 24 jam.

= R 70 untuk Jakarta.

R-70 dalam mm	5 x tiap² tahun	1 x tiap² tahun	1 x tiap² 5 tahun	1 x tiap² 10 tahun	1 x tiap² 20 tahun	1 x tiap² 50 tahun	1 x tiap² 100 tahun
140	0,139	0,239	0,351	0,411	0,473	0,533	0,612
150	0,149	0,256	0,376	0,441	0,507	0,583	0,656
160	0,159	0,273	0,402	0,470	0,541	0,632	0,700
170	0,169	0,290	0,426	0,499	0,574	0,671	0,743
180	0,178	0,308	0,452	0,529	0,608	0,711	0,785
190	0,188	0,324	0,476	0,568	0,642	0,750	0,830
200	0,198	0,342	0,501	0,587	0,676	0,790	0,875
210	0,208	0,359	0,527	0,625	0,710	0,830	0,919
220	0,218	0,376	0,552	0,646	0,744	0,869	0,961
230	0,228	0,393	0,577	0,675	0,777	0,908	1,006
240	0,238	0,410	0,602	0,705	0,811	0,948	1,030
250	0,248	0,427	0,627	0,735	0,845	0,988	1,094
260	0,258	0,444	0,652	0,764	0,878	1,027	1,137
270	0,268	0,461	0,677	0,793	0,912	1,067	1,18
280	0,278	0,478	0,702	0,823	0,946	1,106	1,225
290	0,288	0,495	0,723	0,852	0,980	1,146	1,268
300	0,298	0,513	0,753	0,881	1,014	1,165	1,313

CONTOH

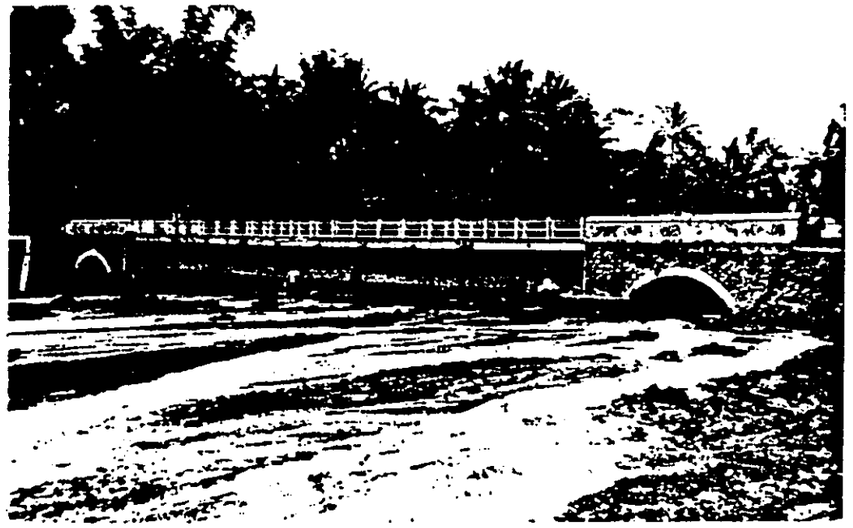
DIKETAHUI: Air hujan max. dalam 24 jam yang diselidiki selama 25 tahun = 212 mm.
F = 62,1 km² c = 0

DITANYAKAN: Max. afvoer yang sekali dapat terjadi atau melebihi dari 25 tahun.

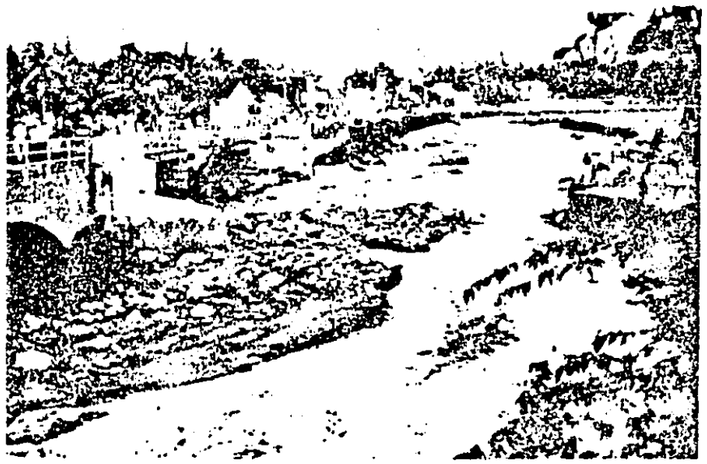
JAWAB: Dari nomogram sebelah kiri ditemukan R 70 = 257
Dari grafiek sengah αβq = 9,16
Untuk R 70 = 250 terdapat max. afvoer (pemrosi
5 x tiap² tahun = 9,16 x 62,1 x 0,248 = 14,1 m³/dt
1 x tiap² 20 tahun = 9,16 x 62,1 x 0,845 = 48,0 m³/dt

FIG. 19 DAMAGE BY LAHAR IN THE MERAPI AREA

(1)



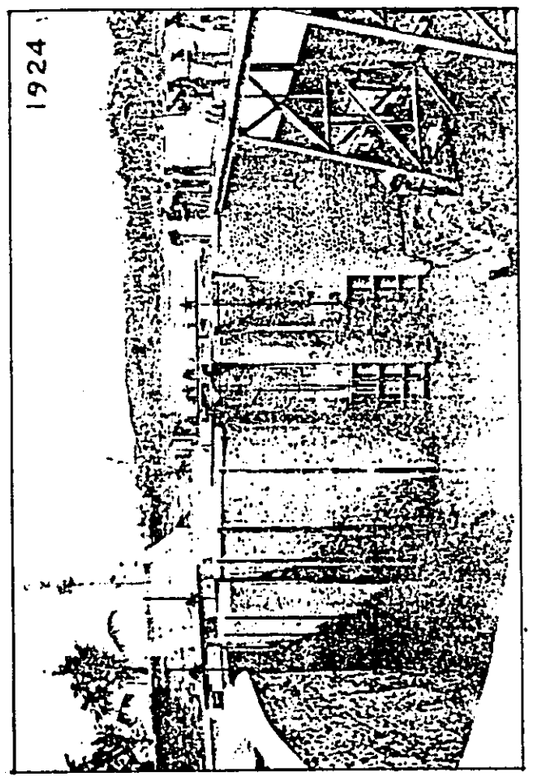
(3)



(2)

1. The old Salam bri. in Krasak River in 1975.
2. Just after the lahar on 25th Nov. 1976 at the old - Salam bri. The River bed rised about 4 m at - a time.
3. The Ngepos bri. : in Putih River just after - the 1976 lahar.

FIG. 20 RIVER BED RISE IN PROGO AT KAMIJORO INTAKE WEIR SITE.



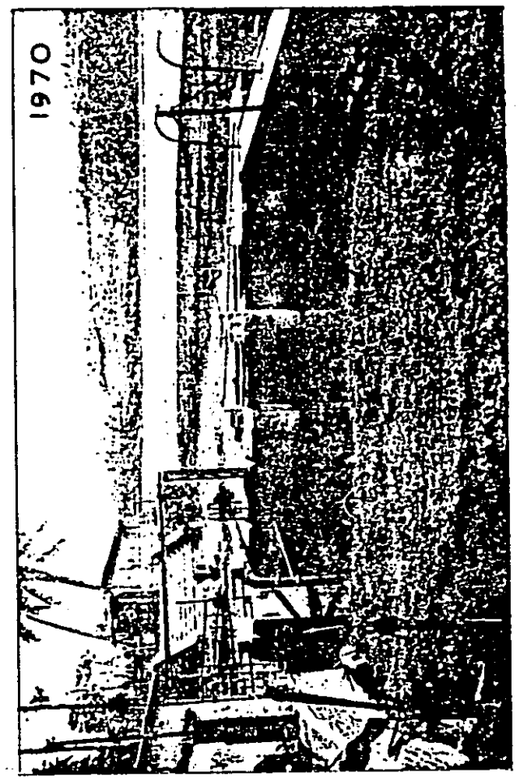


FIG. 21 HISTORY OF KAMIJORO INTAKE WEIR

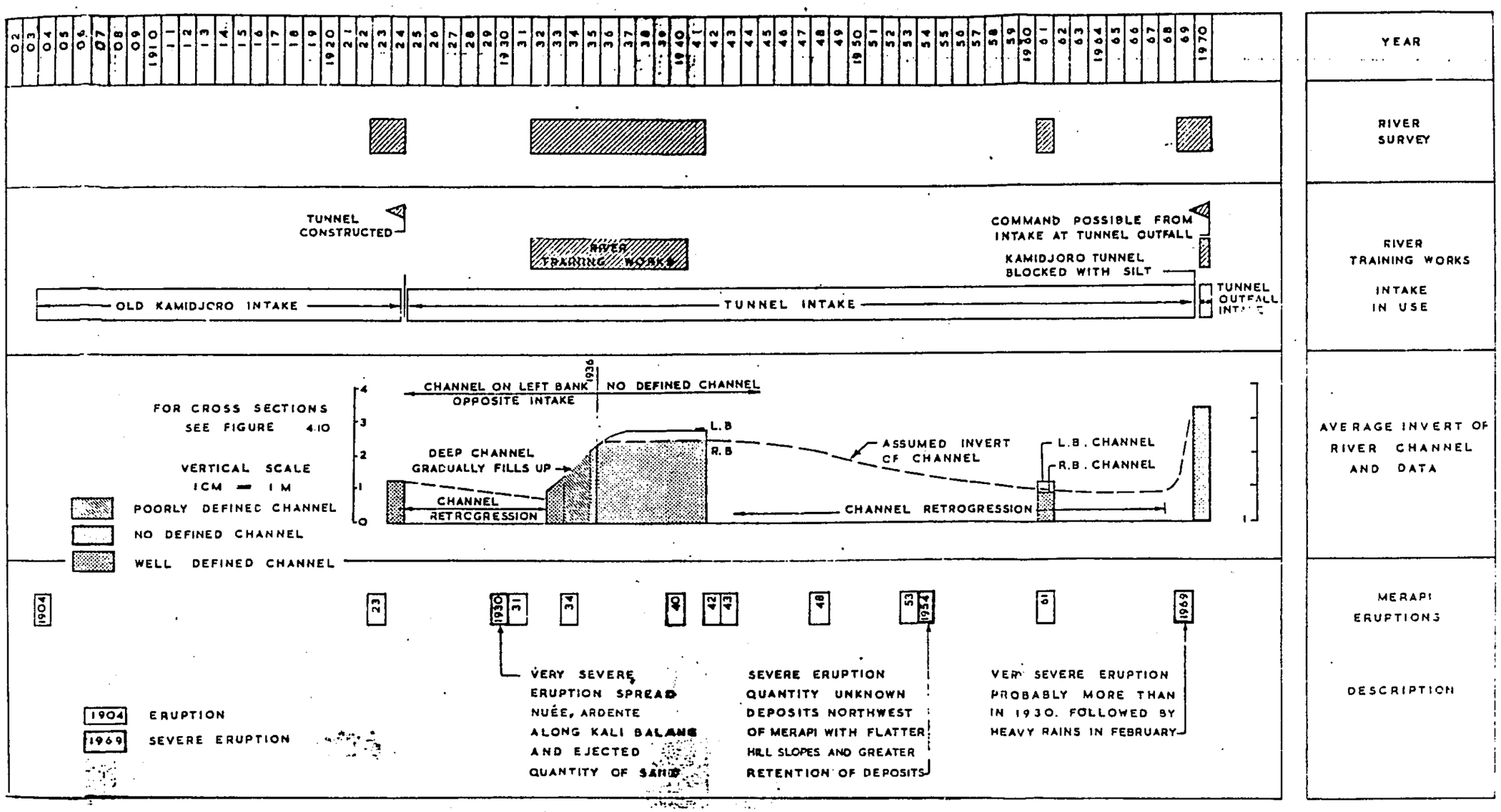


FIG. 22 CROSS SECTION OF PROGO . RIVER ARROUND KAMIJORO WEIR

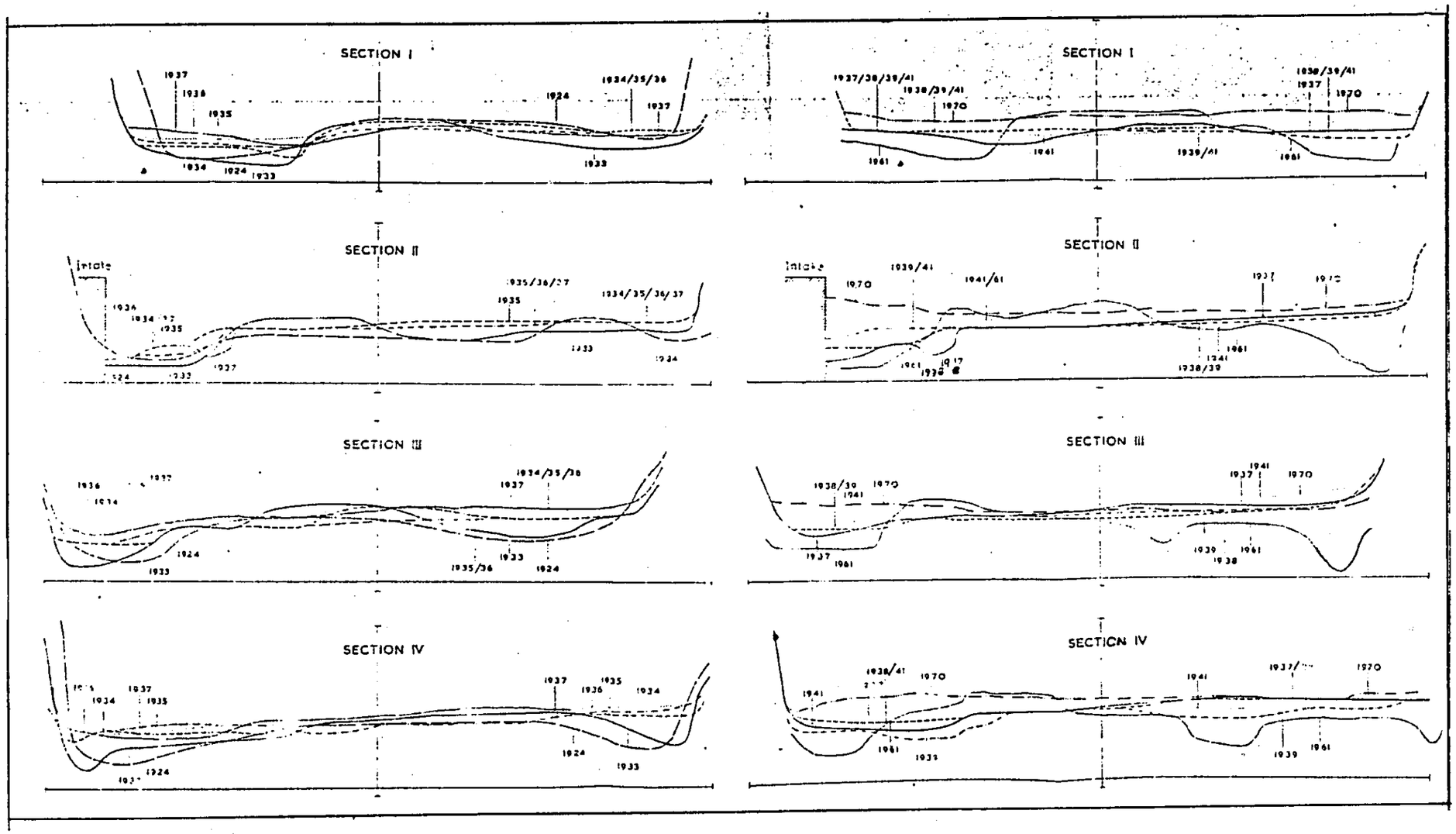
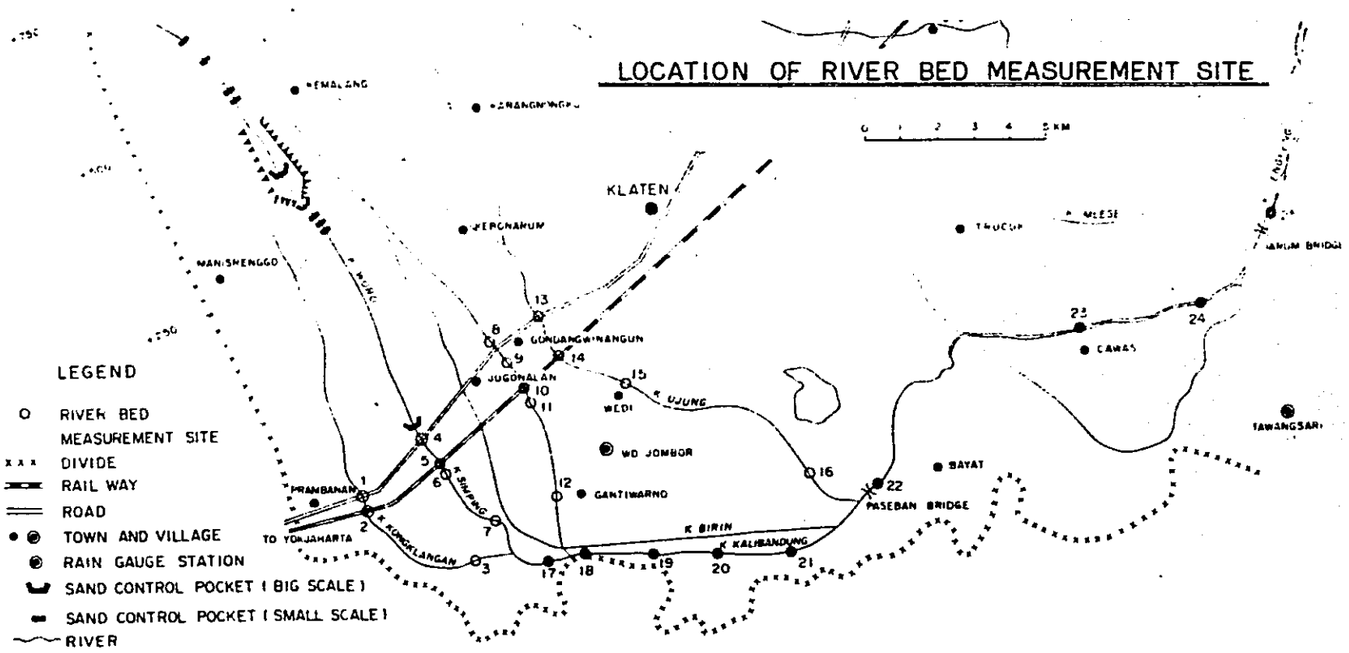
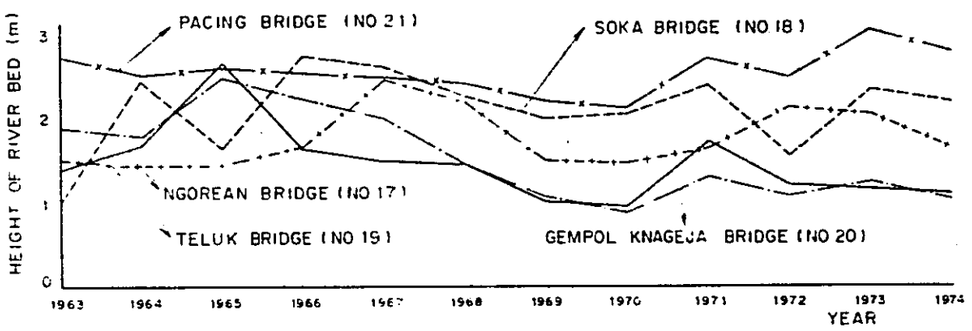


FIG. 23 RIVER BED VARIATION ALONG DENGKENG RIVER.





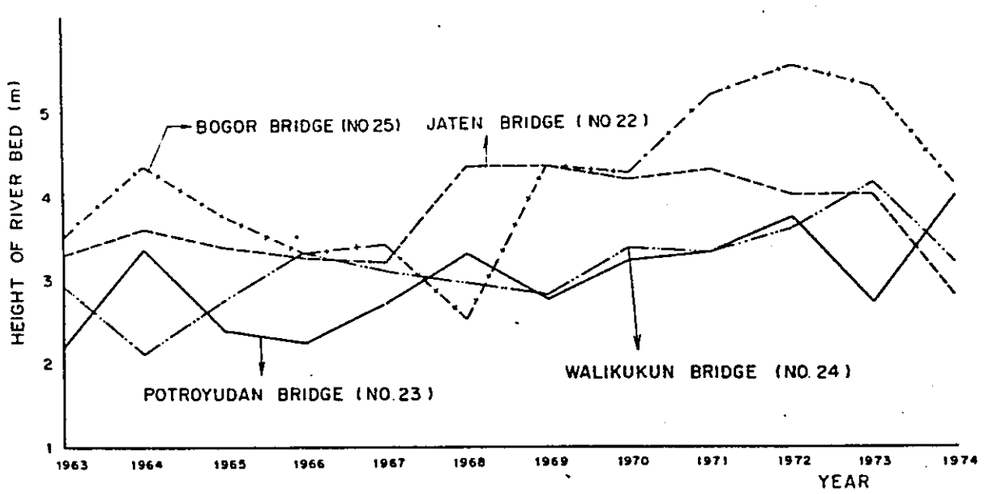


FIG. 24 RIVER MOUTH CLOG (1)

TOPOGRAPHIC MAP 1955 - 1957

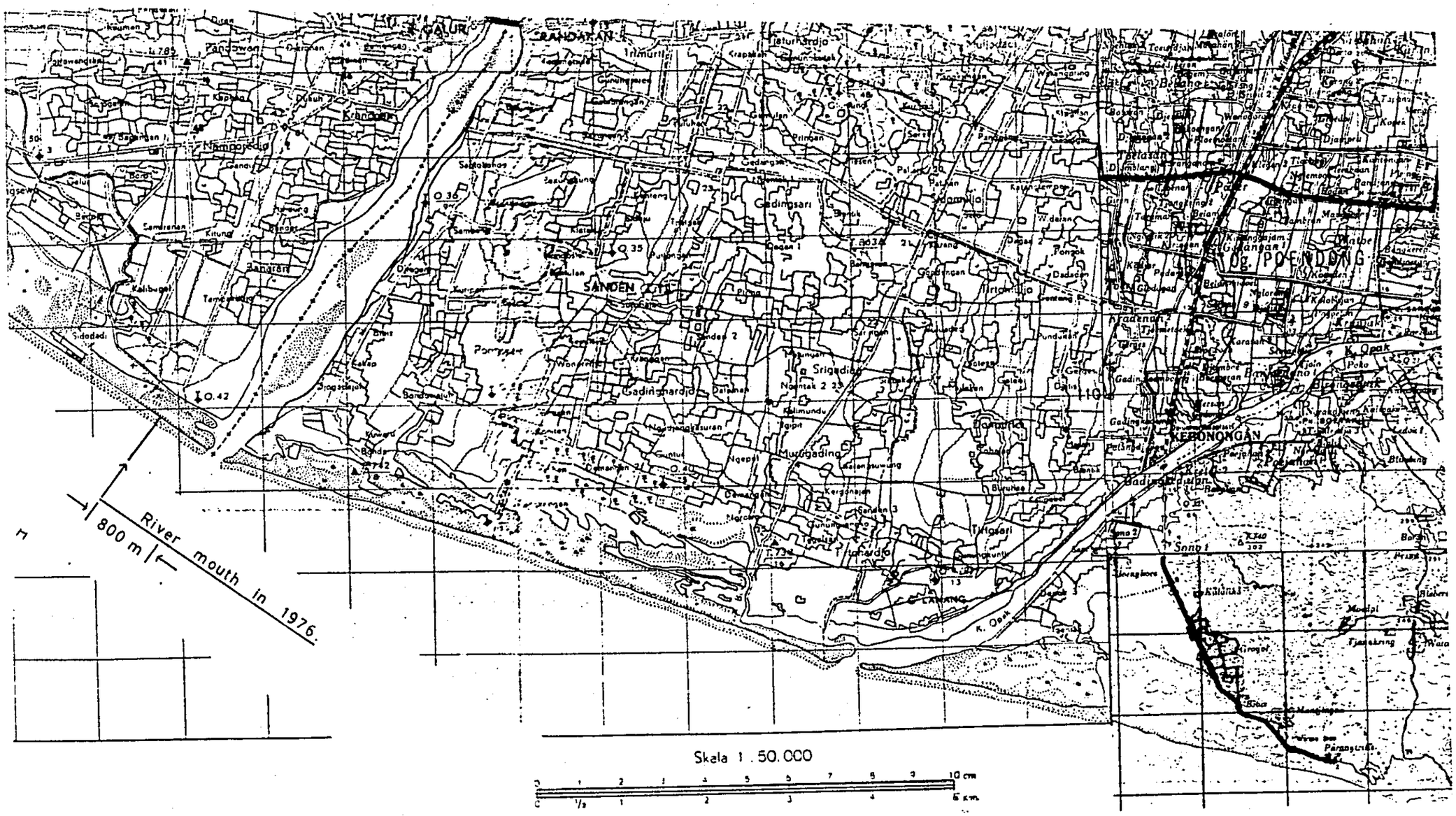


FIG. 24 RIVER MOUTH CLOG (2)

AIRAL PHOTOGRAPH 1976

Fig 25 GRAIN SIZE DISTRIBUTION ALONG KRASAK RIVER (1)

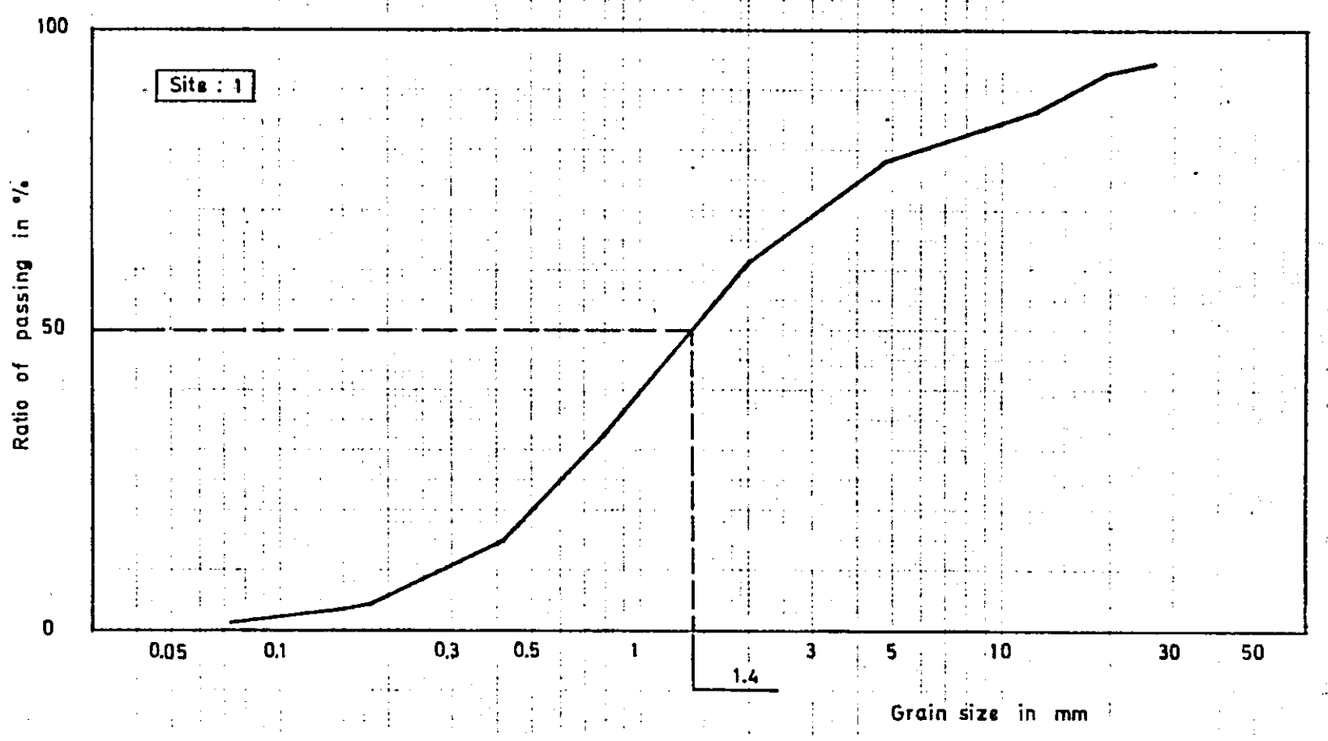


Fig 25 GRAIN SIZE DISTRIBUTION ALONG KRASAK RIVER (2)

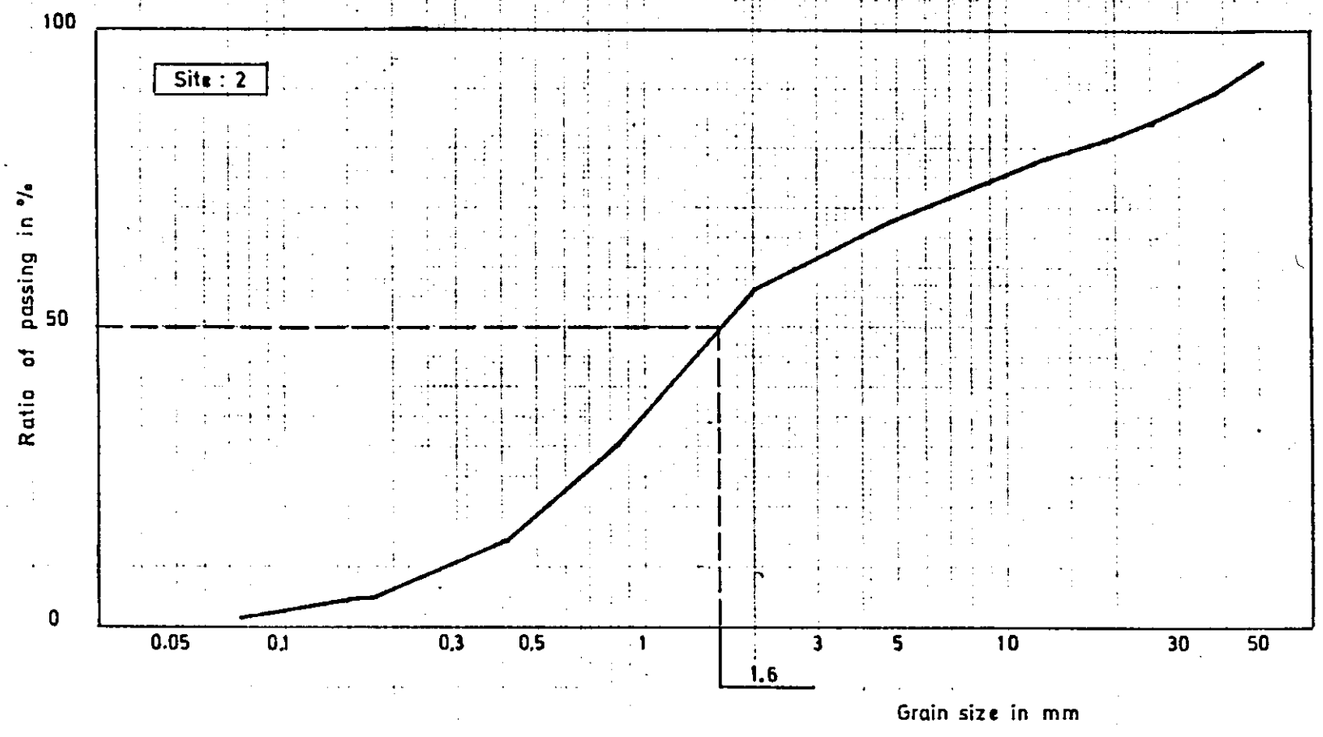


Fig 25 GRAIN SIZE DISTRIBUTION ALONG KRASAK RIVER (3)

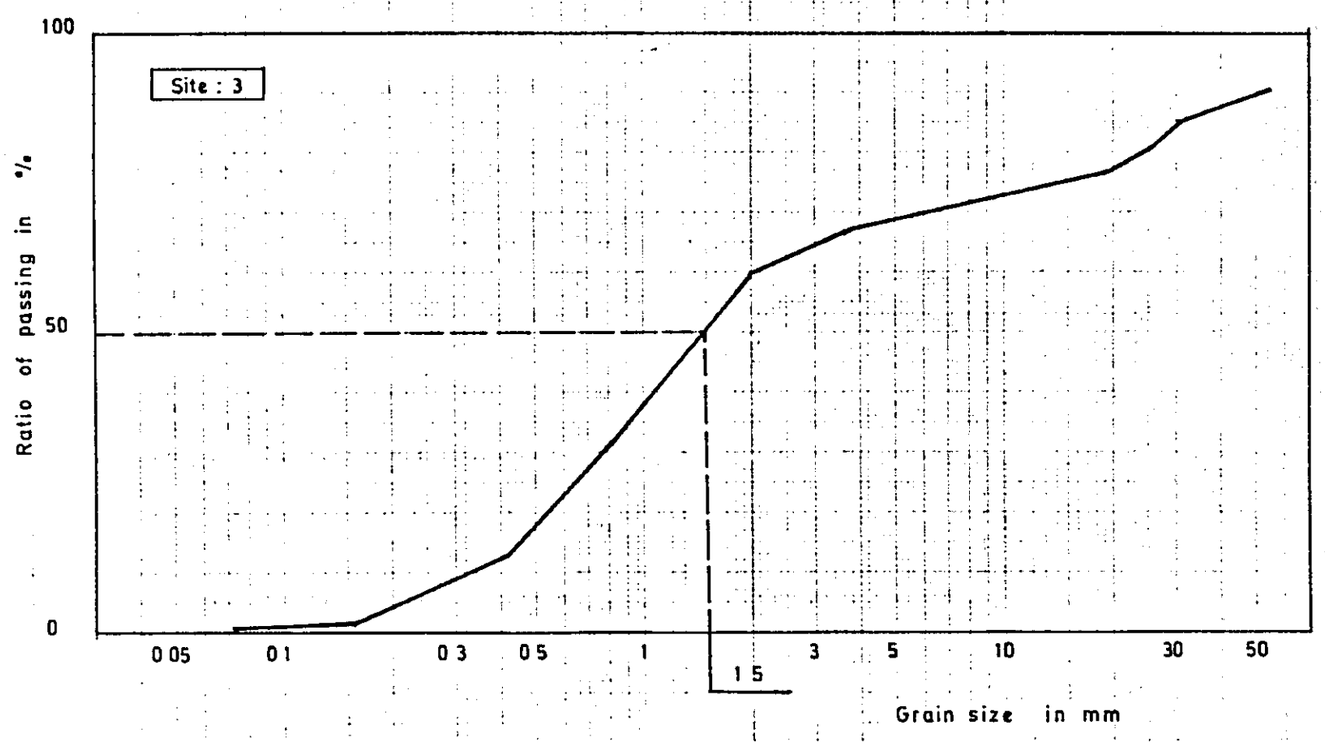


Fig 25 GRAIN SIZE DISTRIBUTION ALONG KRASAK RIVER (4)

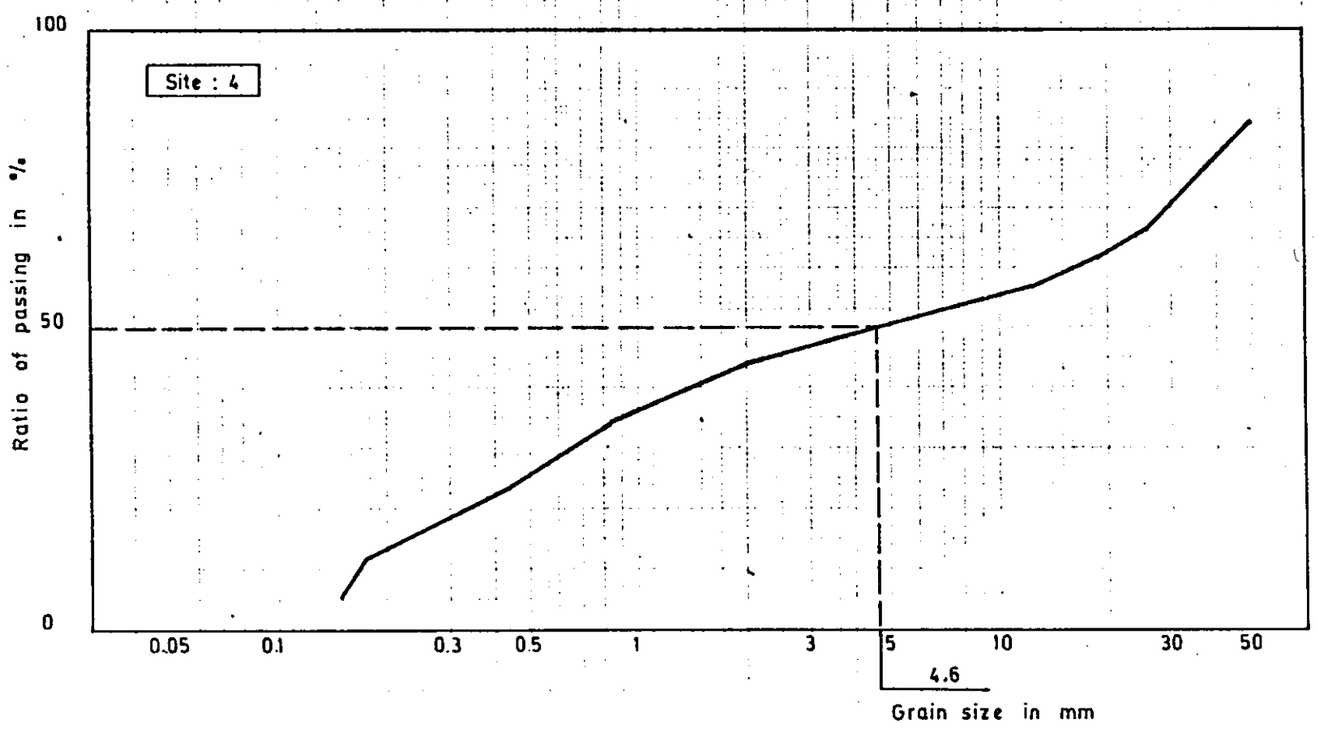


Fig 25 GRAIN SIZE DISTRIBUTION ALONG KRASAK RIVER (5)

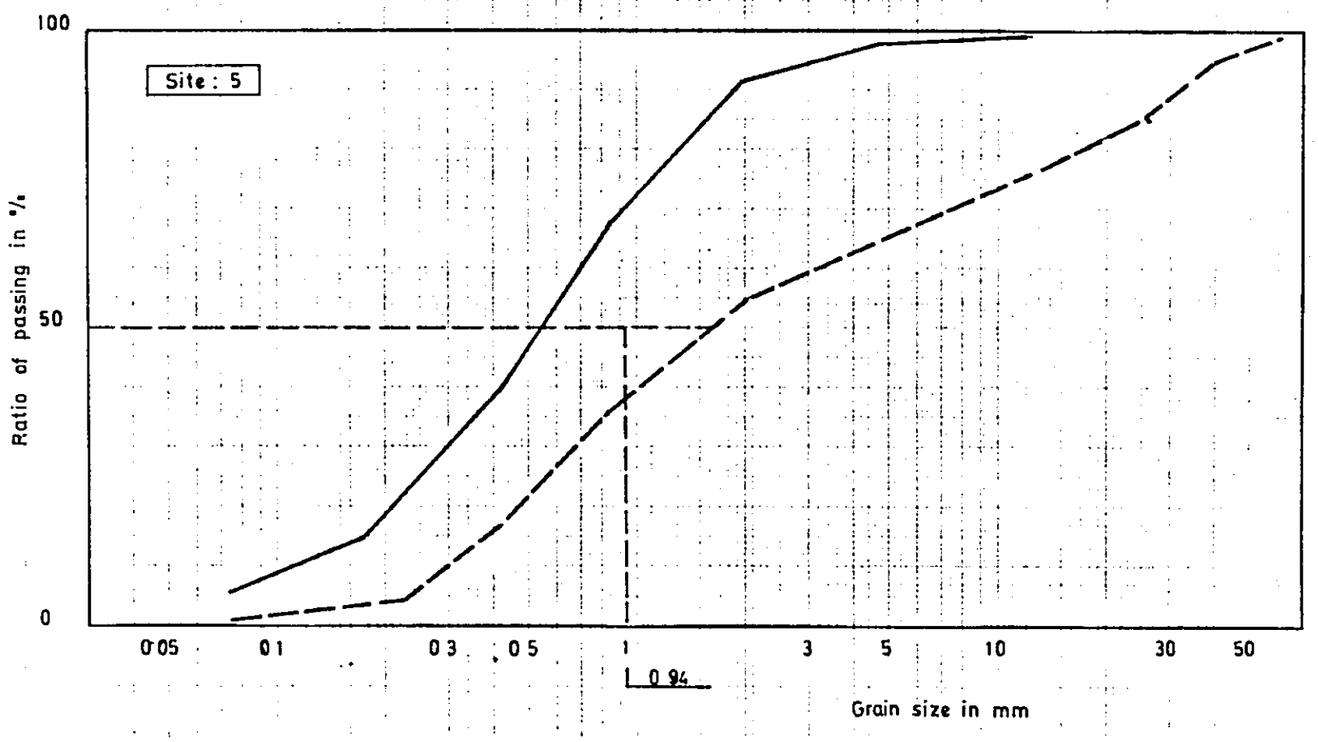


Fig 25 GRAIN SIZE DISTRIBUTION ALONG KRASAK RIVER (6)

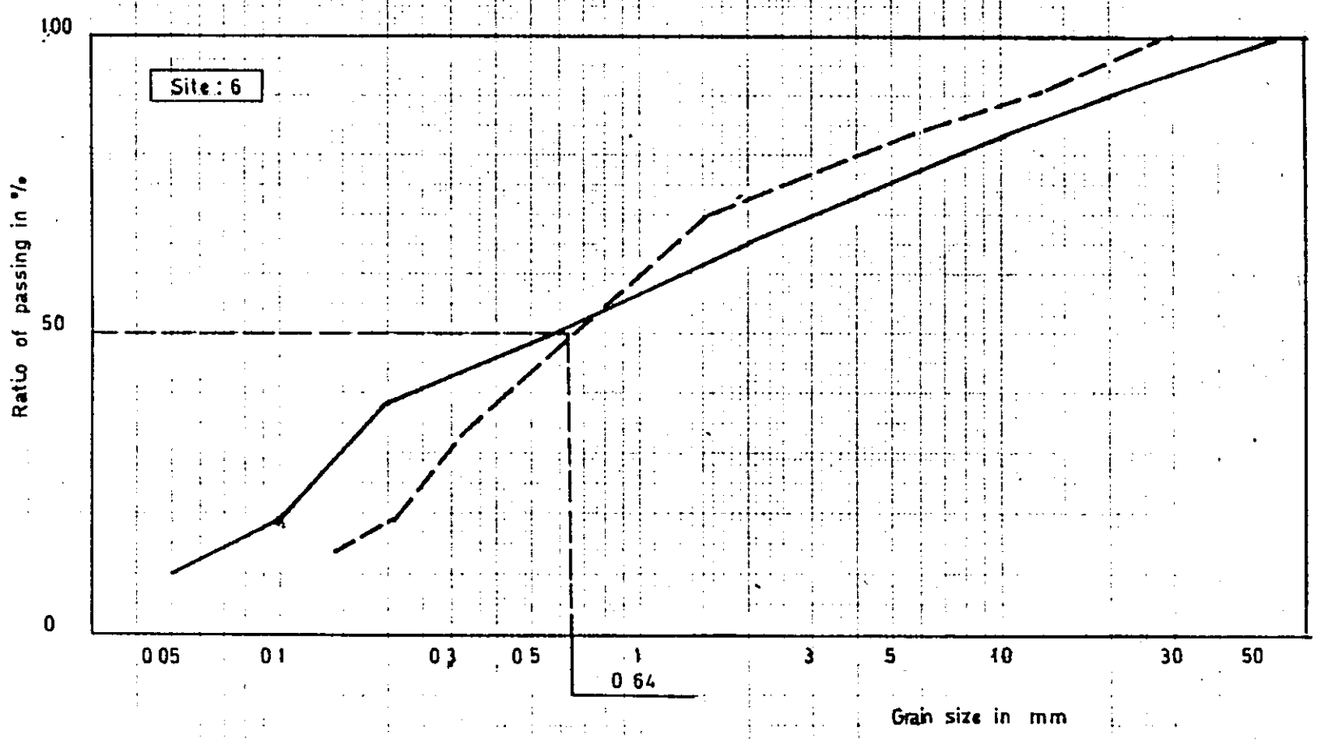
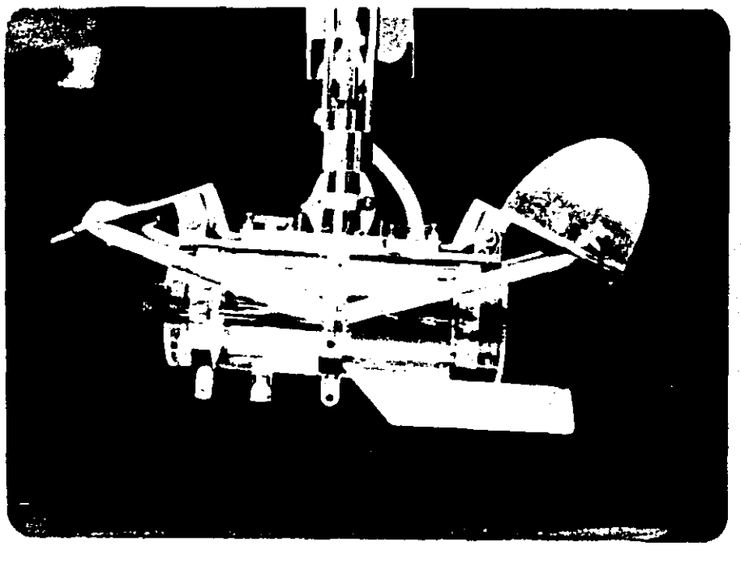
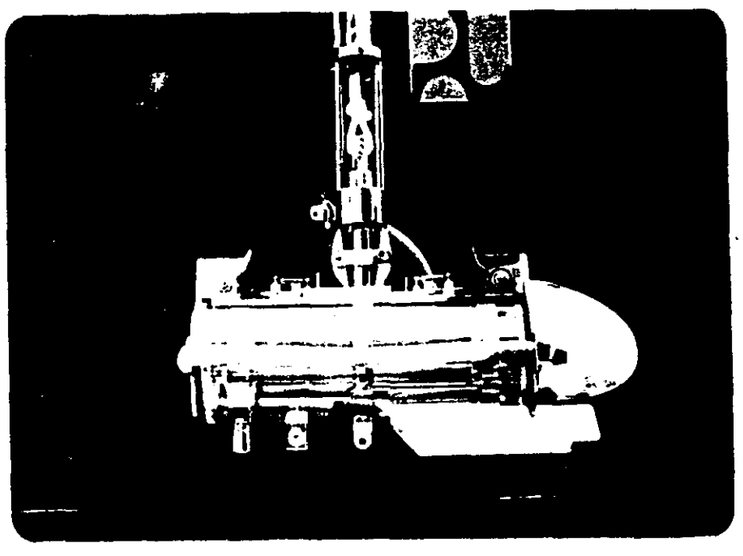


FIG. 26 SUSPENDED LOAD SAMPLER

(1) BEFORE TRAP CONDITION.



(2) AFTER TRAP CONDITION.

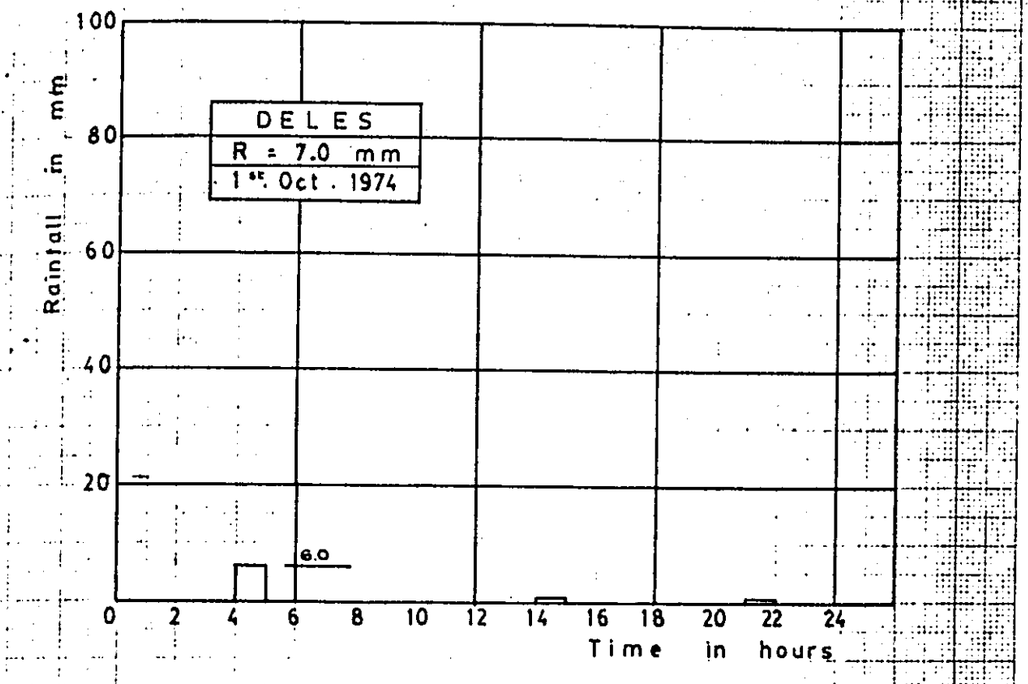


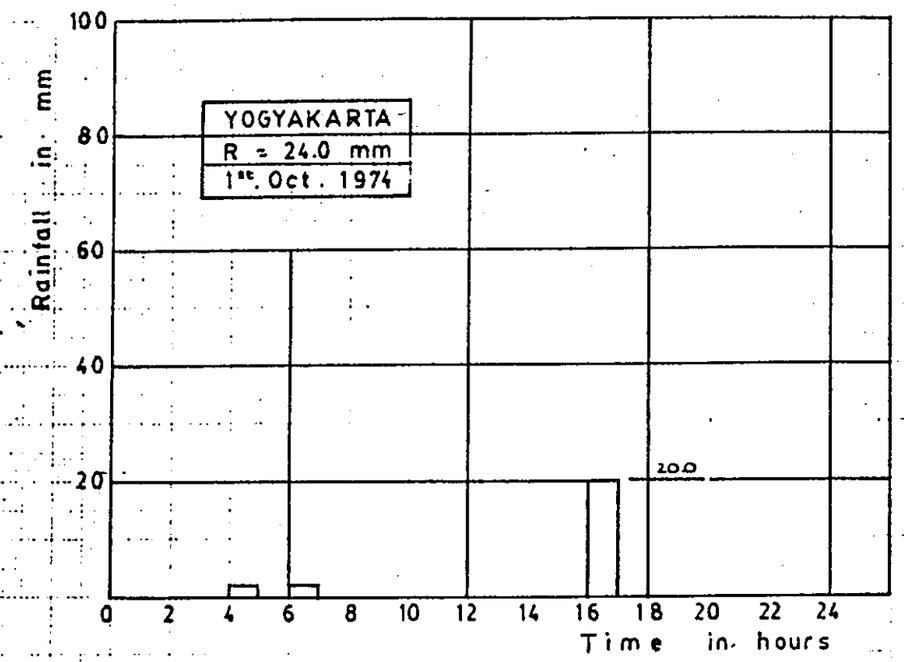
NOTE : _____

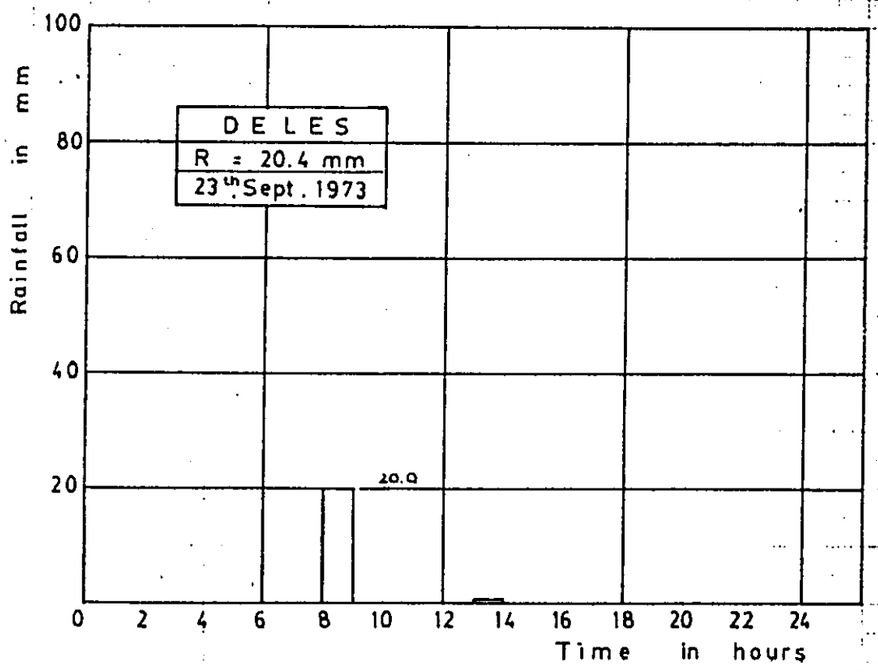
VOLU WATER IS SAMPLED BY The ϕ = 11 cm , L = 32 cm and V = 3.039 cc OF PIPE.

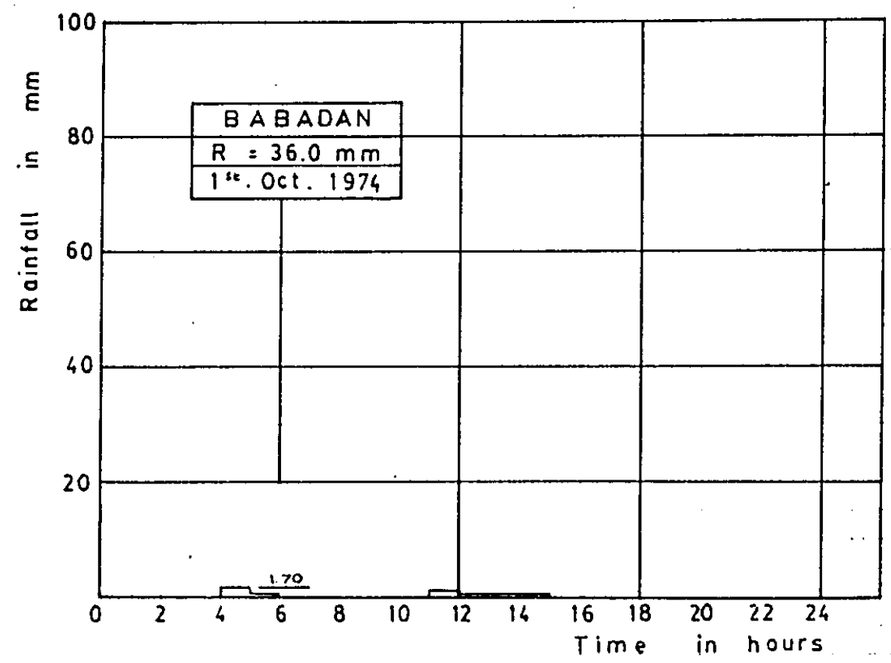
FIG. 27 HOURLY RAINFALL RECORDS IN MERAPI AREA

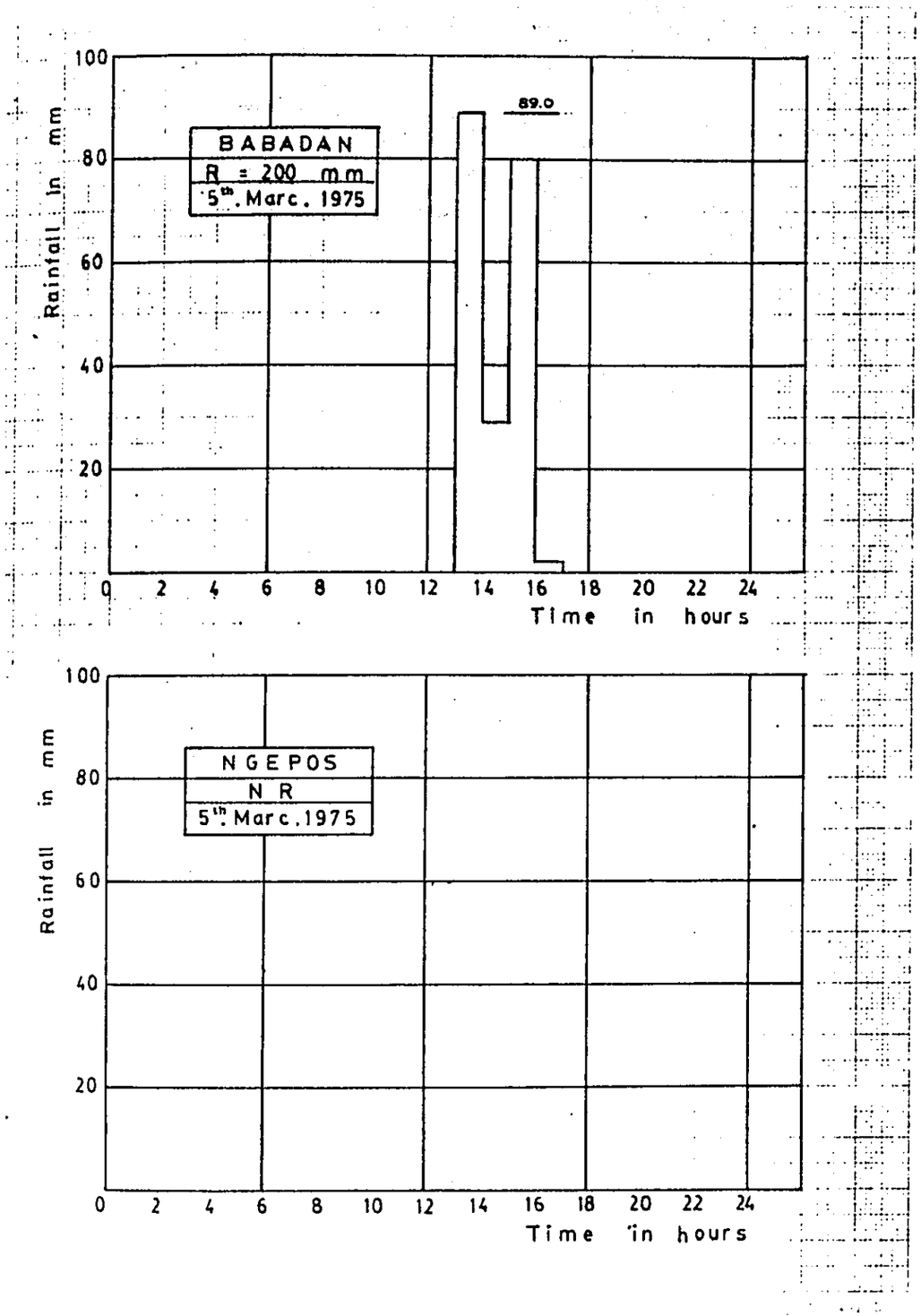
(1973 - 1977)

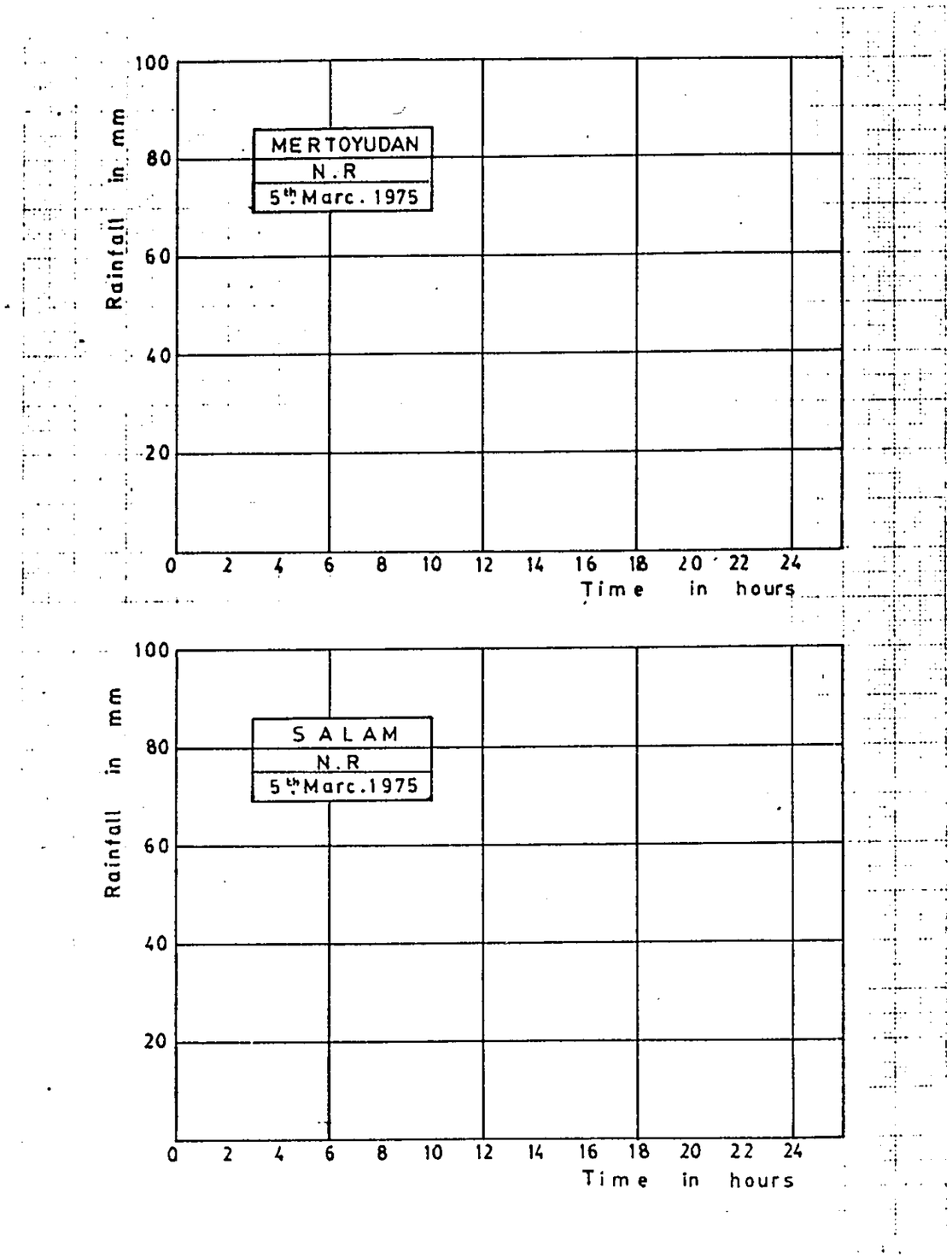

DELES
R = 7.0 mm
1st. Oct. 1974
6.0
Rainfall in mm
Time in hours


YOGYAKARTA
R = 24.0 mm
1st. Oct. 1974
20.0
Rainfall in mm
Time in hours


DELES
R = 20.4 mm
23th Sept. 1973
20.0
Rainfall in mm
Time in hours

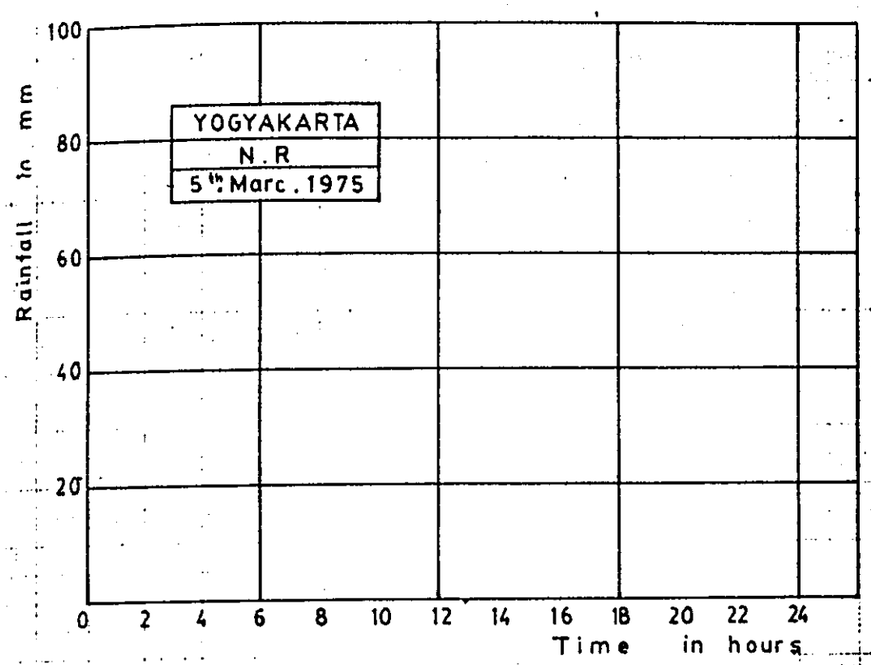

BABADAN
R = 36.0 mm
1st. Oct. 1974
1.70
Rainfall in mm
Time in hours

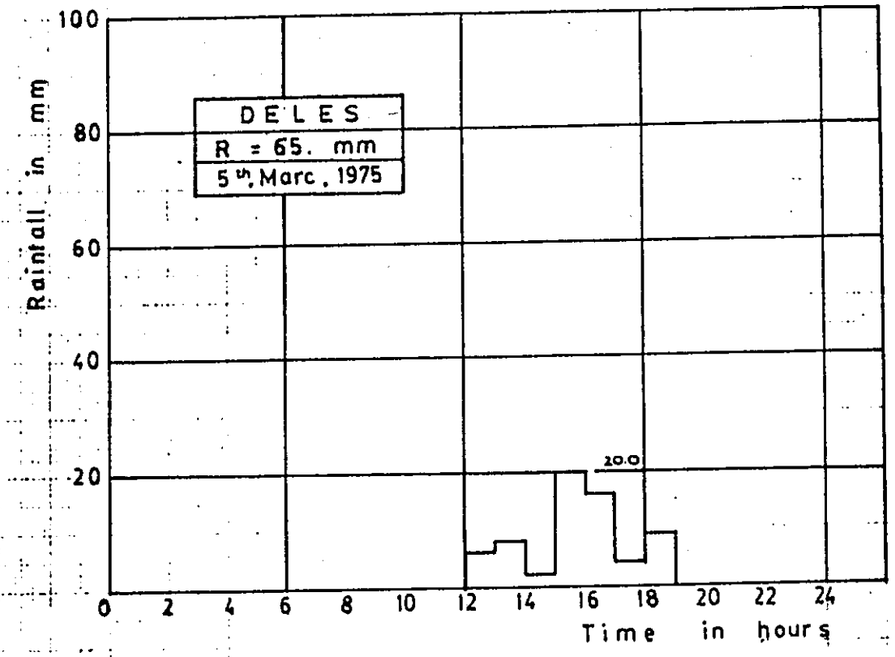

BABADAN
R = 200 mm
5th. Marc. 1975
89.0
Rainfall in mm
Time in hours

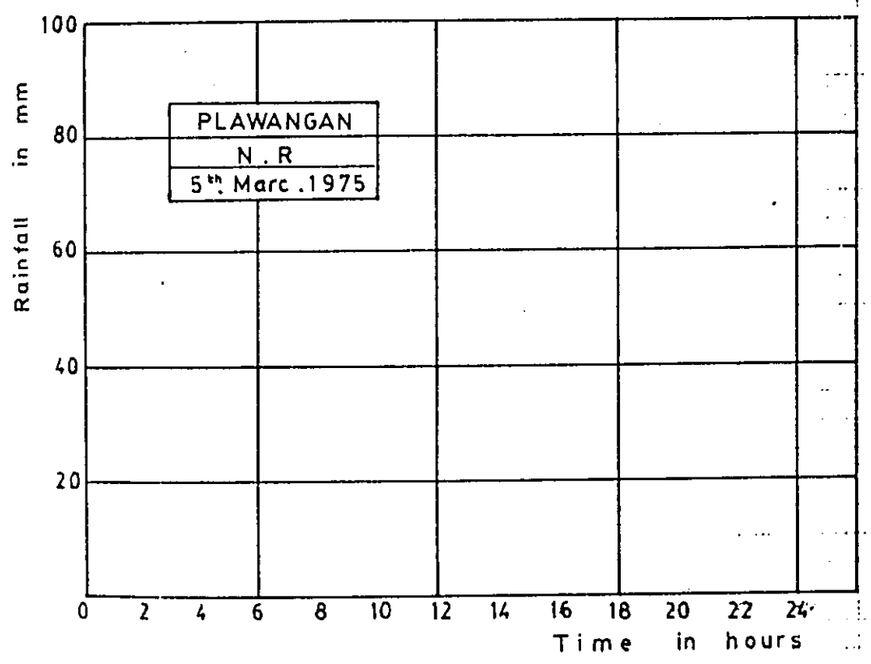

MERTOYUDAN
N.R
5th Marc. 1975
Rainfall in mm
Time in hours

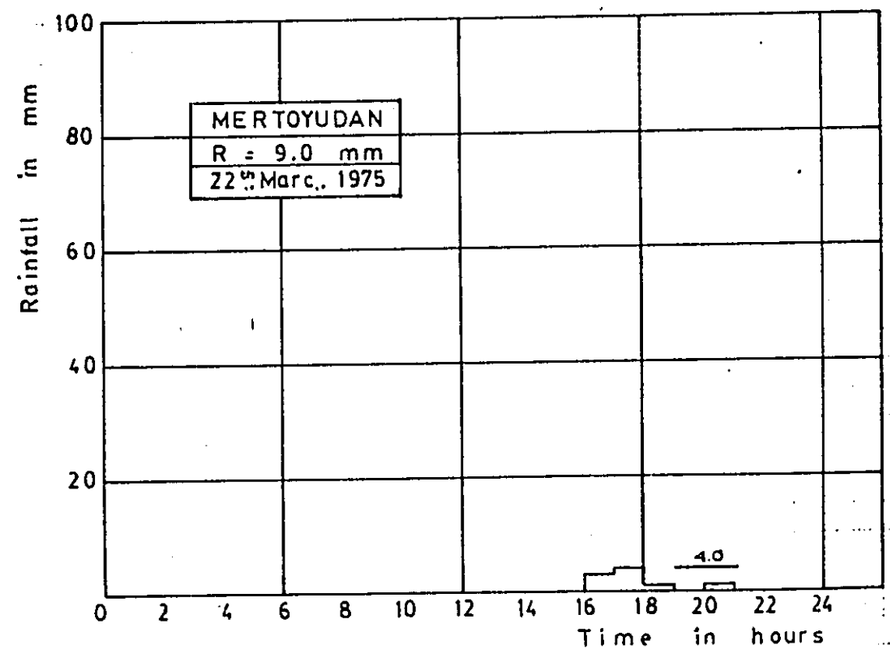
NGEPOS
N R
5th Marc.1975
Rainfall in mm
Time in hours

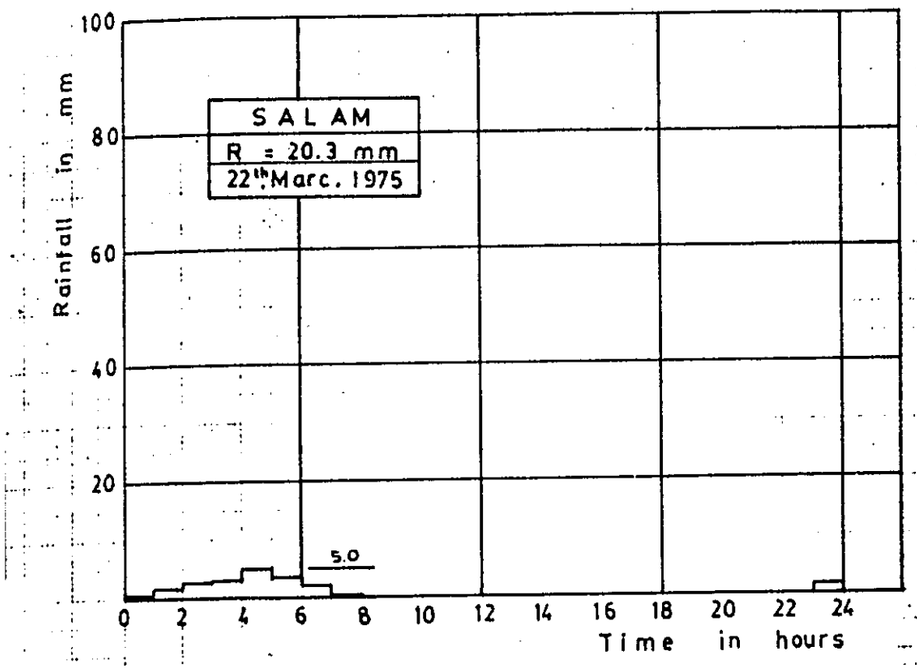
SALAM
N.R
5th Marc.1975
Rainfall in mm
Time in hours

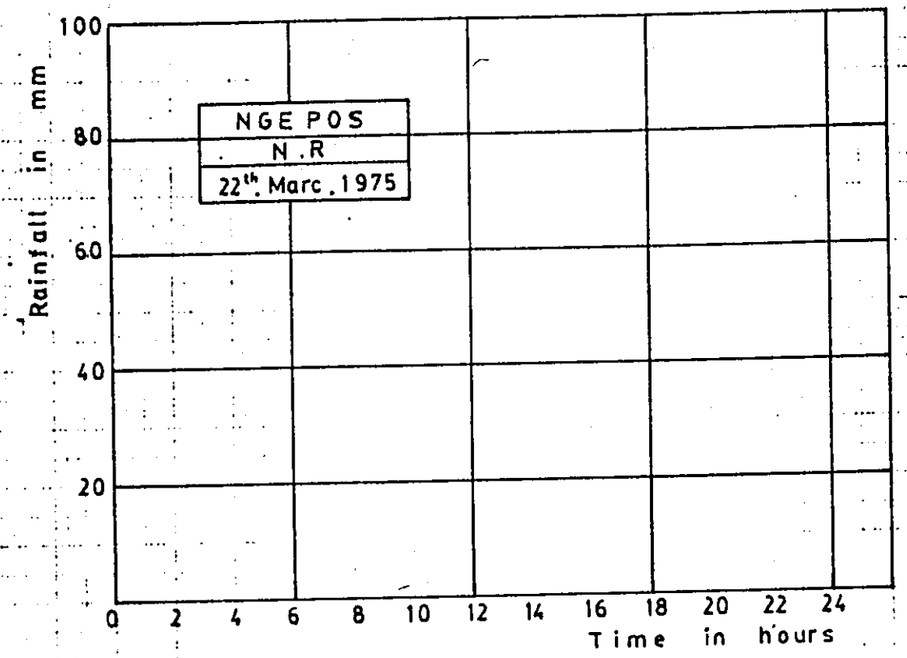

YOGYAKARTA
N.R
5th Marc. 1975
Rainfall in mm
100
80
60
40
20
0 2 4 6 8 10 12 14 16 18 20 22 24
Time in hours

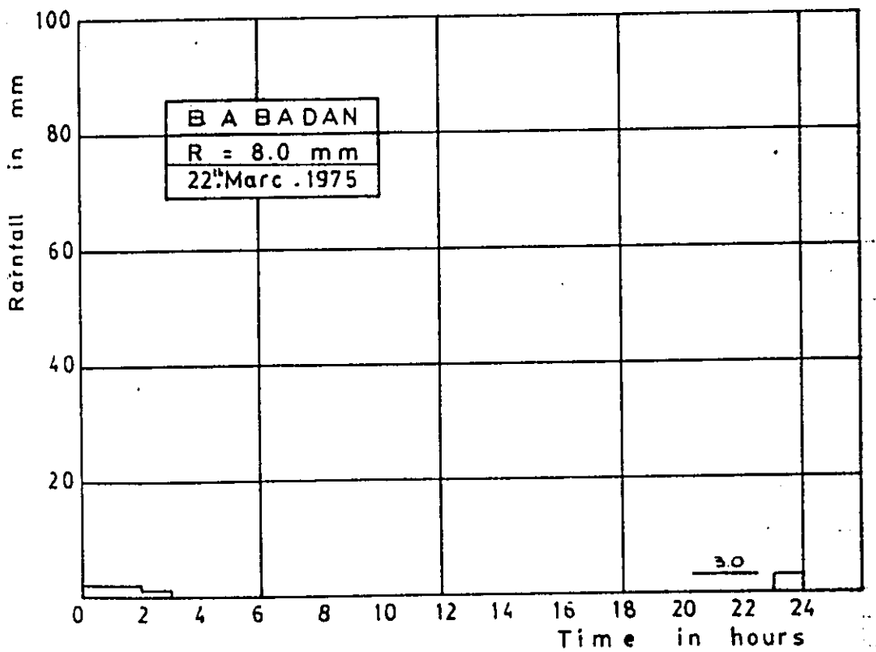

DELES
R = 65. mm
5th Marc. 1975
20.0
Rainfall in mm
100
80
60
40
20
0 2 4 6 8 10 12 14 16 18 20 22 24
Time in hours

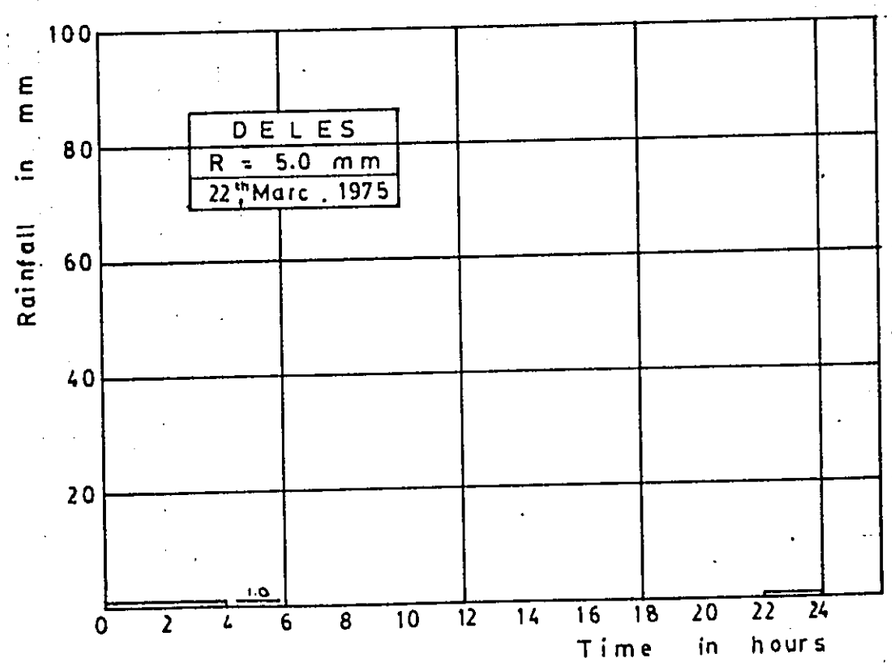

PLAWANGAN
N.R
5th Marc. 1975
Rainfall in mm
100
80
60
40
20
0 2 4 6 8 10 12 14 16 18 20 22 24
Time in hours

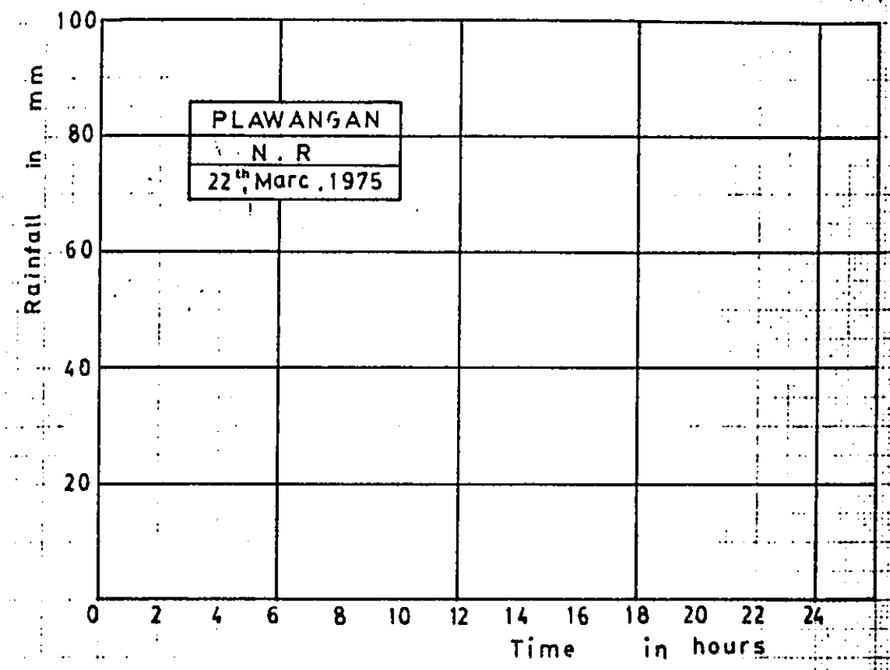

MERTOYUDAN
R = 9.0 mm
22th Marc. 1975
4.0
Rainfall in mm
100
80
60
40
20
0 2 4 6 8 10 12 14 16 18 20 22 24
Time in hours

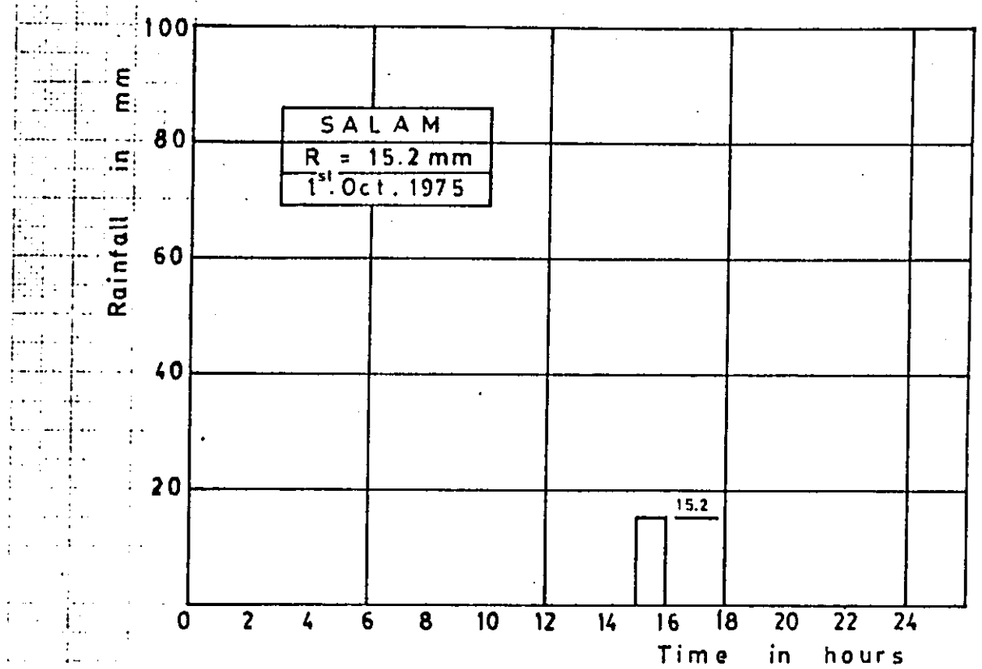

SALAM
R = 20.3 mm
22th Marc. 1975
5.0
Rainfall in mm
Time in hours

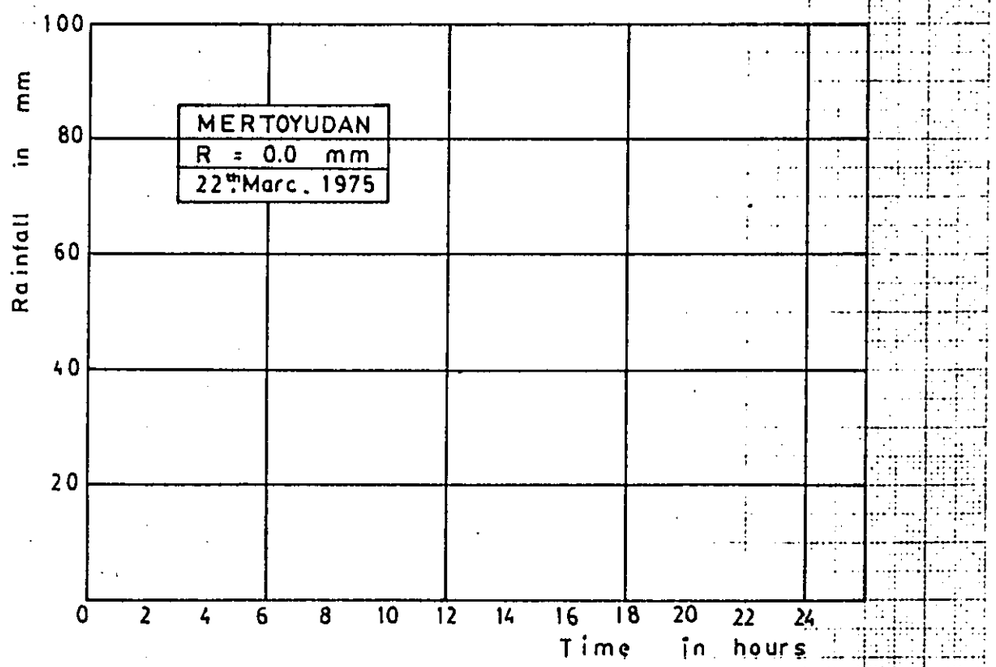

NGE POS
N.R
22th Marc. 1975
Rainfall in mm
Time in hours

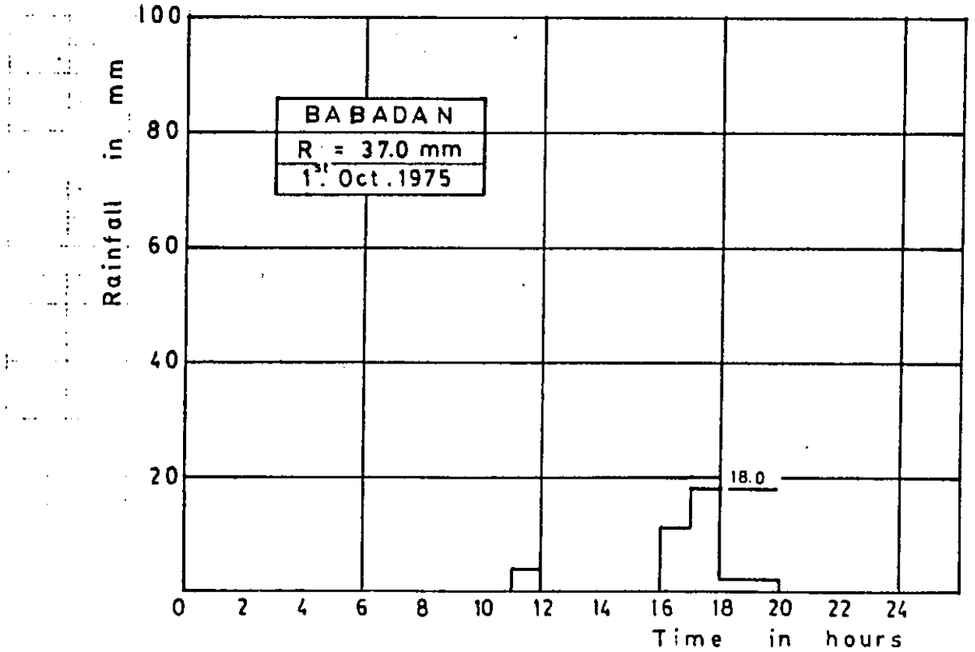

BABADAN
R = 8.0 mm
22th Marc. 1975
3.0
Rainfall in mm
Time in hours

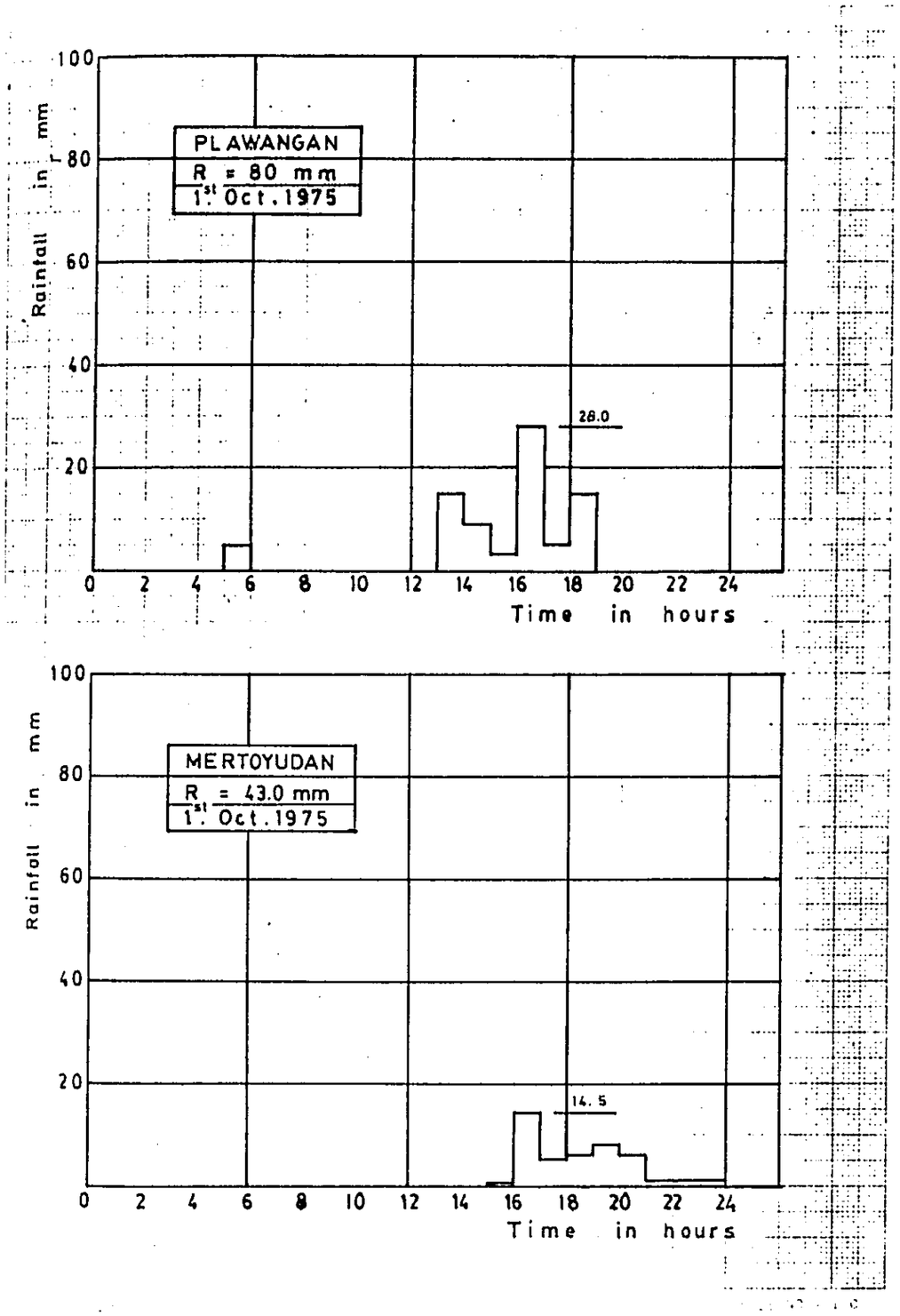

DELES
R = 5.0 mm
22th Marc. 1975
1.0
Rainfall in mm
Time in hours

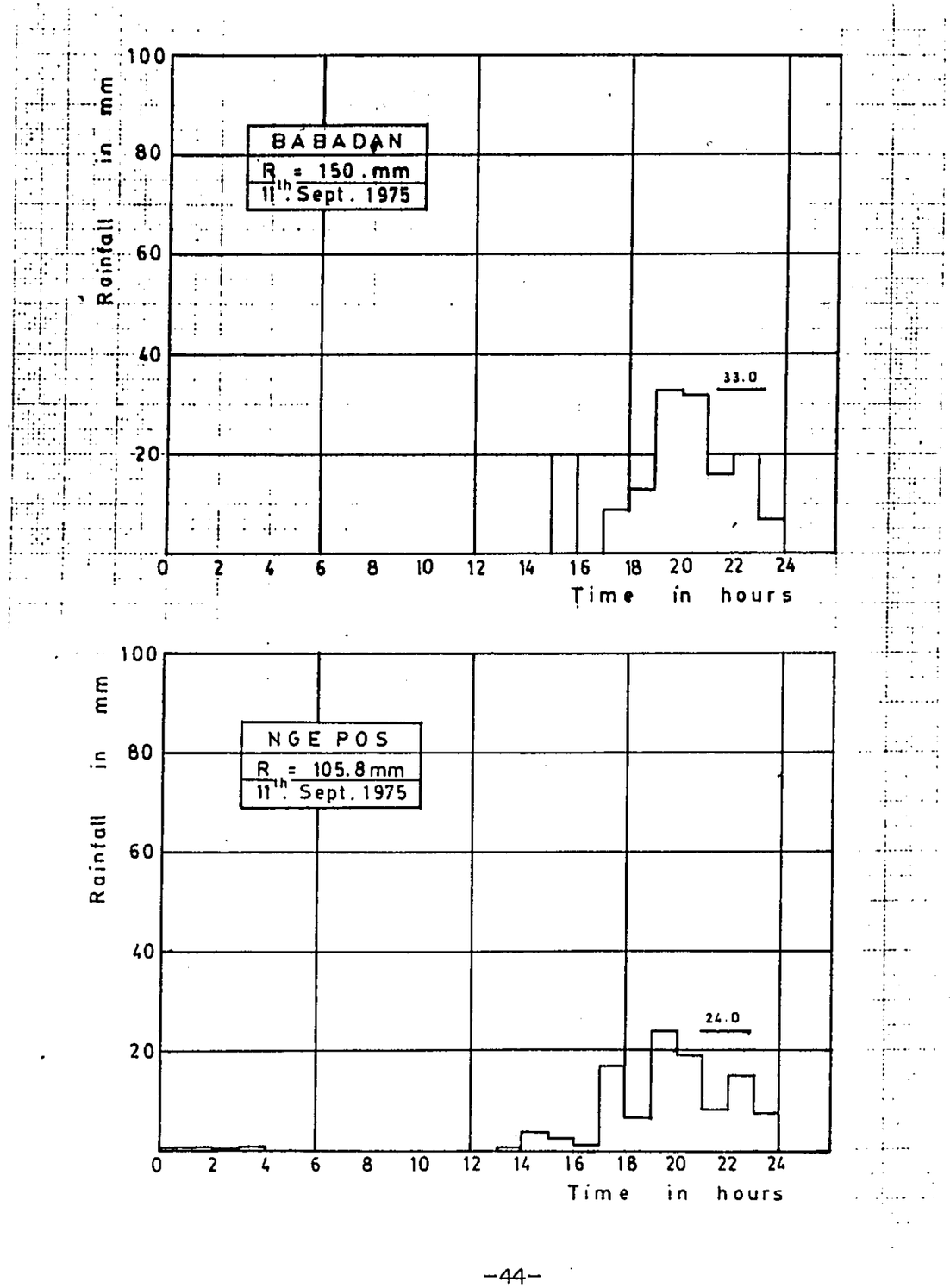

PLAWANGAN
N. R
22th Marc. 1975
Rainfall in mm
Time in hours


SALAM
R = 15.2 mm
1st Oct. 1975
15.2
Rainfall in mm
Time in hours


MERTOYUDAN
R = 0.0 mm
22th Marc. 1975
Rainfall in mm
Time in hours

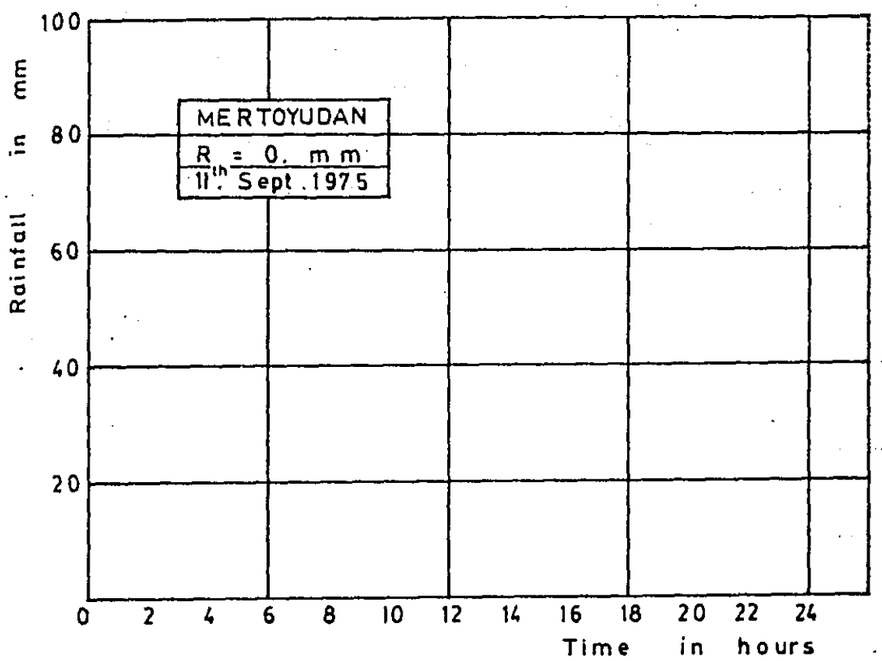

BABADAN
R = 37.0 mm
1st Oct. 1975
18.0
Rainfall in mm
Time in hours

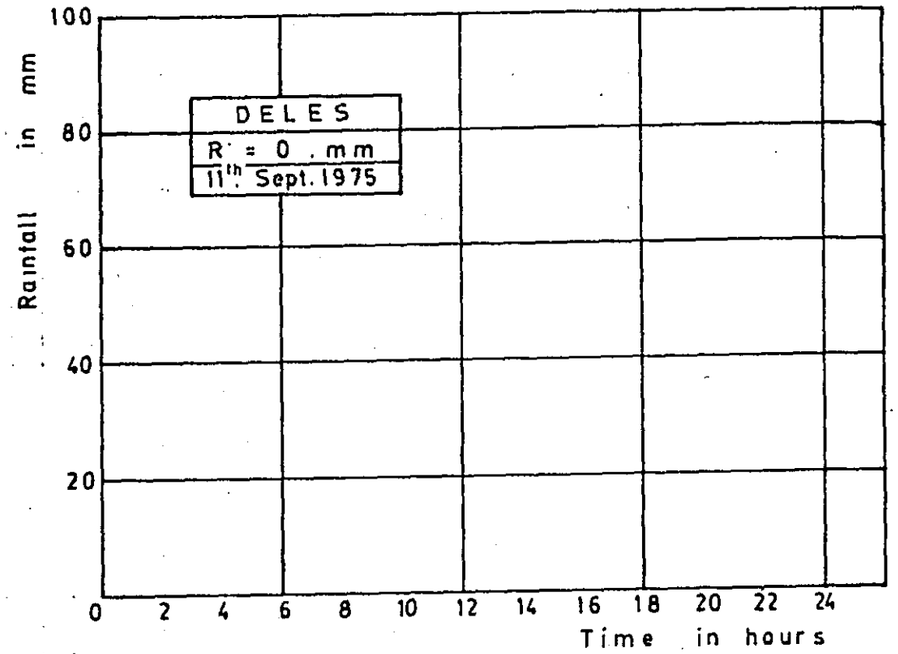

PLAWANGAN
R = 80 mm
1st Oct. 1975
28.0
Rainfall in mm
Time in hours

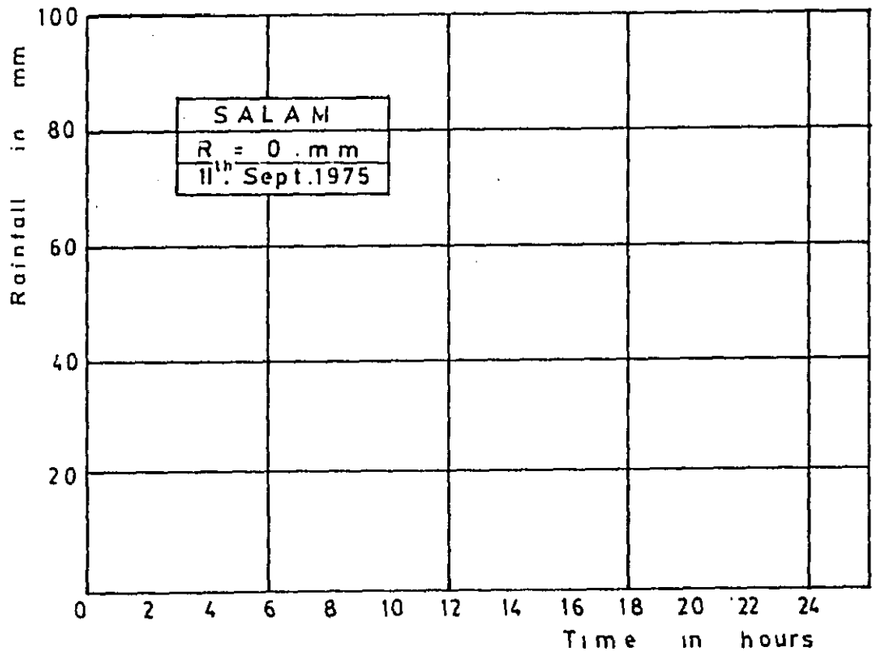

BABADAN
R = 150. mm
11th Sept. 1975
33.0
Rainfall in mm
Time in hours

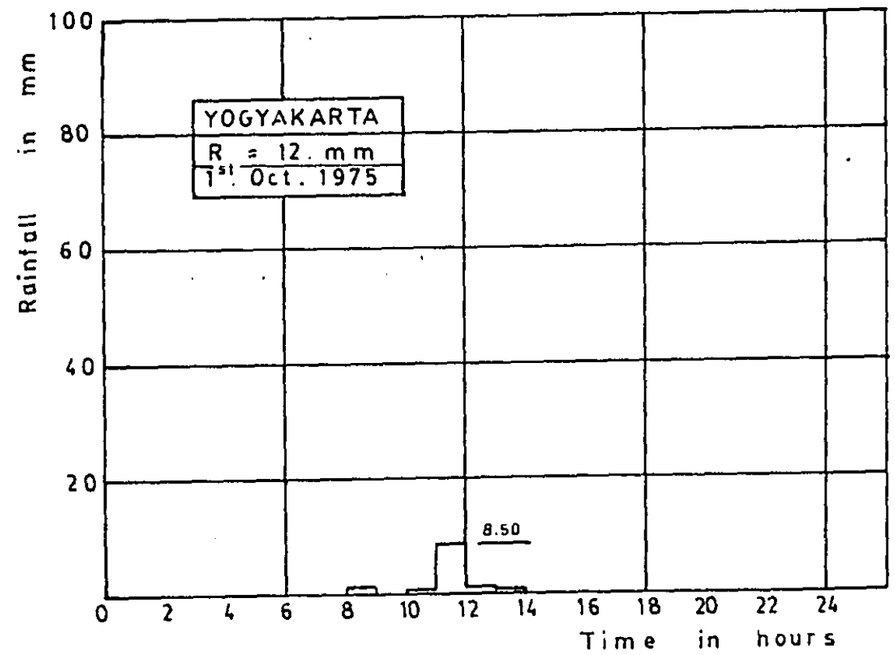
MERTOYUDAN
R = 43.0 mm
1st Oct. 1975
14.5
Rainfall in mm
Time in hours

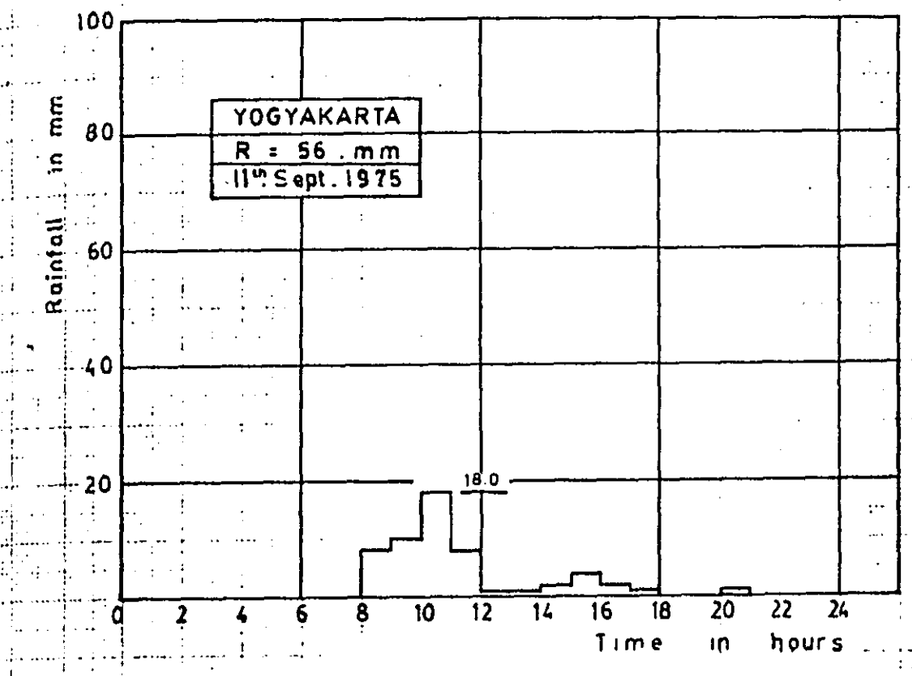
NGE POS
R = 105.8 mm
11th Sept. 1975
24.0
Rainfall in mm
Time in hours

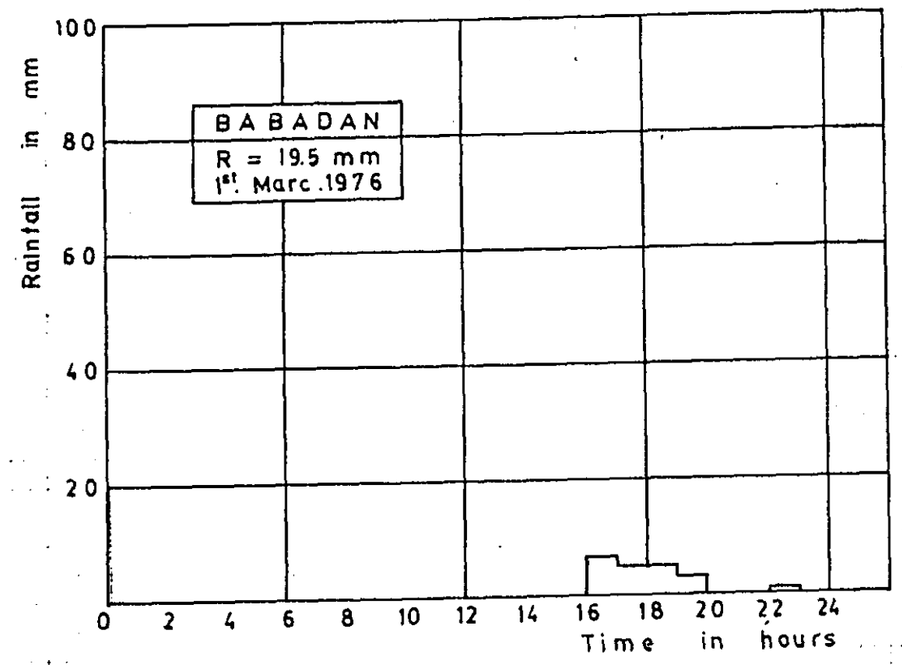

MERTOYUDAN
R = 0. mm
11th Sept. 1975
Rainfall in mm
100
80
60
40
20
0 2 4 6 8 10 12 14 16 18 20 22 24
Time in hours

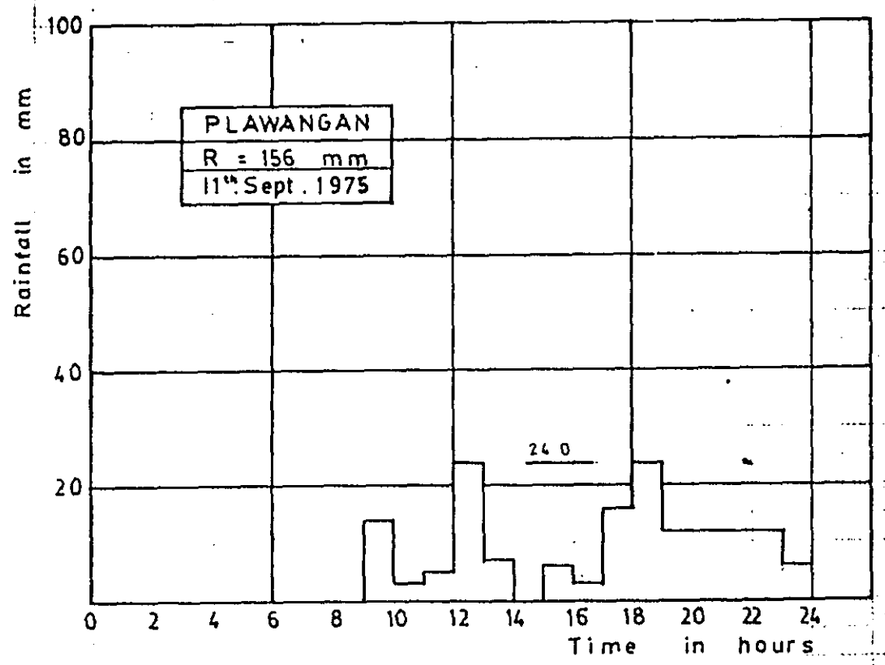

DELES
R = 0 . mm
11th Sept. 1975
Rainfall in mm
100
80
60
40
20
0 2 4 6 8 10 12 14 16 18 20 22 24
Time in hours

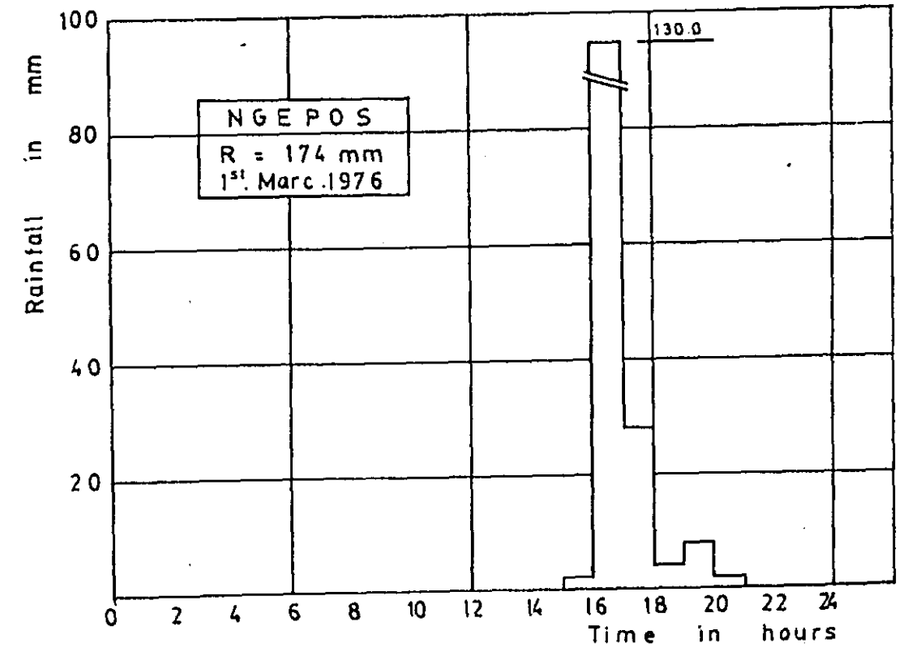

SALAM
R = 0 . mm
11th Sept. 1975
Rainfall in mm
100
80
60
40
20
0 2 4 6 8 10 12 14 16 18 20 22 24
Time in hours

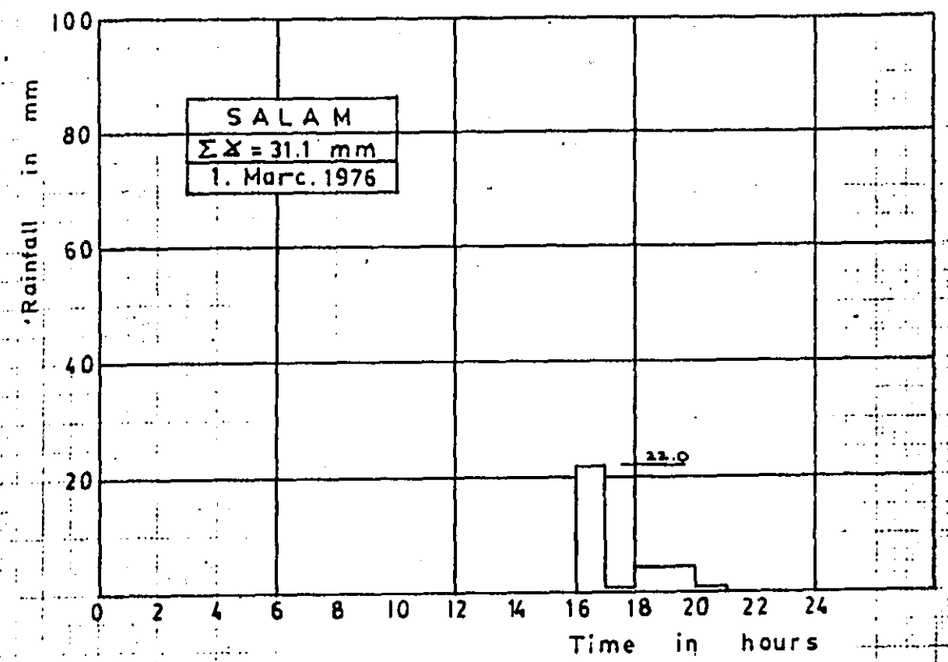

YOGYAKARTA
R = 12. mm
1st Oct. 1975
8.50
Rainfall in mm
100
80
60
40
20
0 2 4 6 8 10 12 14 16 18 20 22 24
Time in hours

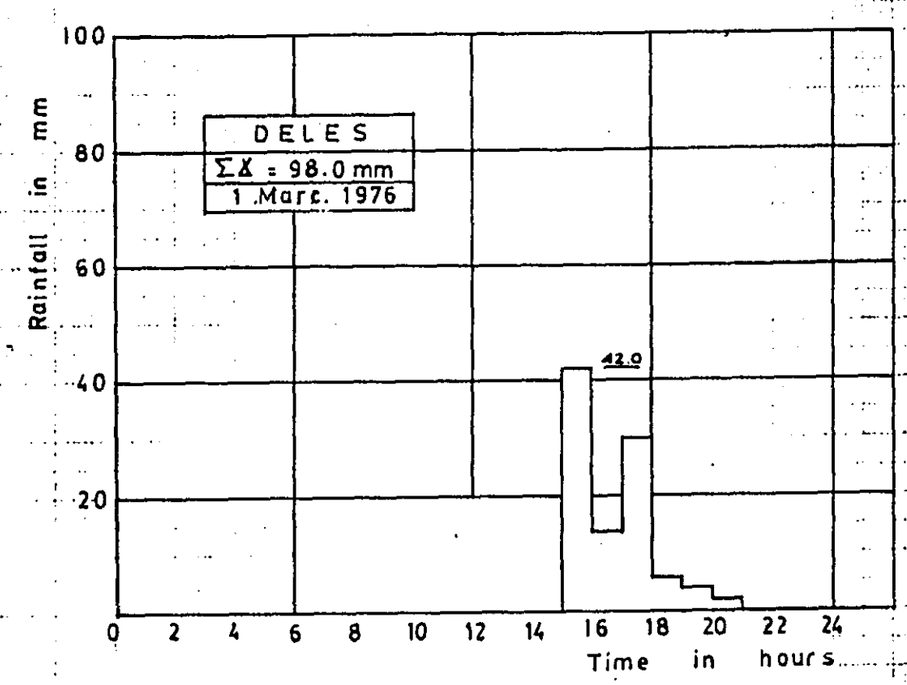

YOGYAKARTA
R = 56 . mm
11th Sept. 1975
18.0
Rainfall in mm
Time in hours

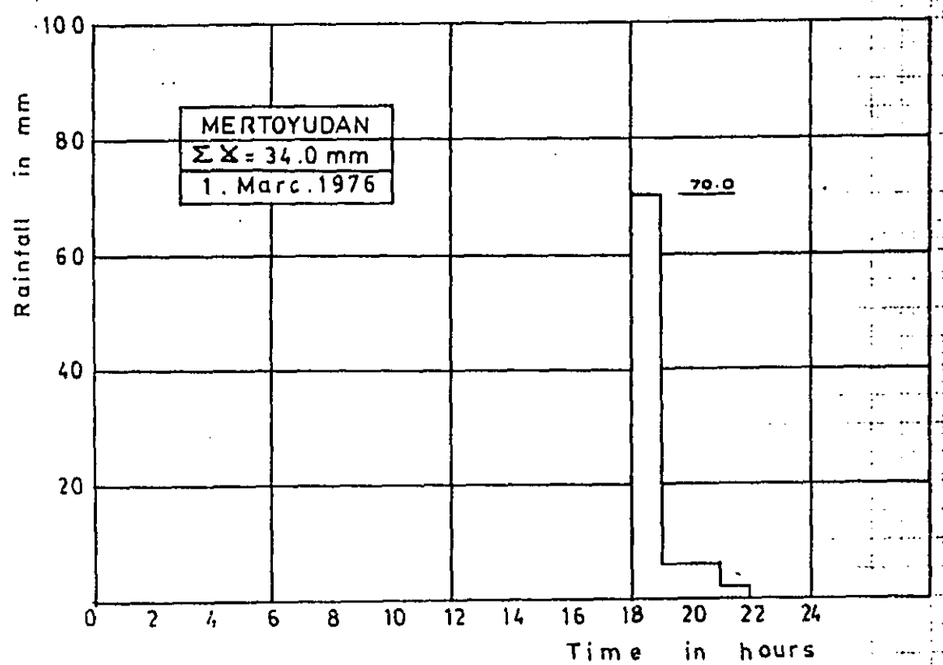

BABADAN
R = 19.5 mm
1st Marc. 1976
Rainfall in mm
Time in hours

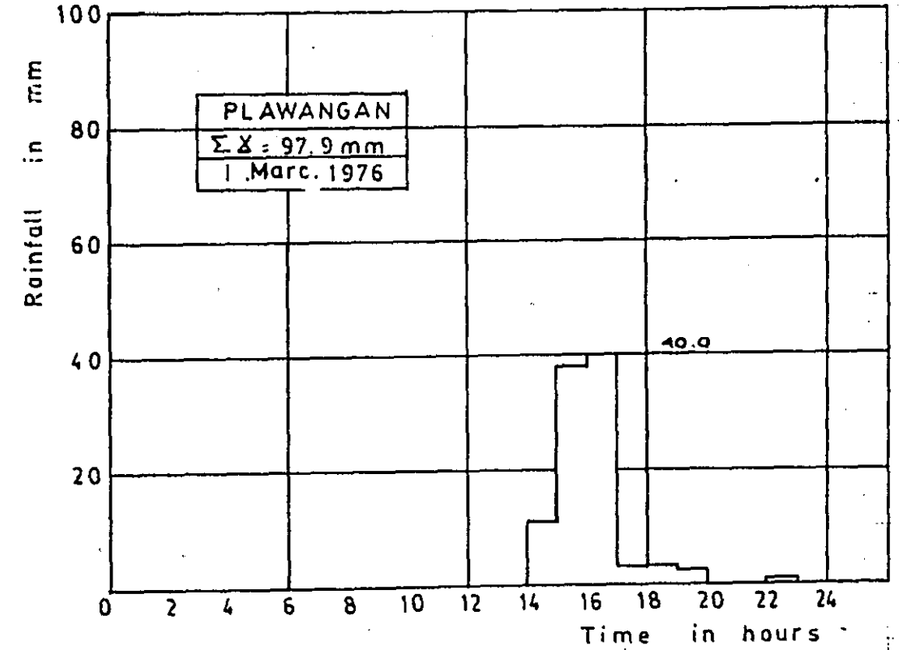

PLAWANGAN
R = 156 mm
11th Sept. 1975
24 0
Rainfall in mm
Time in hours

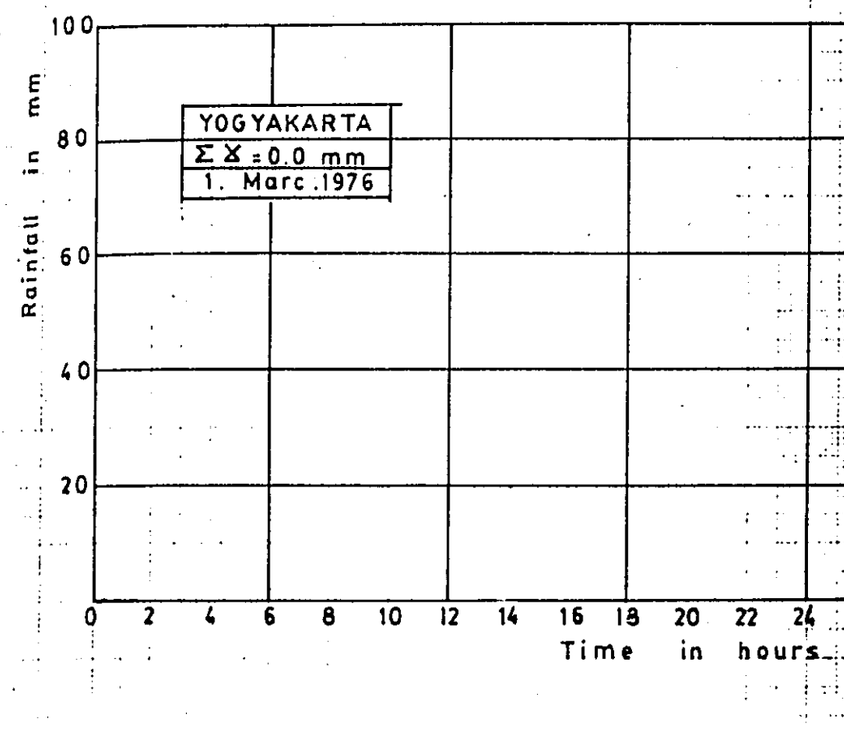

NGEPOS
R = 174 mm
1st Marc. 1976
130.0
Rainfall in mm
Time in hours

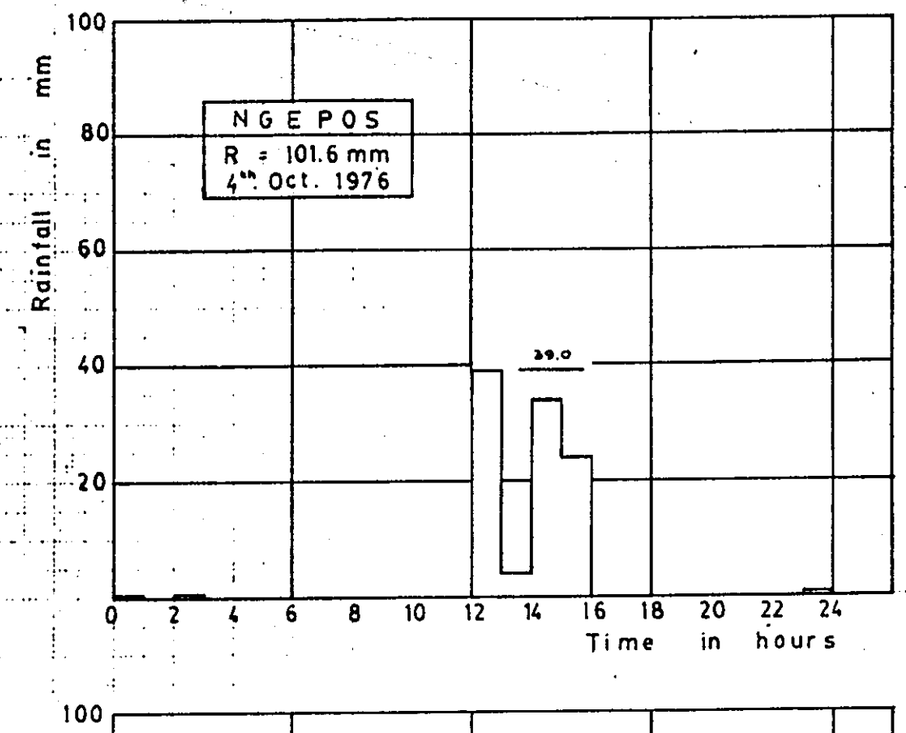

SALAM
ΣX = 31.1 mm
1. Marc. 1976
22.0
Rainfall in mm
Time in hours

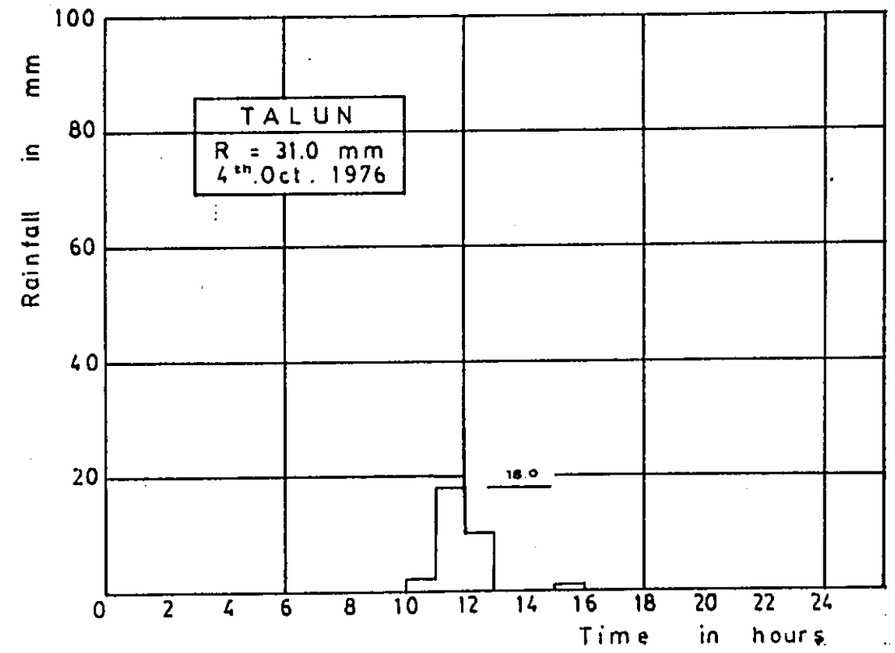

DELES
ΣX = 98.0 mm
1 .Marc. 1976
42.0
Rainfall in mm
Time in hours

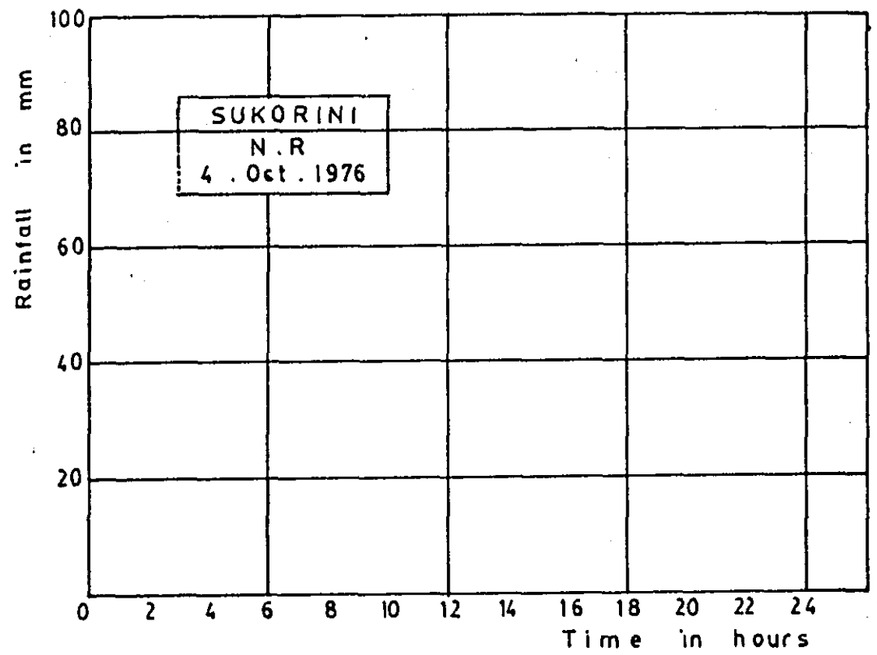

MERTOYUDAN
ΣX = 34.0 mm
1. Marc. 1976
70.0
Rainfall in mm
Time in hours

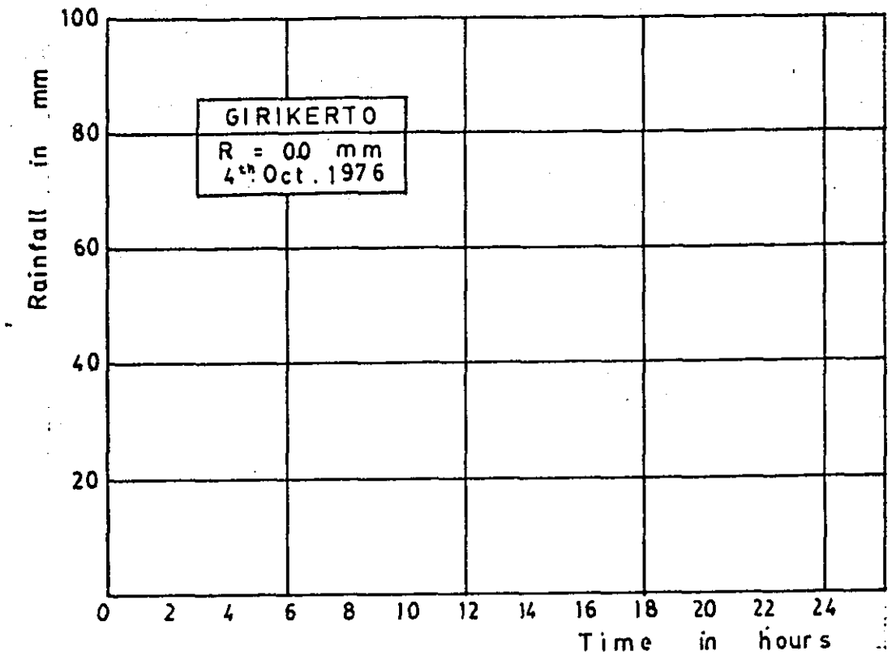

PLAWANGAN
ΣX = 97.9 mm
1 .Marc. 1976
40.0
Rainfall in mm
Time in hours

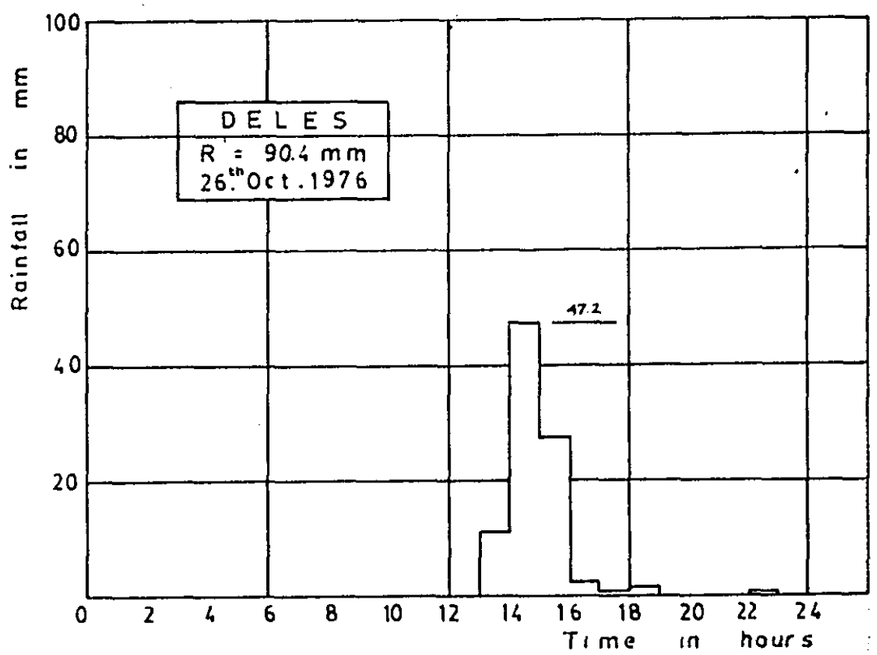

YOGYAKARTA
Σ X = 0.0 mm
1. Marc.1976
Rainfall in mm
Time in hours

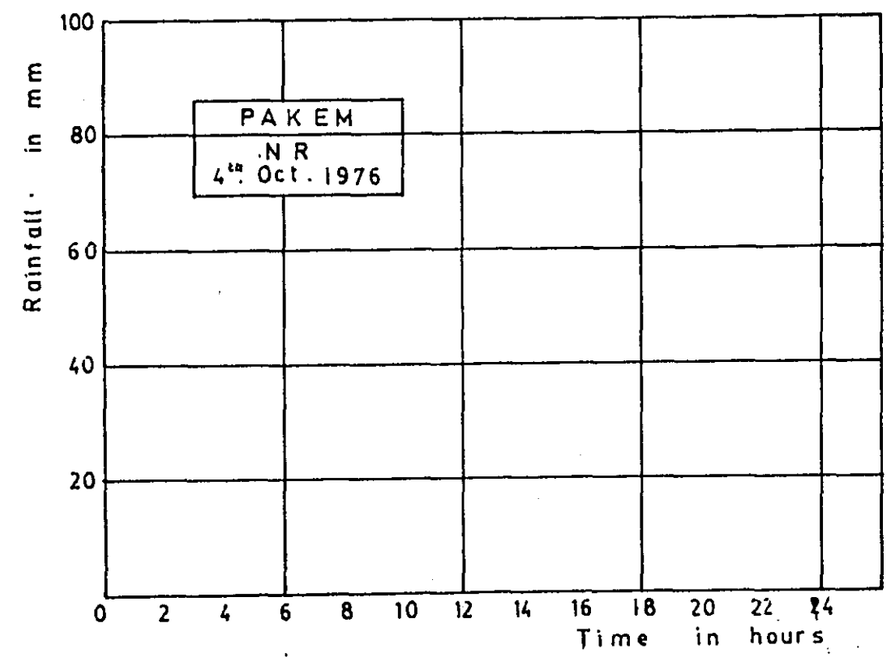

NGEPOS
R = 101.6 mm
4th Oct. 1976
39.0
Rainfall in mm
Time in hours

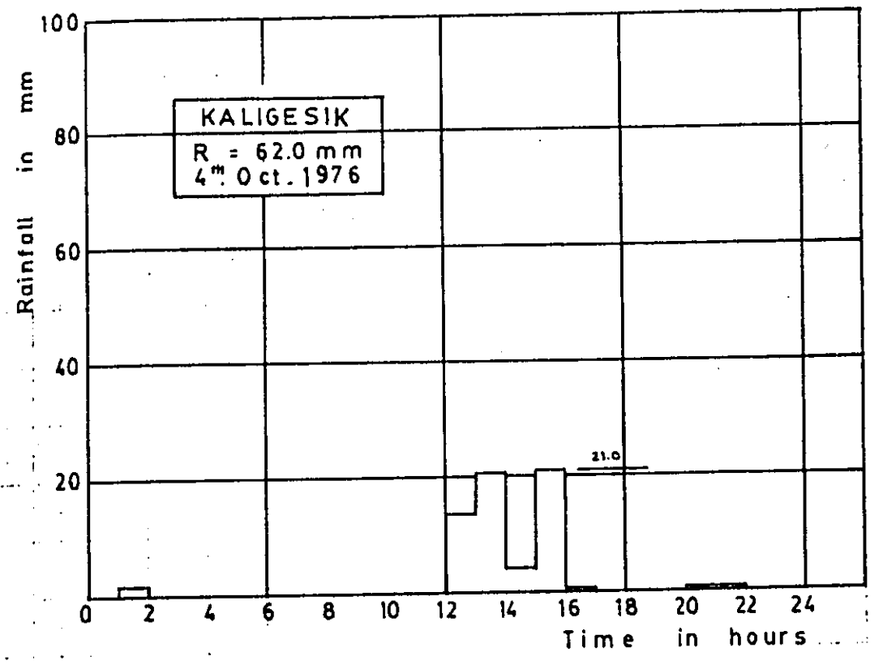

TALUN
R = 31.0 mm
4th Oct. 1976
18.0
Rainfall in mm
Time in hours

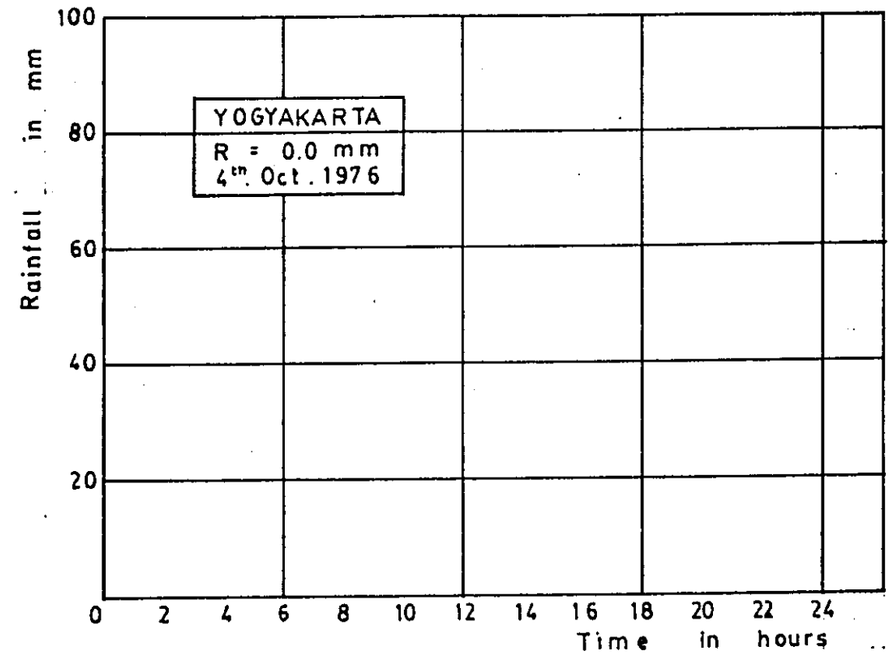

SUKORINI
N.R
4 . Oct . 1976
Rainfall in mm
100
80
60
40
20
0 2 4 6 8 10 12 14 16 18 20 22 24
Time in hours

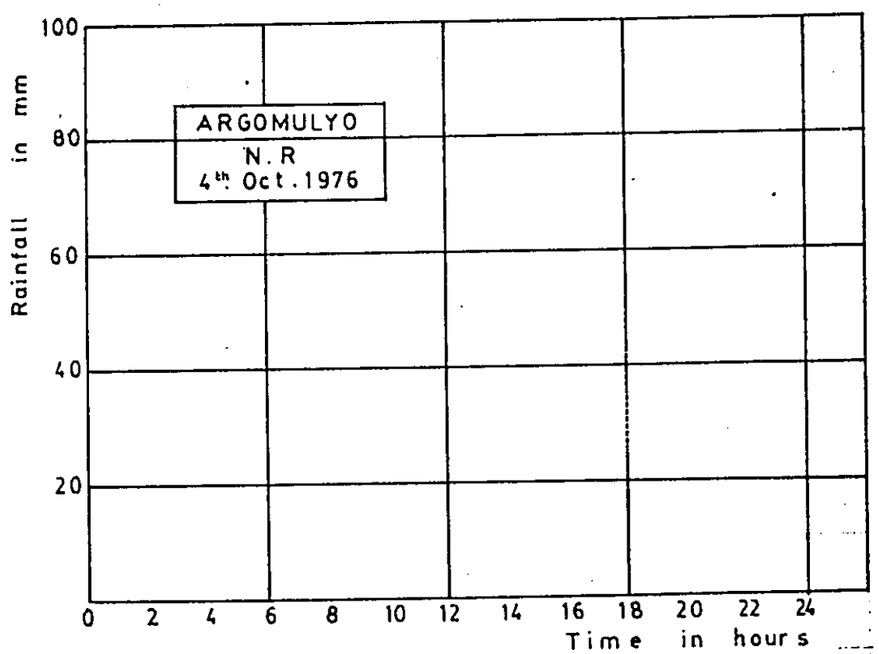

GIRIKERTO
R = 0.0 mm
4th Oct . 1976
Rainfall in mm
100
80
60
40
20
0 2 4 6 8 10 12 14 16 18 20 22 24
Time in hours

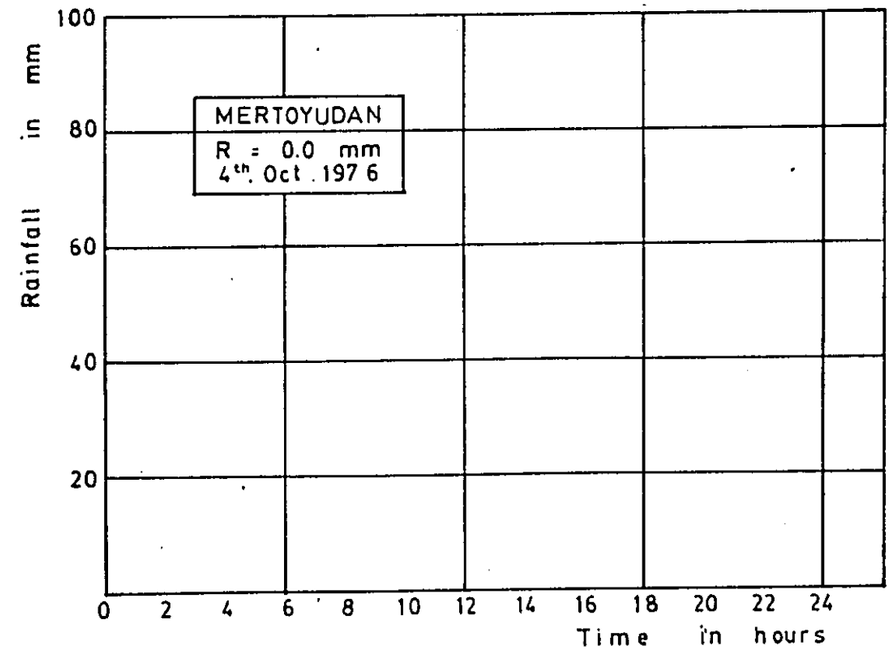

DELES
R = 90.4 mm
26th Oct . 1976
47.2
Rainfall in mm
100
80
60
40
20
0 2 4 6 8 10 12 14 16 18 20 22 24
Time in hours

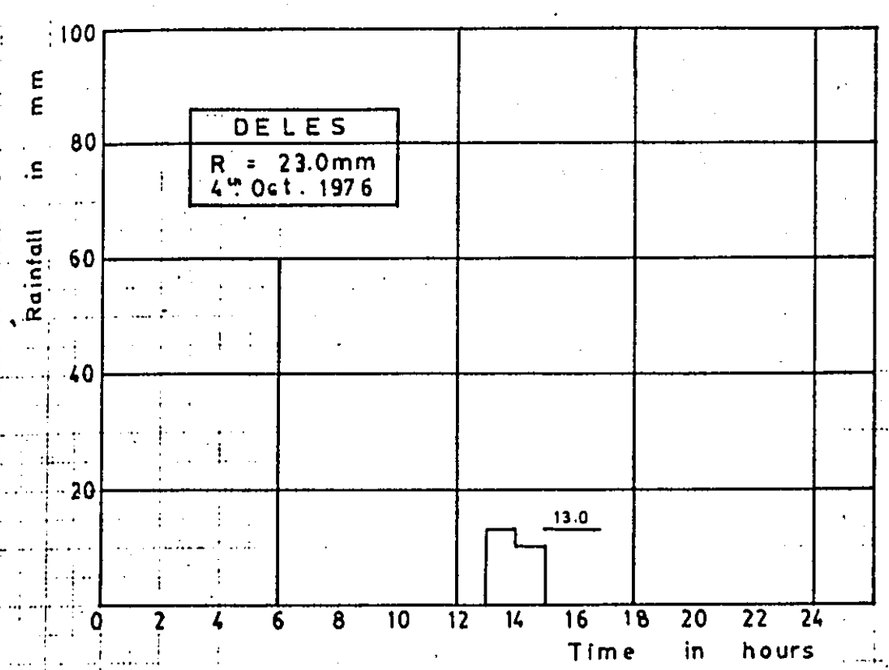

PAKEM
.N R
4th Oct . 1976
Rainfall in mm
100
80
60
40
20
0 2 4 6 8 10 12 14 16 18 20 22 24
Time in hours

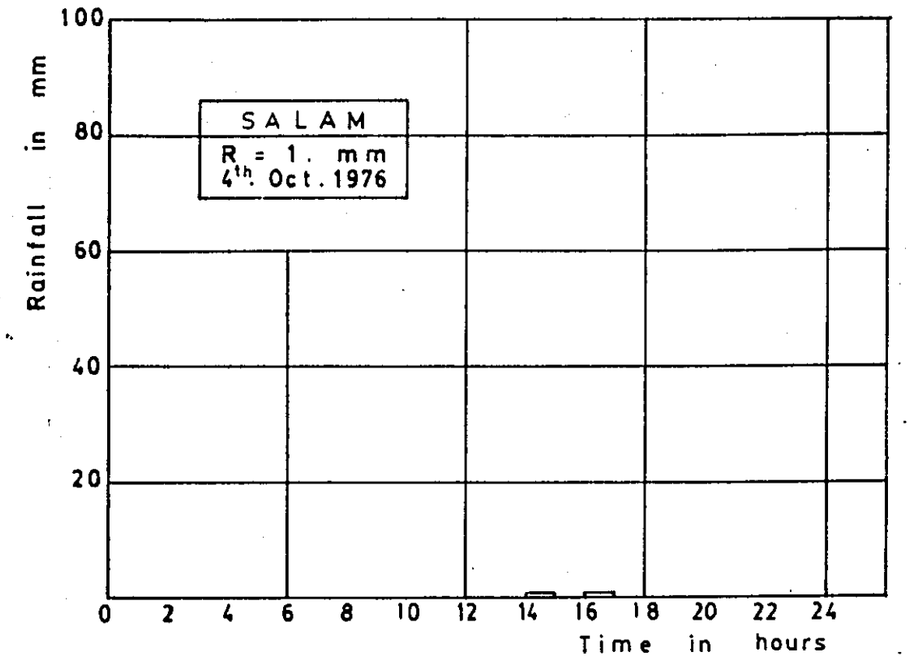

KALIGESIK
R = 62.0 mm
4th Oct. 1976
21.0
Rainfall in mm
Time in hours

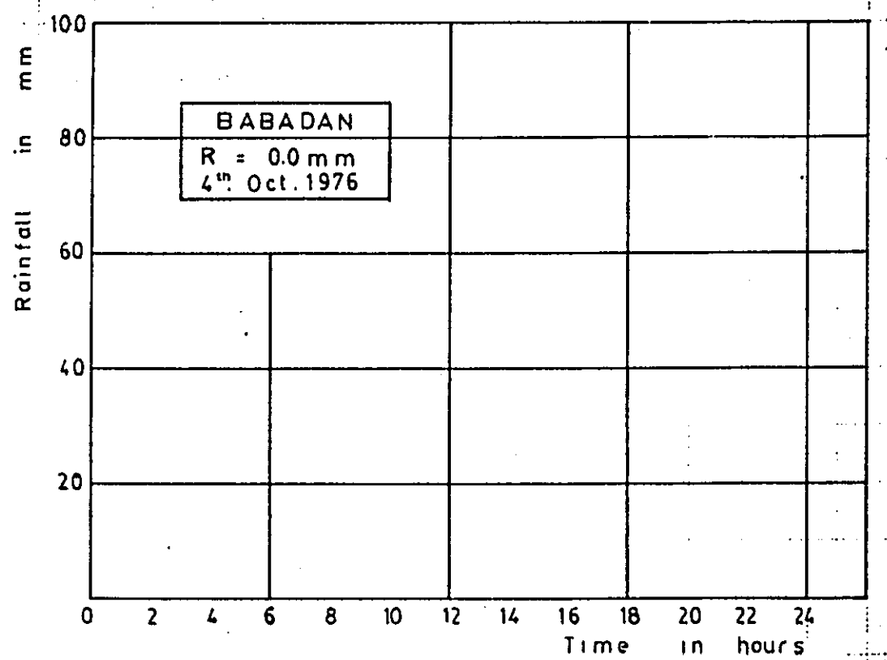

YOGYAKARTA
R = 0.0 mm
4th Oct. 1976
Rainfall in mm
Time in hours

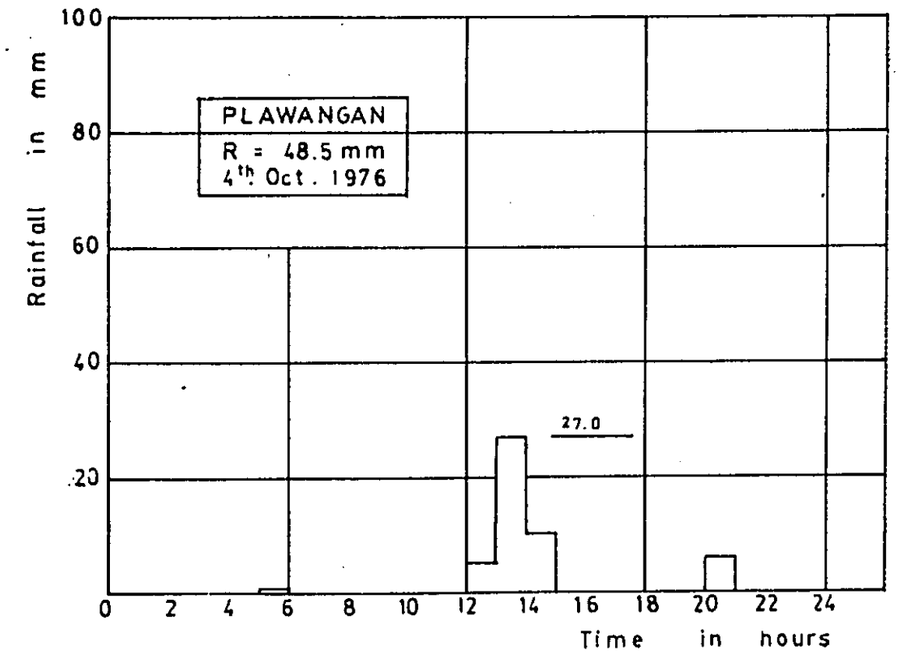

ARGOMULYO
N.R
4th Oct. 1976
Rainfall in mm
Time in hours

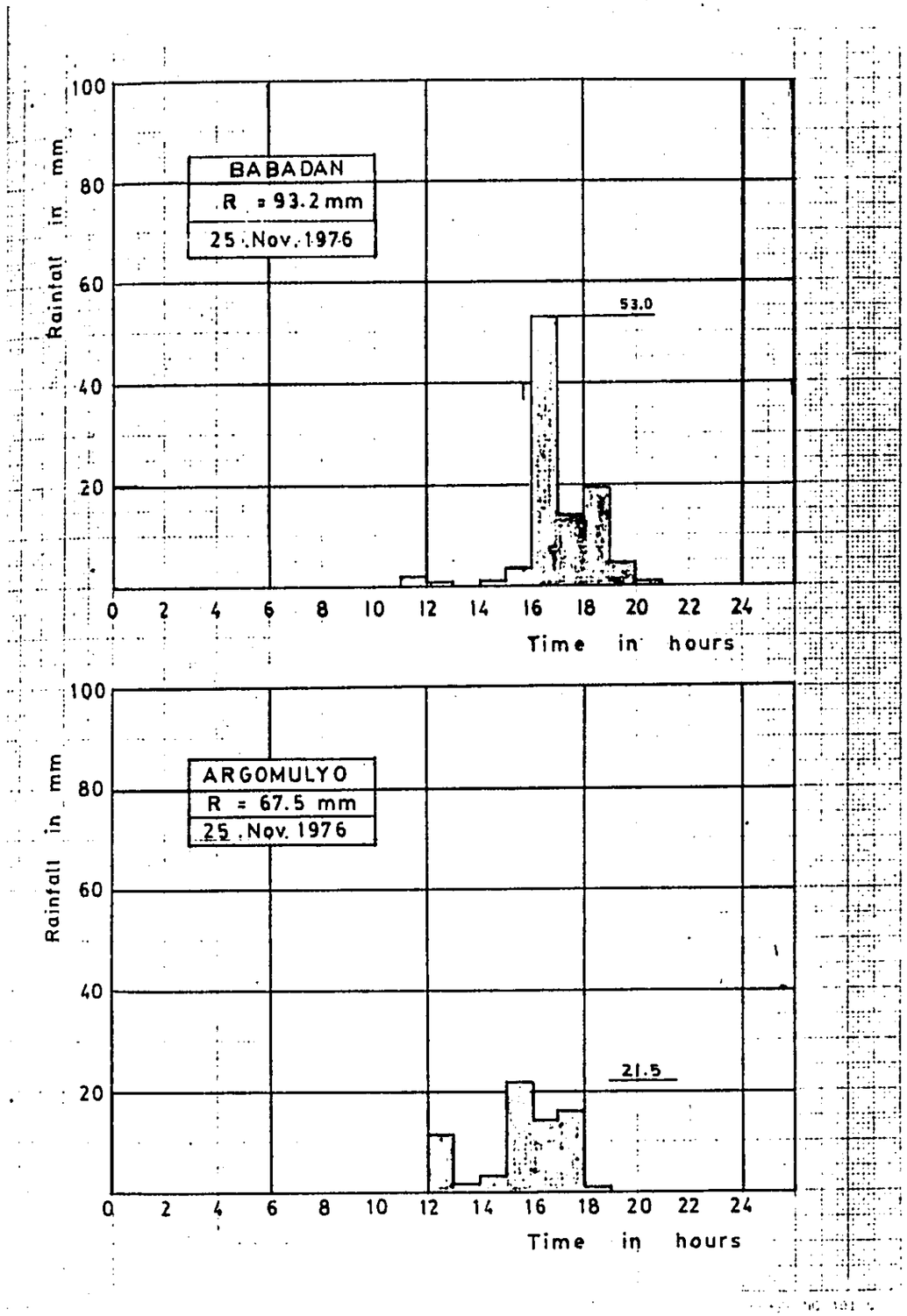

MERTOYUDAN
R = 0.0 mm
4th Oct. 1976
Rainfall in mm
Time in hours

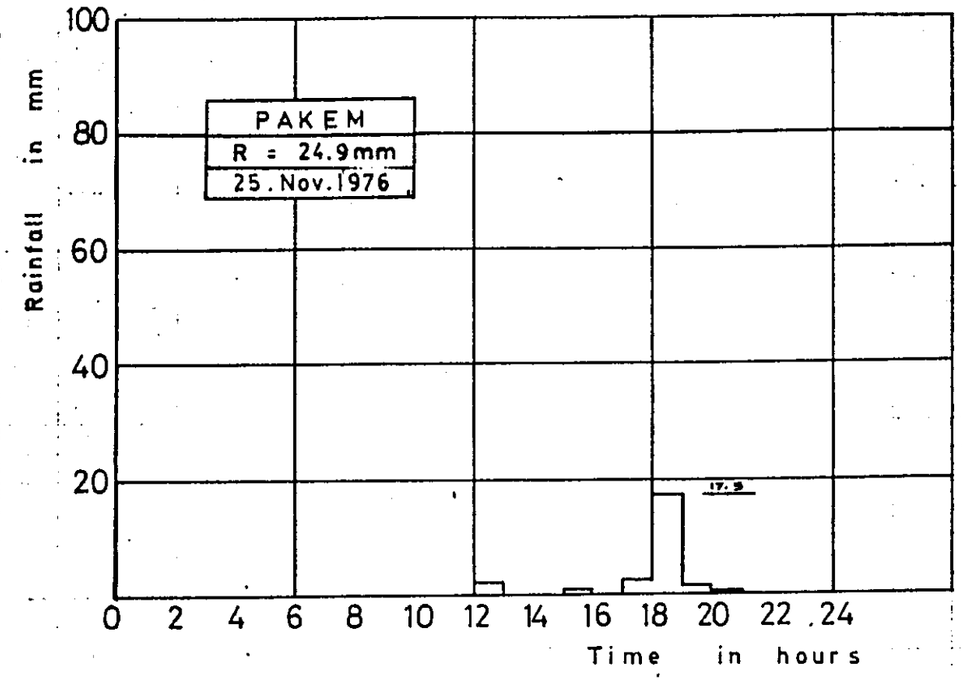

DELES
R = 23.0mm
4th Oct. 1976
13.0
Rainfall in mm
Time in hours


SALAM
R = 1. mm
4th Oct. 1976
Rainfall in mm
Time in hours

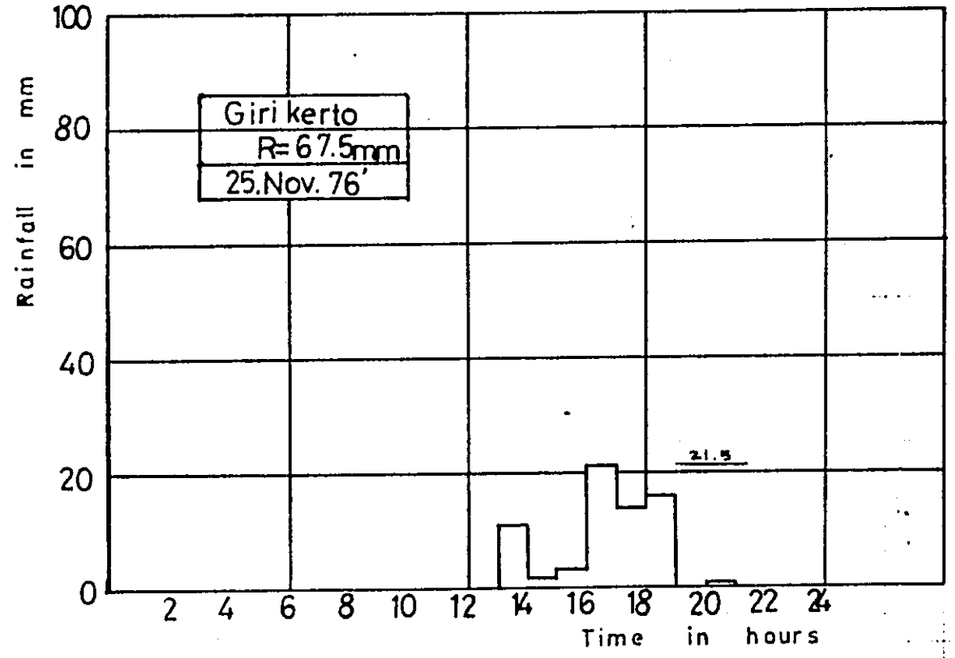

BABADAN
R = 0.0 mm
4th Oct. 1976
Rainfall in mm
Time in hours

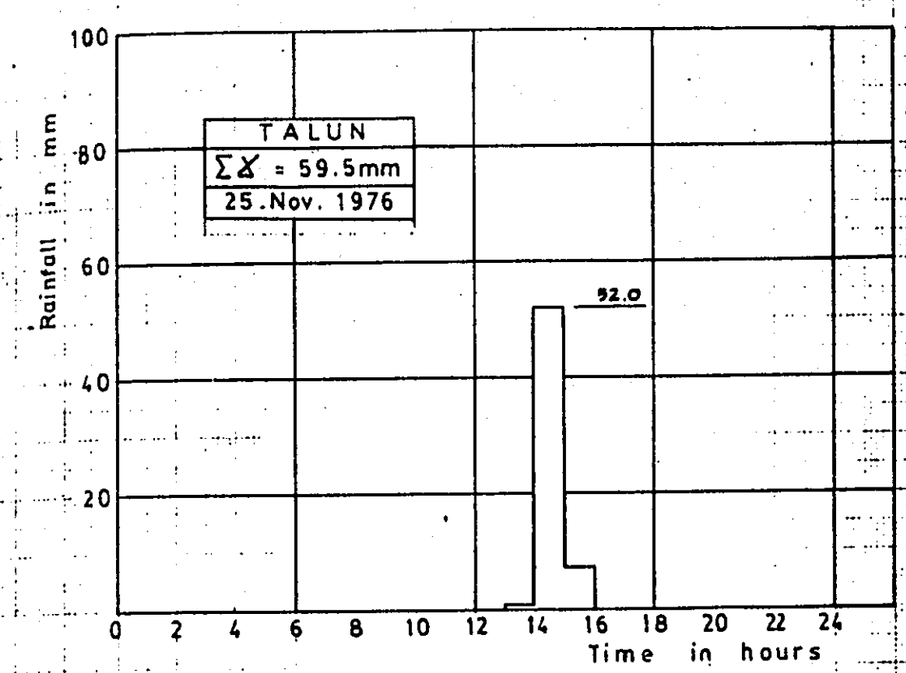

PLAWANGAN
R = 48.5 mm
4th Oct. 1976
27.0
Rainfall in mm
Time in hours

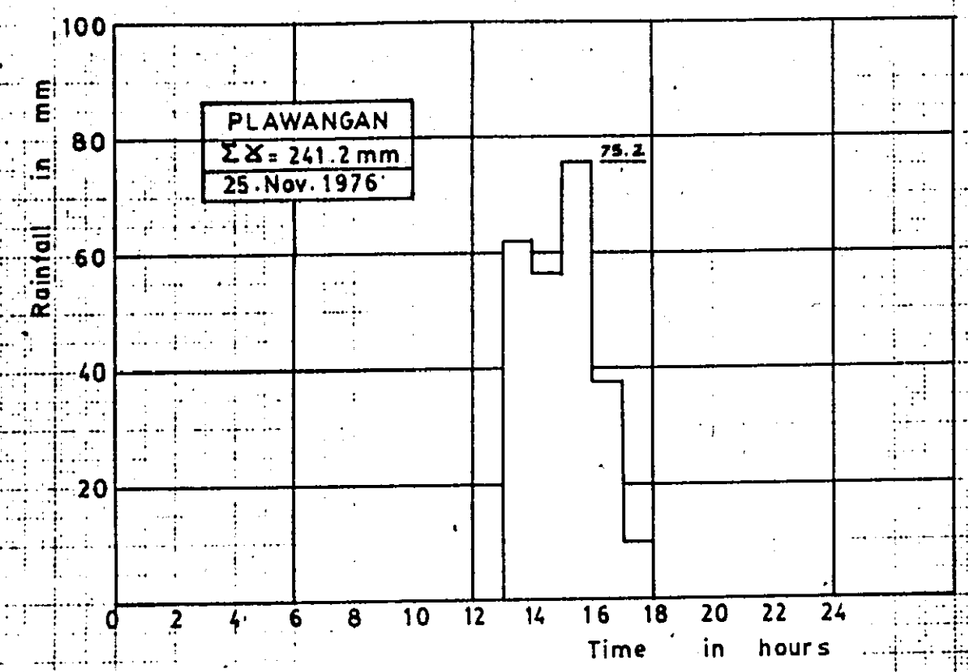

BABADAN
R = 93.2 mm
25.Nov.1976
53.0
Rainfall in mm
Time in hours

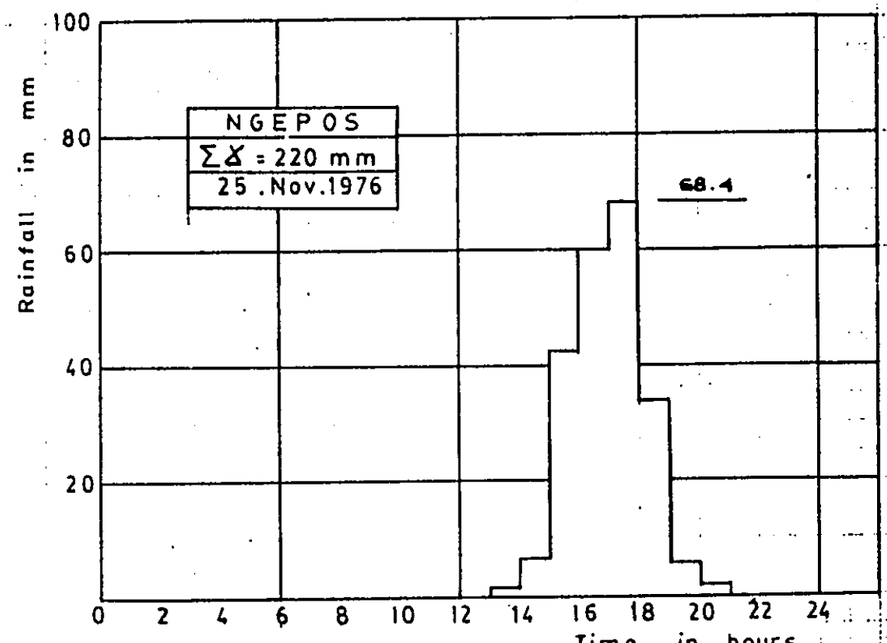

PAKEM
R = 24.9mm
25.Nov.1976
17.5
Rainfall in mm
Time in hours

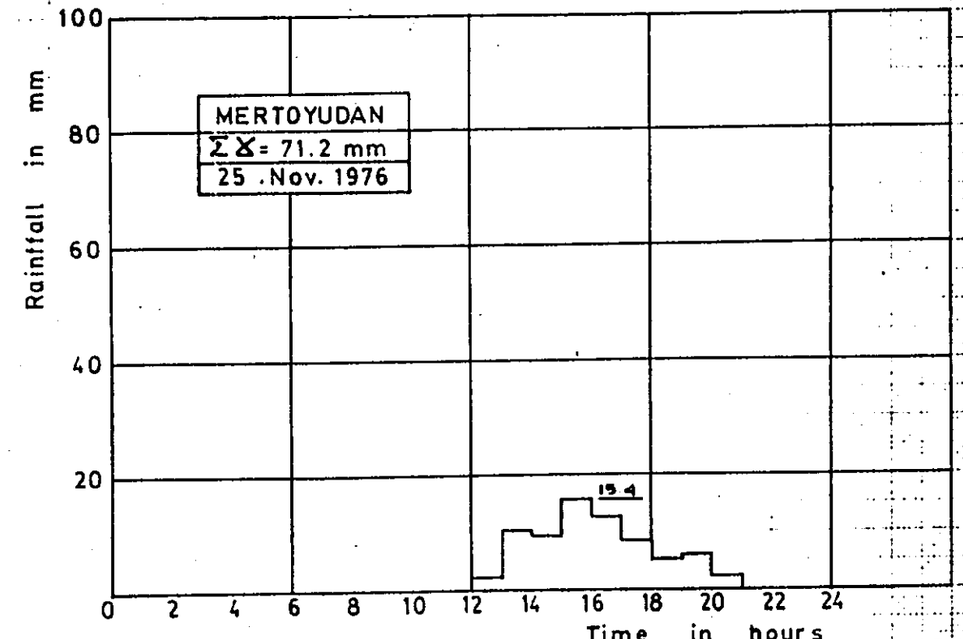
ARGOMULYO
R = 67.5 mm
25.Nov.1976
21.5
Rainfall in mm
Time in hours

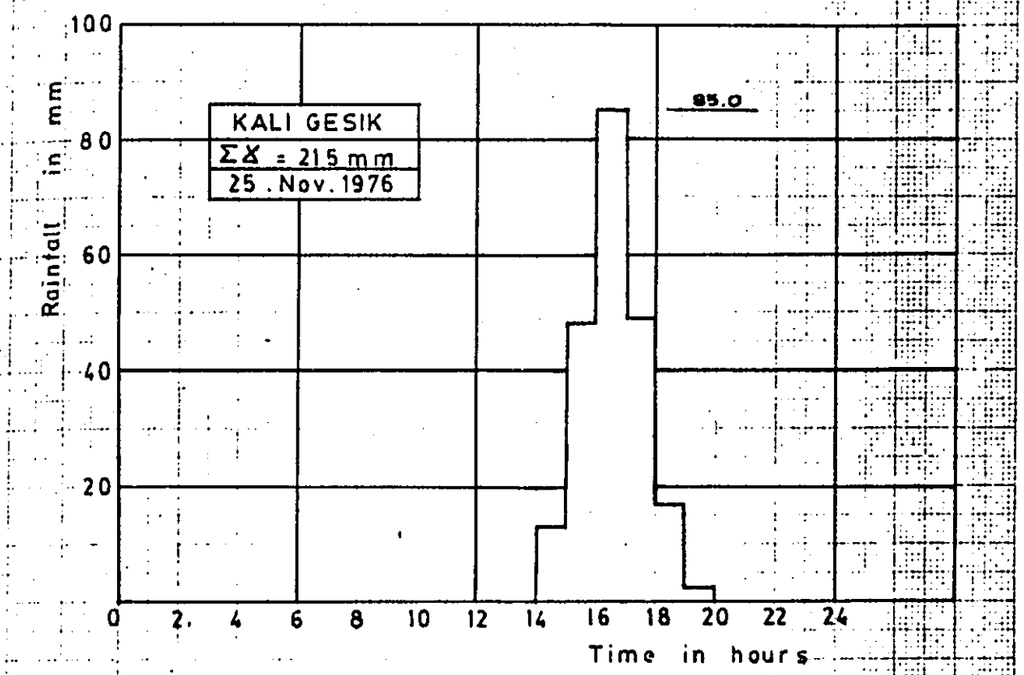

Giri kerto
R=67.5mm
25.Nov.76'
21.5
Rainfall in mm
Time in hours

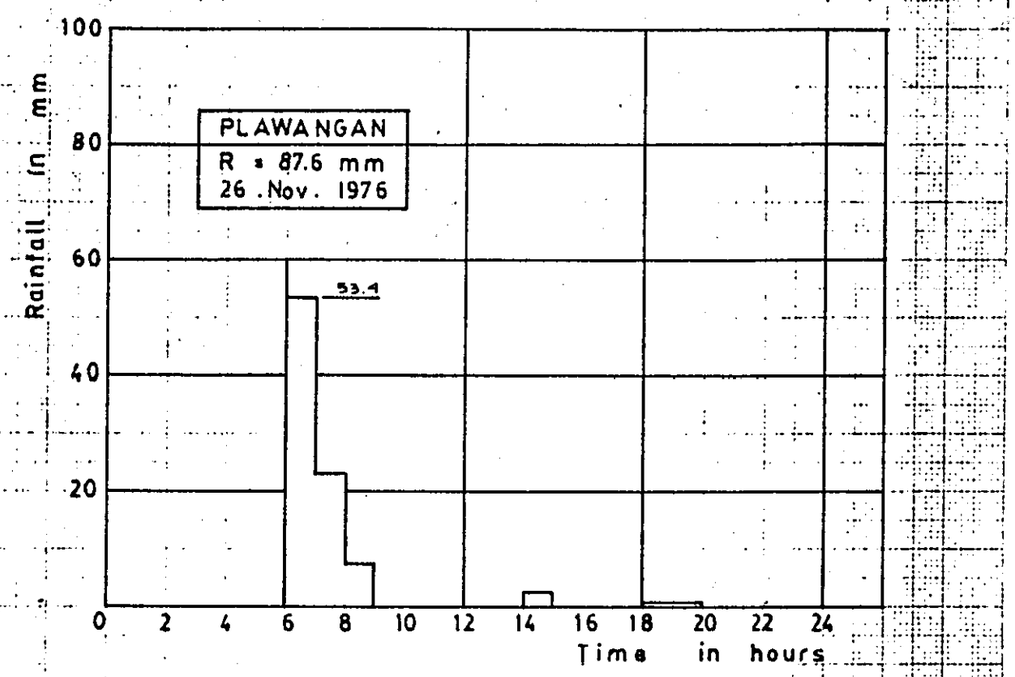

TALUN
ΣX = 59.5mm
25.Nov. 1976
92.0
Rainfall in mm
Time in hours

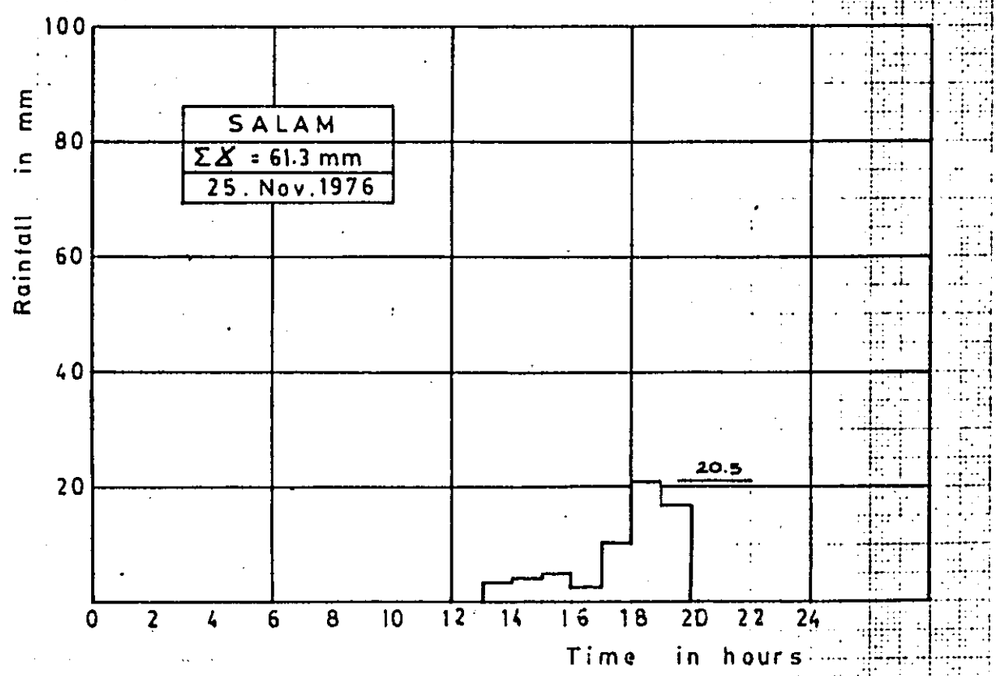

PLAWANGAN
ΣX = 241.2 mm
25.Nov. 1976
75.2
Rainfall in mm
Time in hours

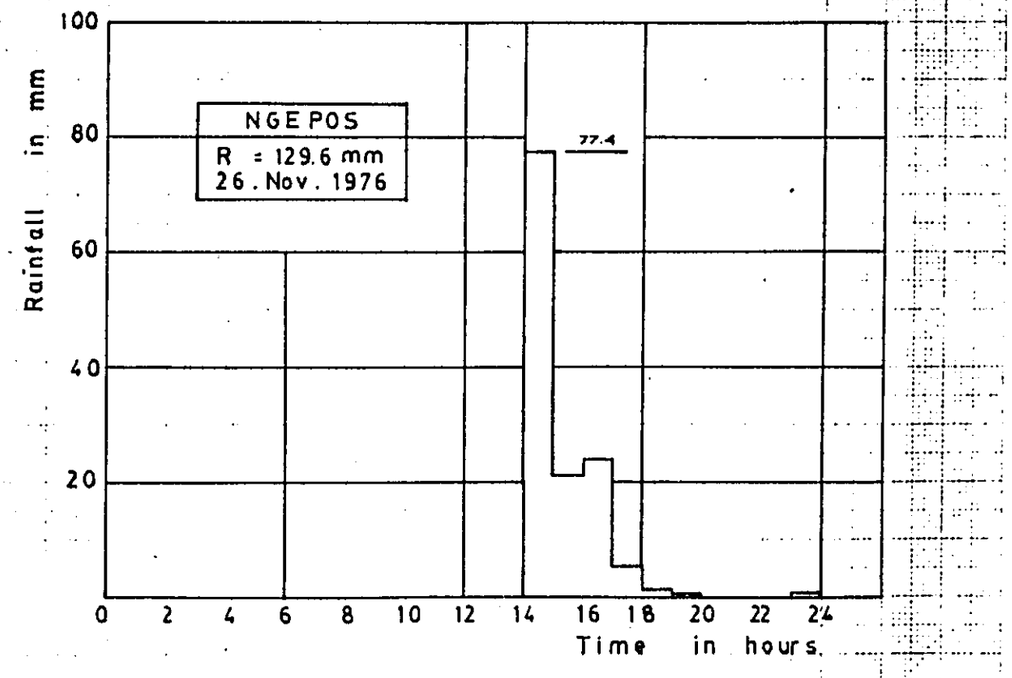

NGEPOS
ΣX = 220 mm
25.Nov.1976
68.4
Rainfall in mm
Time in hours

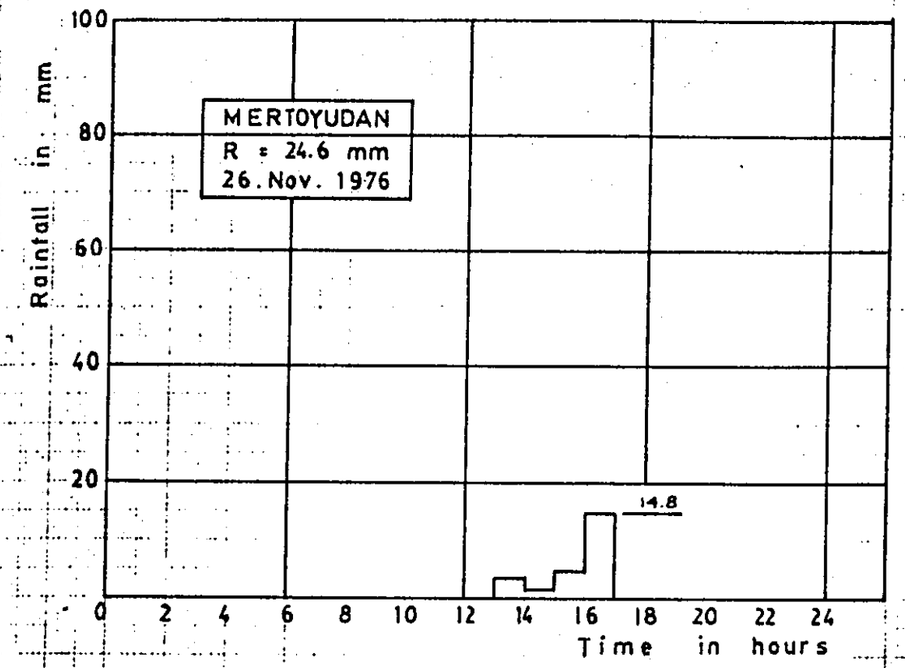

MERTOYUDAN
ΣX = 71.2 mm
25.Nov. 1976
15.4
Rainfall in mm
Time in hours

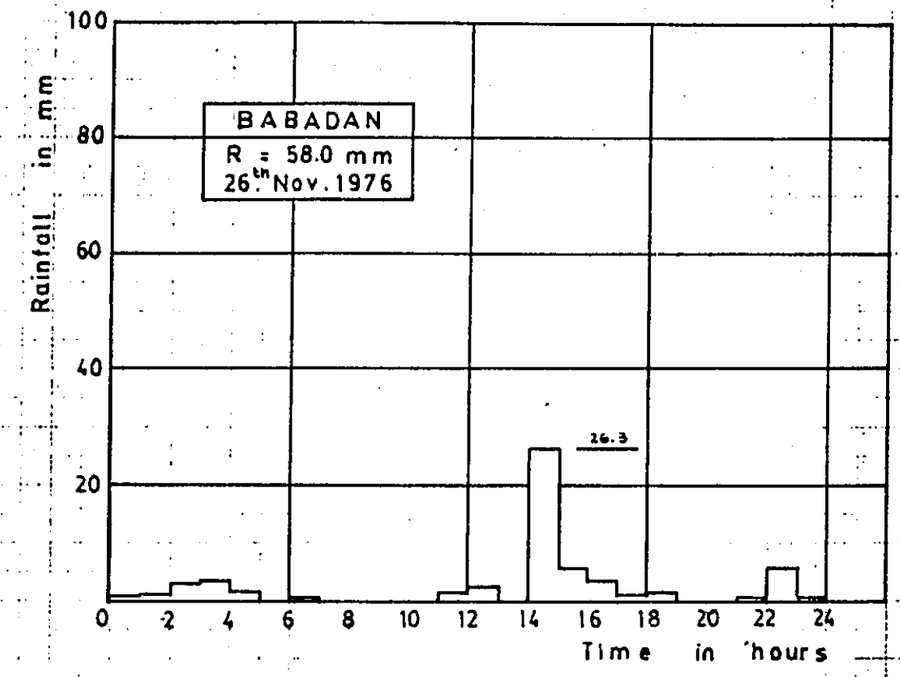

KALI GESIK
ΣX = 215 mm
25 . Nov. 1976
85.0
Rainfall in mm
Time in hours

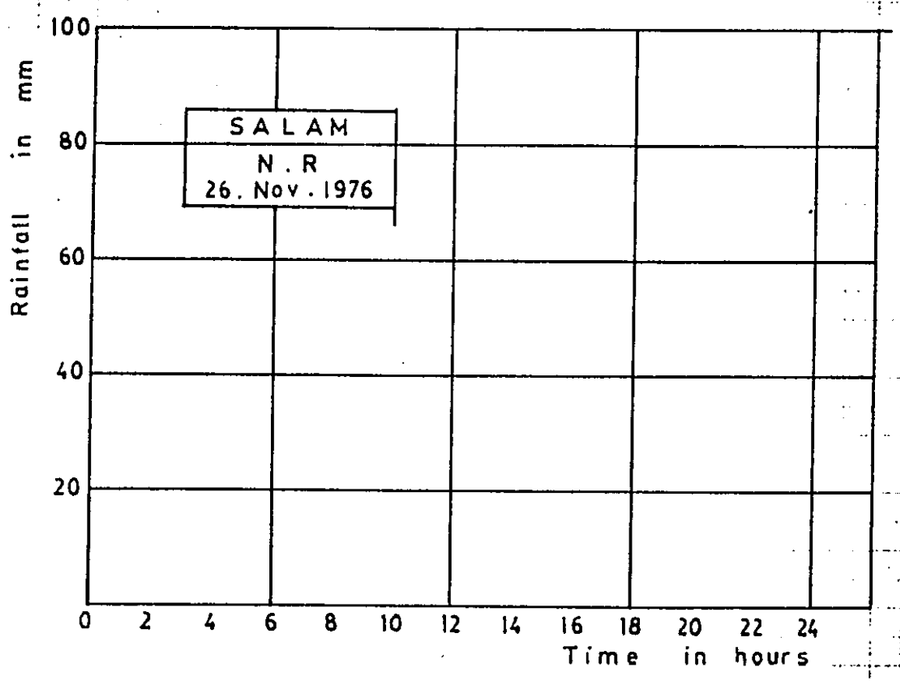

PLAWANGAN
R = 87.6 mm
26 . Nov. 1976
53.4
Rainfall in mm
Time in hours

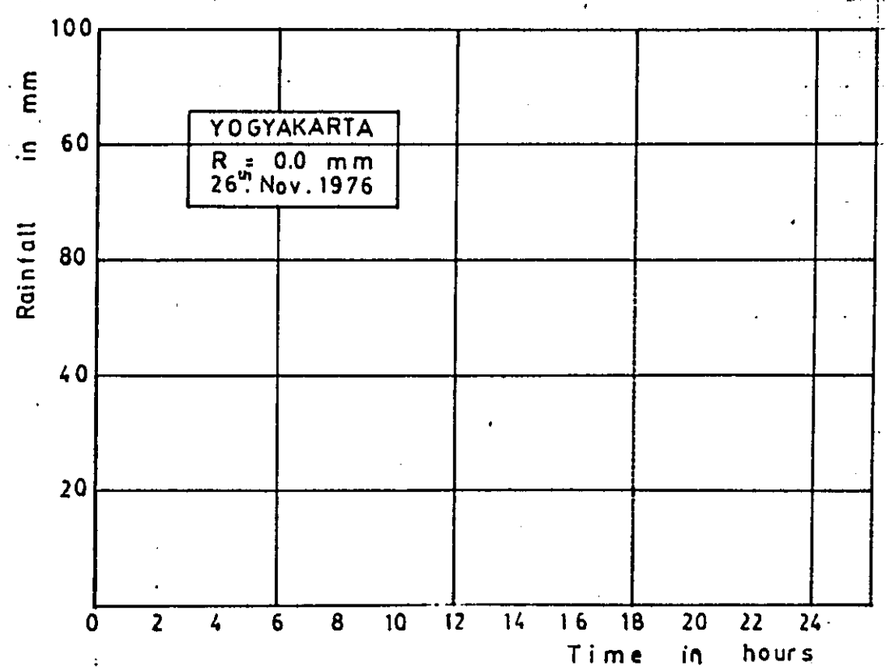

SALAM
ΣX = 61.3 mm
25 . Nov. 1976
20.5
Rainfall in mm
Time in hours

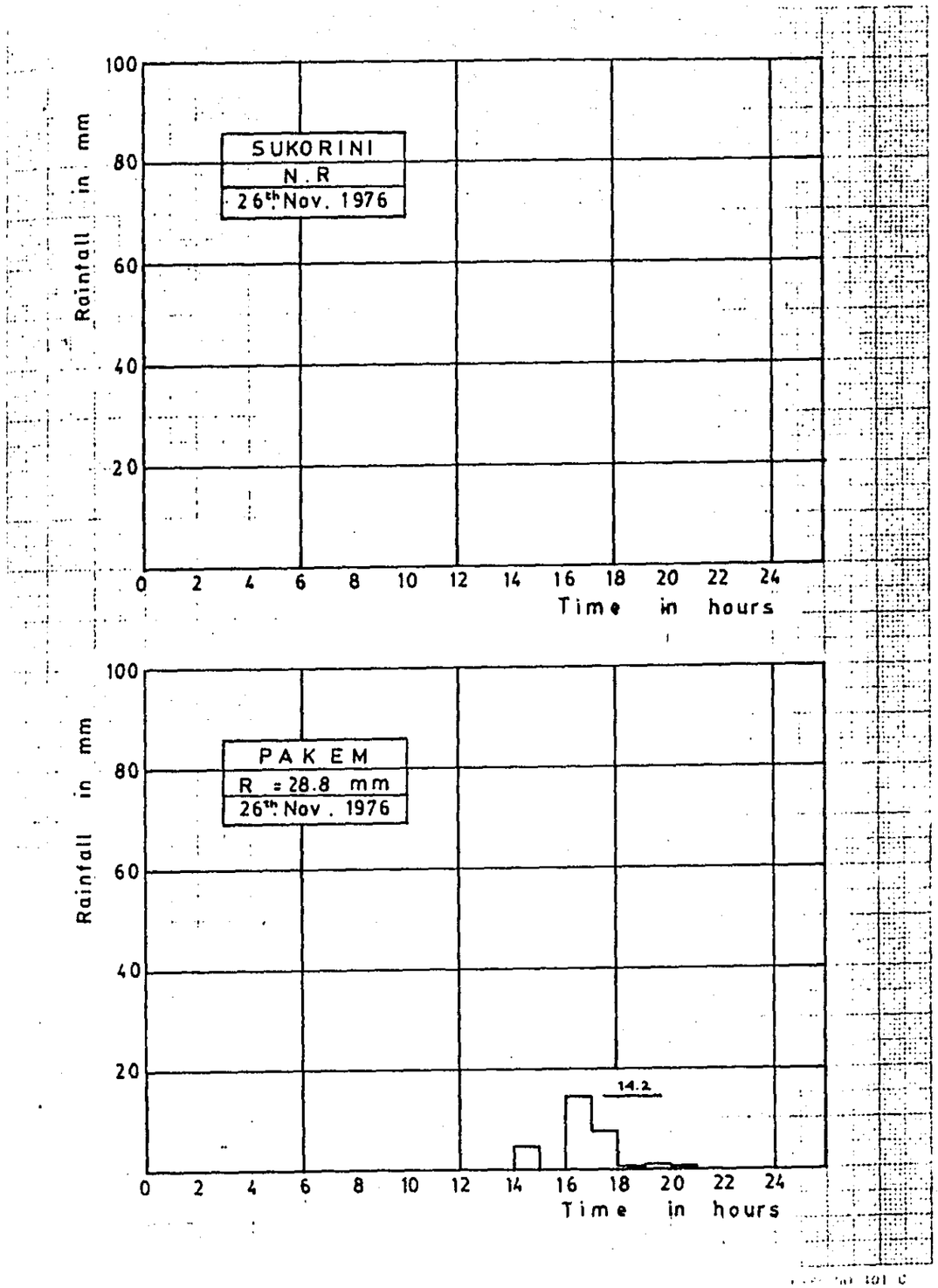

NGEPOS
R = 129.6 mm
26 . Nov. 1976
77.4
Rainfall in mm
Time in hours

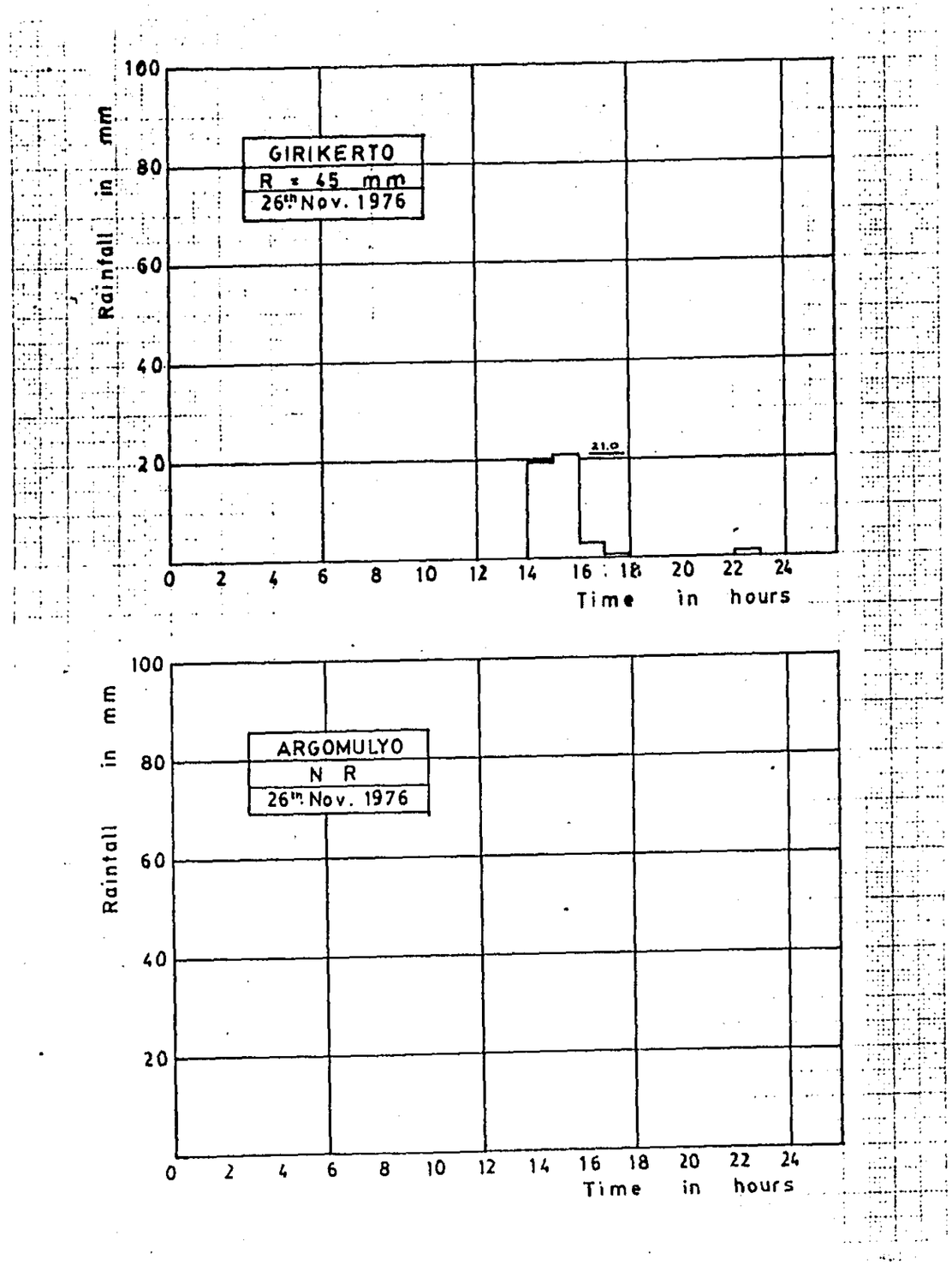

MERTOYUDAN
R = 24.6 mm
26. Nov. 1976
14.8
Rainfall in mm
Time in hours

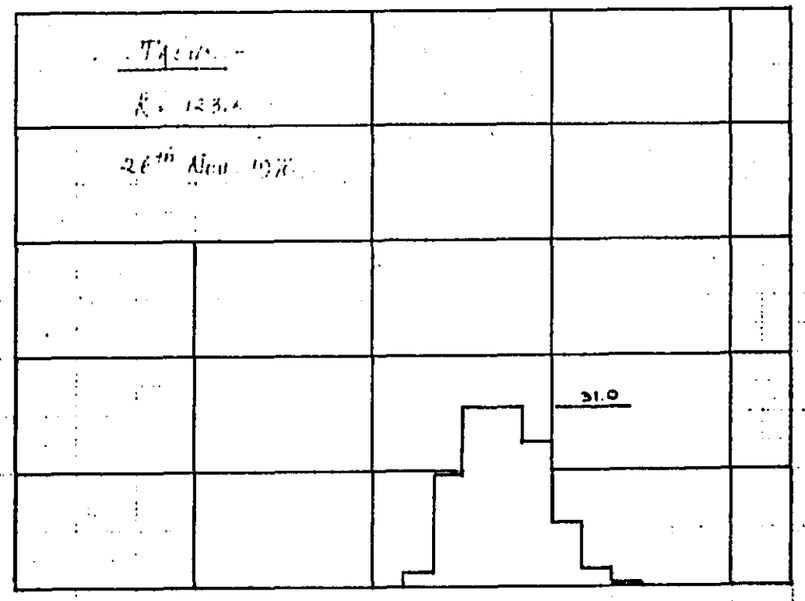

BABADAN
R = 58.0 mm
26th Nov. 1976
26.3
Rainfall in mm
Time in hours

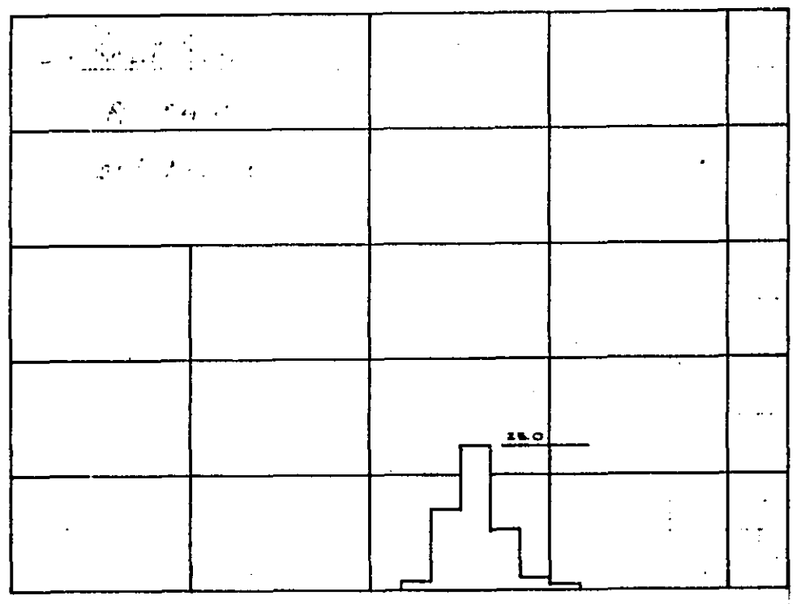

SALAM
N. R
26. Nov. 1976
Rainfall in mm
Time in hours

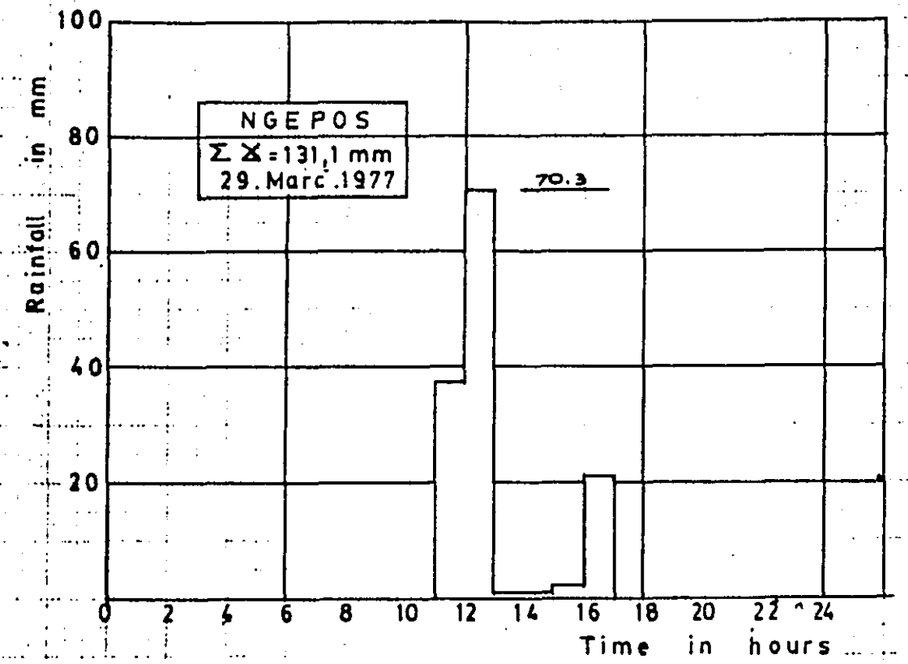

YOGYAKARTA
R = 0.0 mm
26th Nov. 1976
Rainfall in mm
Time in hours


SUKORINI
N.R
26th Nov. 1976
Rainfall in mm
Time in hours
PAKEM
R = 28.8 mm
26th Nov. 1976
14.2
Rainfall in mm
Time in hours


GIRIKERTO
R = 45 mm
26th Nov. 1976
21.0
Rainfall in mm
Time in hours
ARGOMULYO
N R
26th Nov. 1976
Rainfall in mm
Time in hours


31.0


28.0


NGEPOS
Σ X = 131,1 mm
29.Marc.1977
70.3
Rainfall in mm
100
80
60
40
20
0 2 4 6 8 10 12 14 16 18 20 22 24
Time in hours

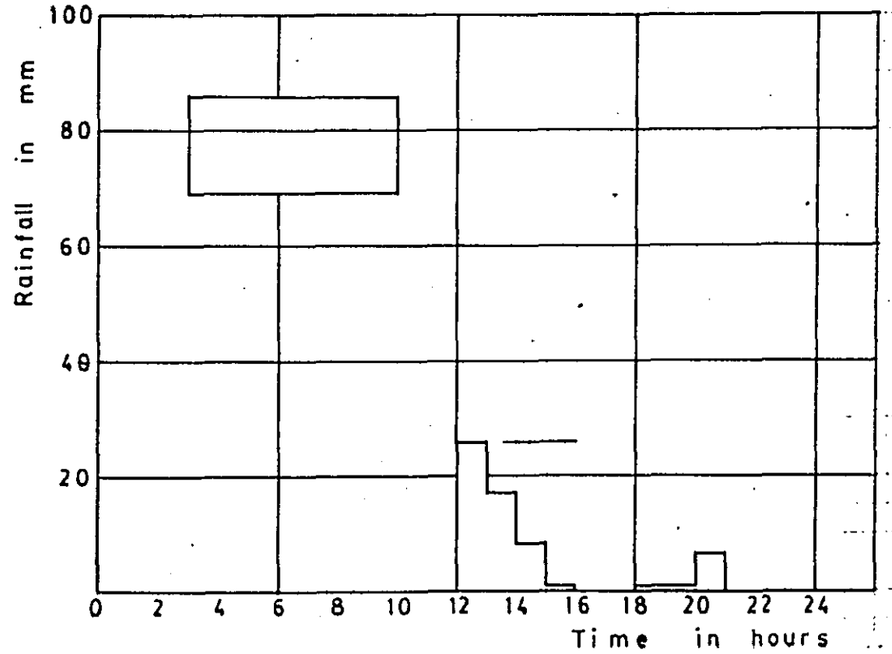
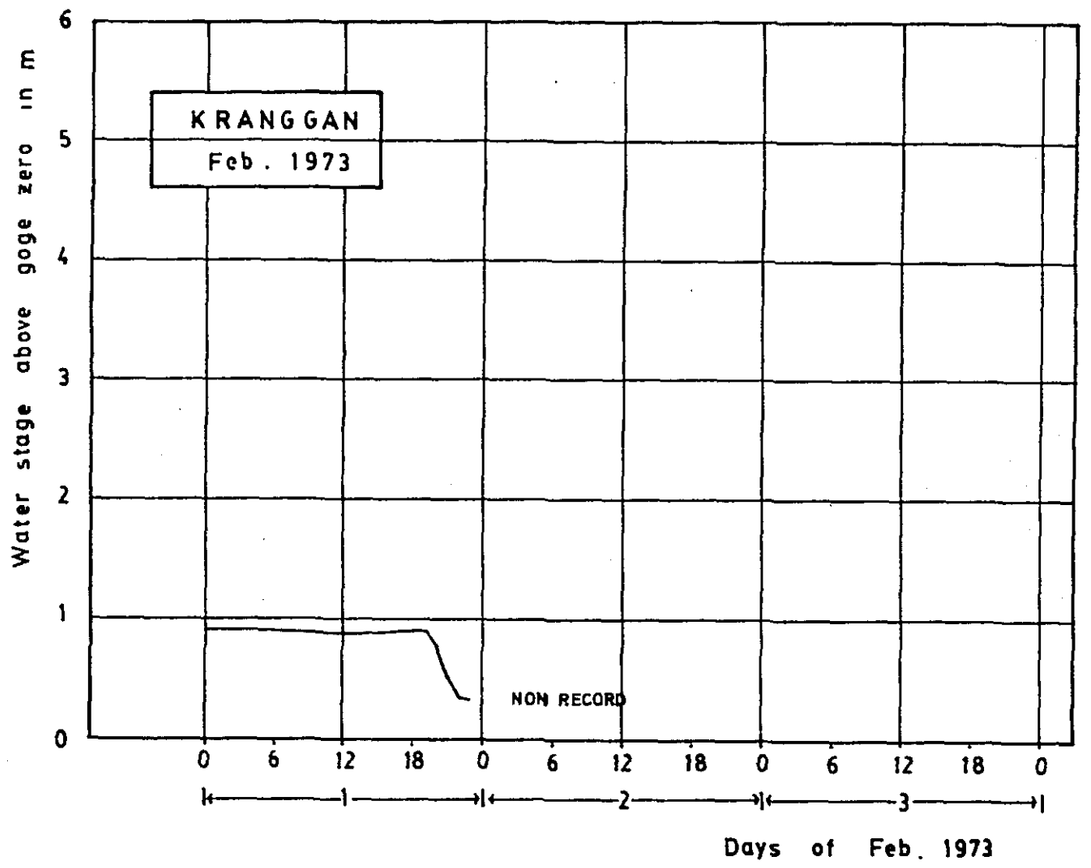
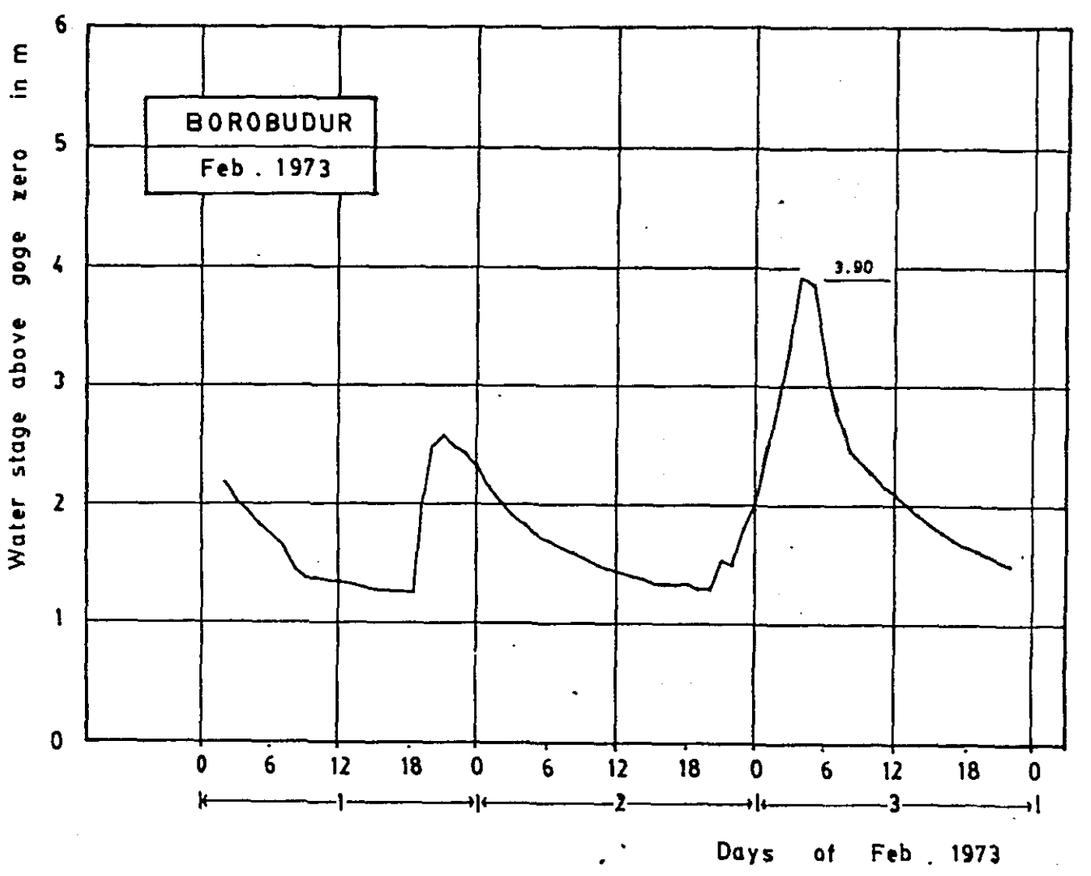
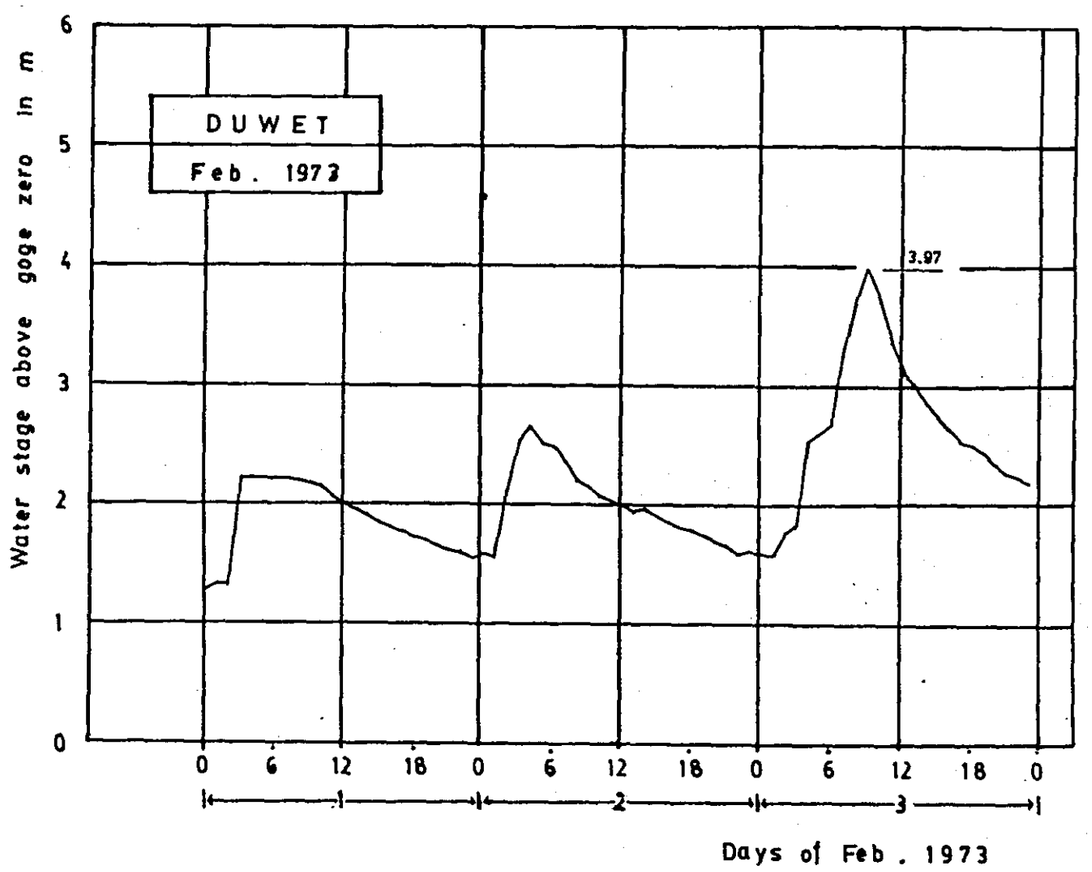
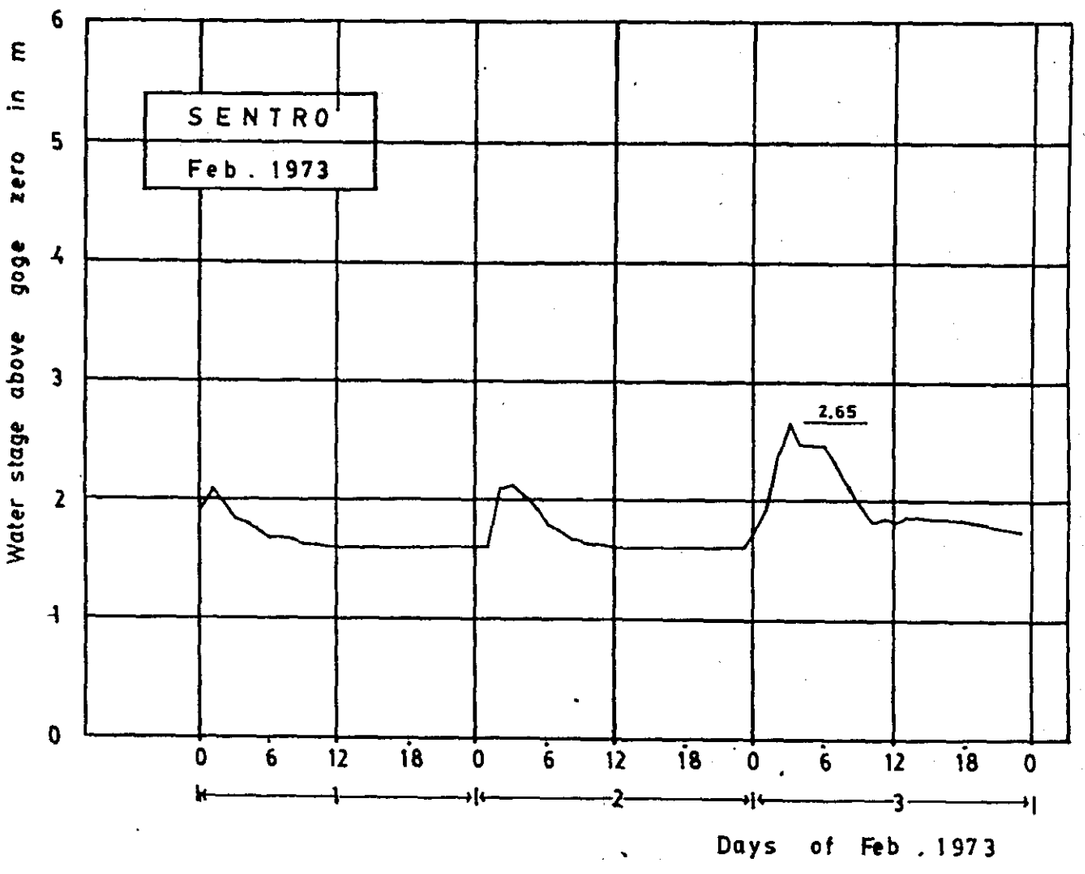

Rainfall in mm
100
80
60
40
20
0 2 4 6 8 10 12 14 16 18 20 22 24
Time in hours

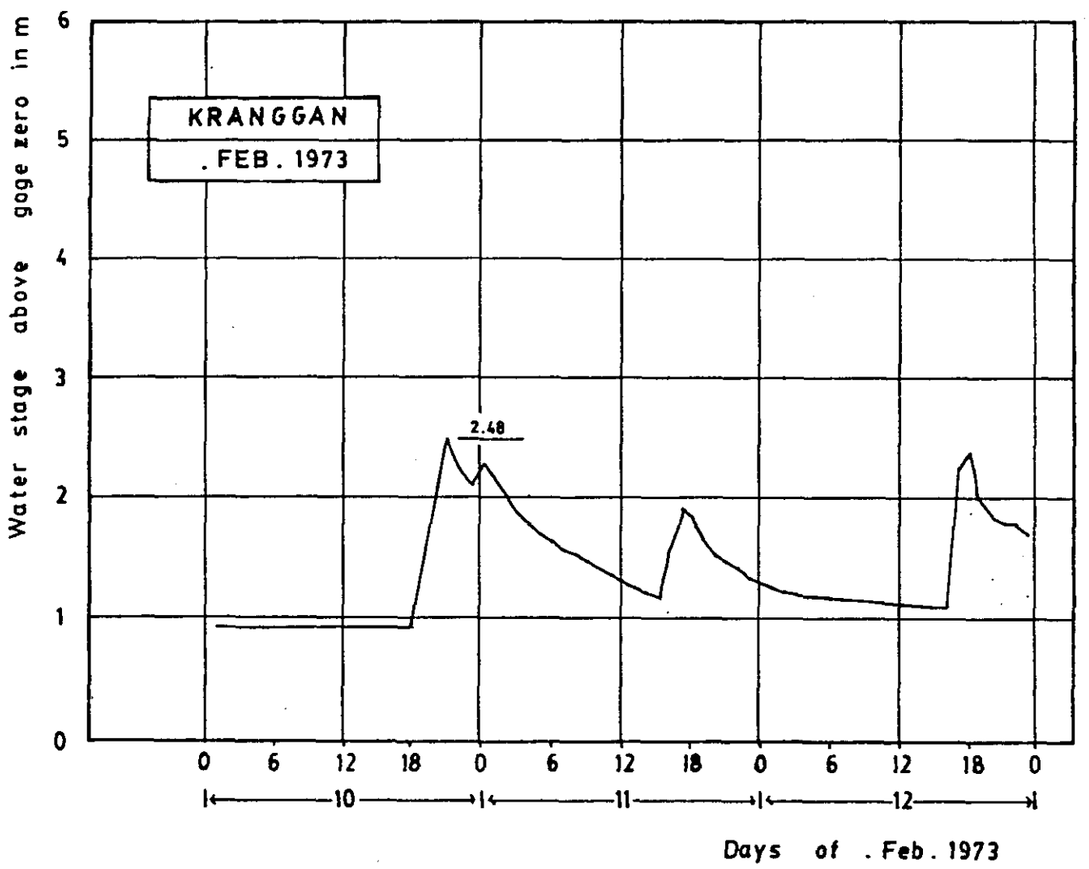
FIG. 28 FLOOD HYDROGRAPHS
IN PROGO RIVER
(1973 - 1977)

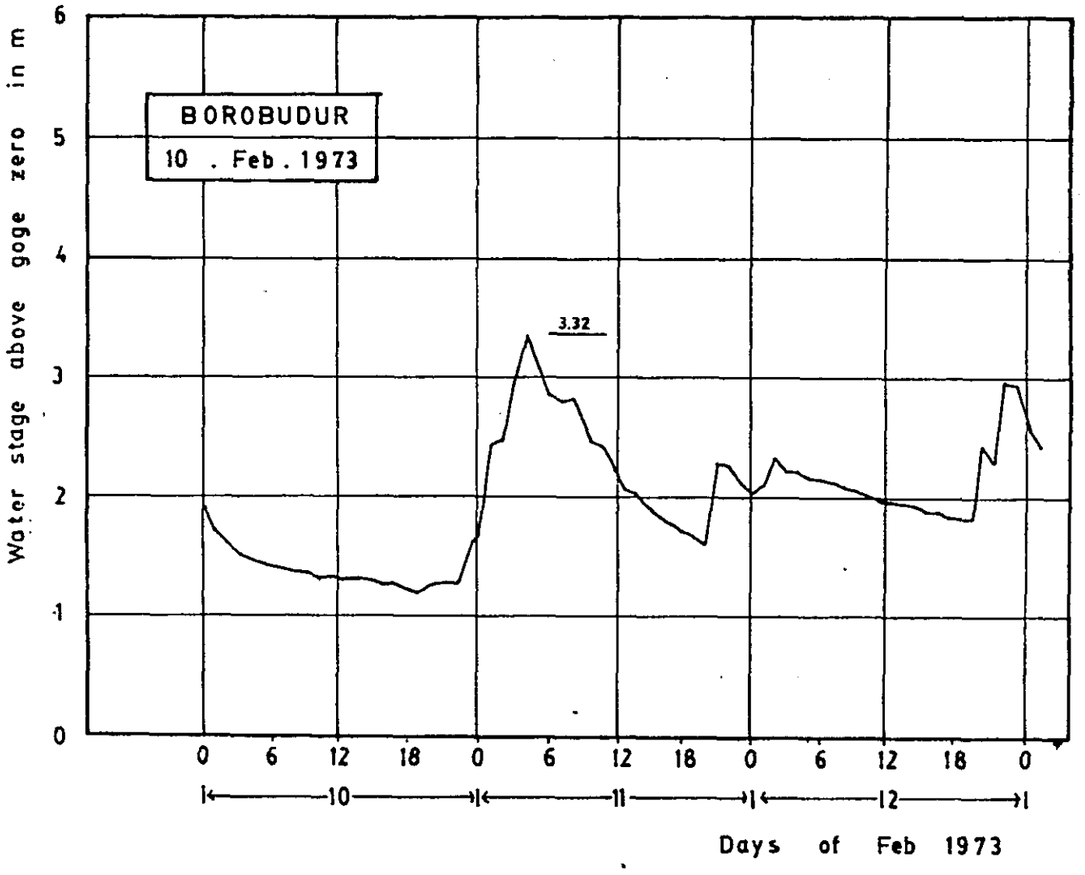

KRANGGAN
Feb. 1973
Water stage above gage zero in m
NON RECORD
Days of Feb. 1973

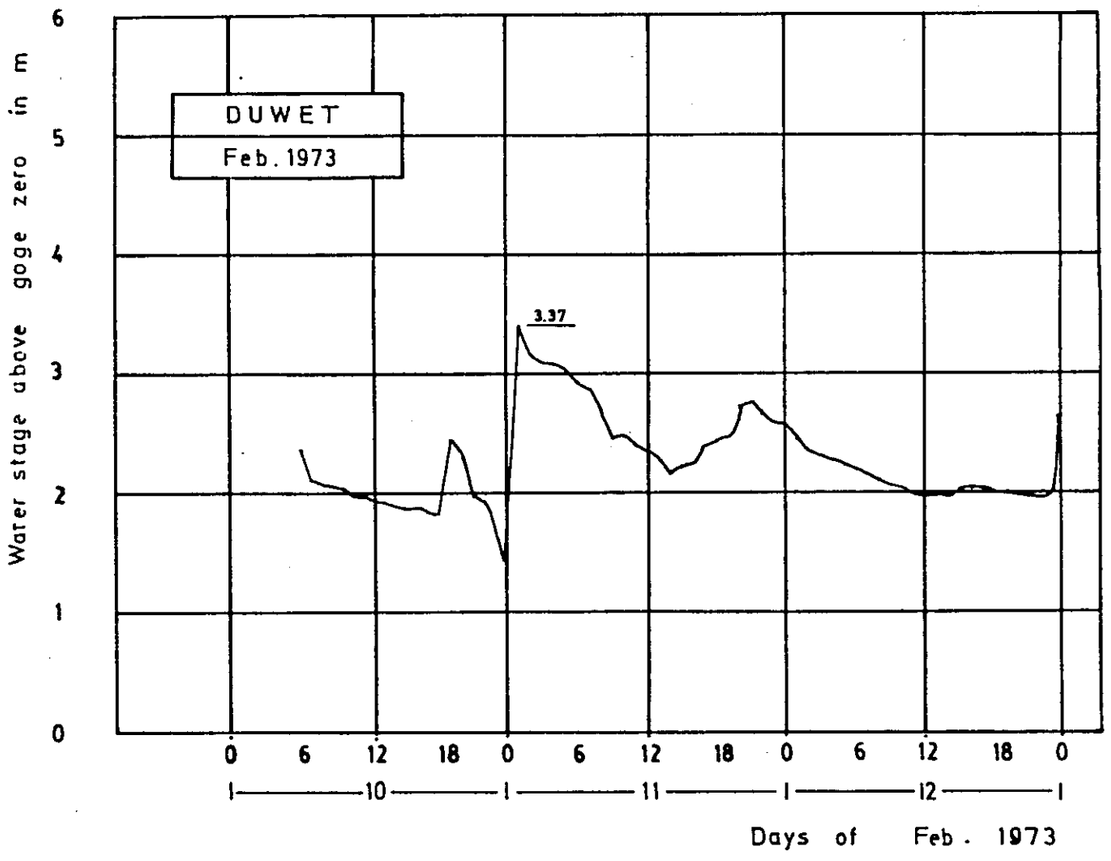

BOROBUDUR
Feb. 1973
Water stage above gage zero in m
3.90
Days of Feb. 1973

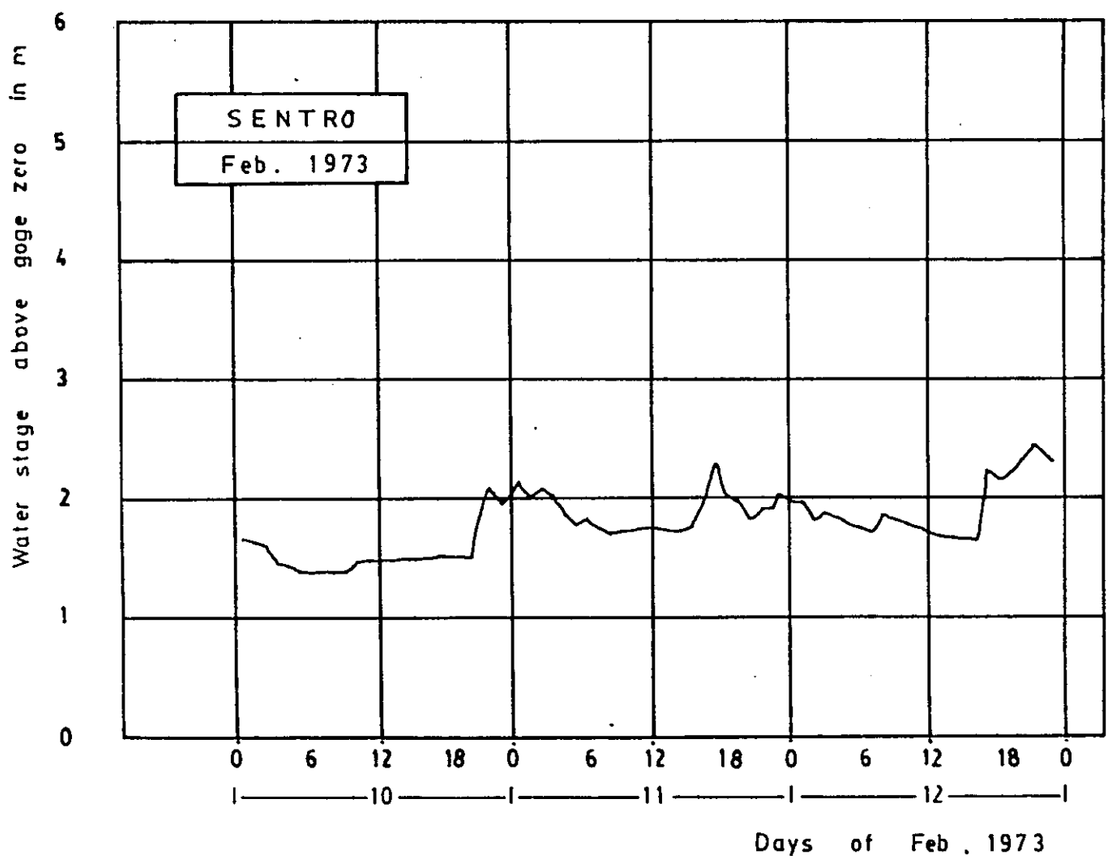

DUWET
Feb. 1973
3.97
Water stage above goge zero in m
0
1
2
3
4
5
6
0 6 12 18 0 6 12 18 0 6 12 18 0
1
2
3
Days of Feb. 1973

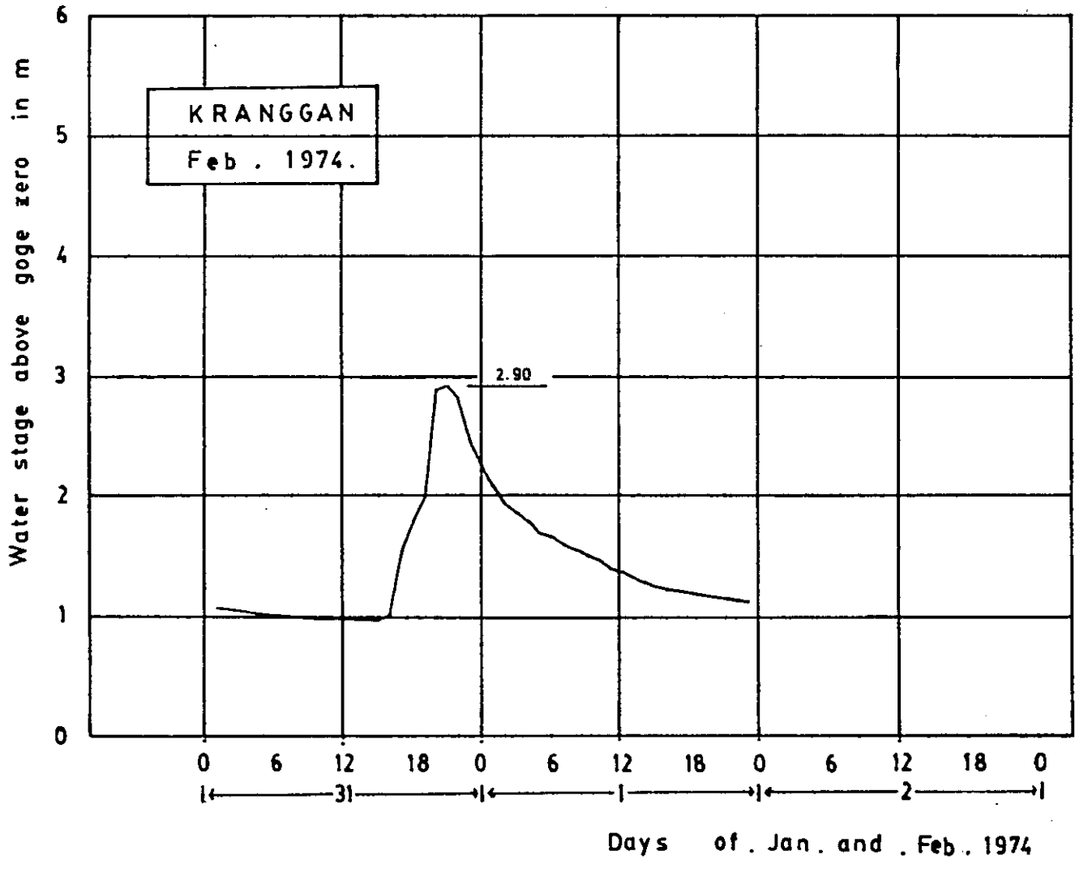

SENTRO
Feb. 1973
2,65
Water stage above goge zero in m
0
1
2
3
4
5
6
0 6 12 18 0 6 12 18 0 6 12 18 0
1
2
3
Days of Feb. 1973

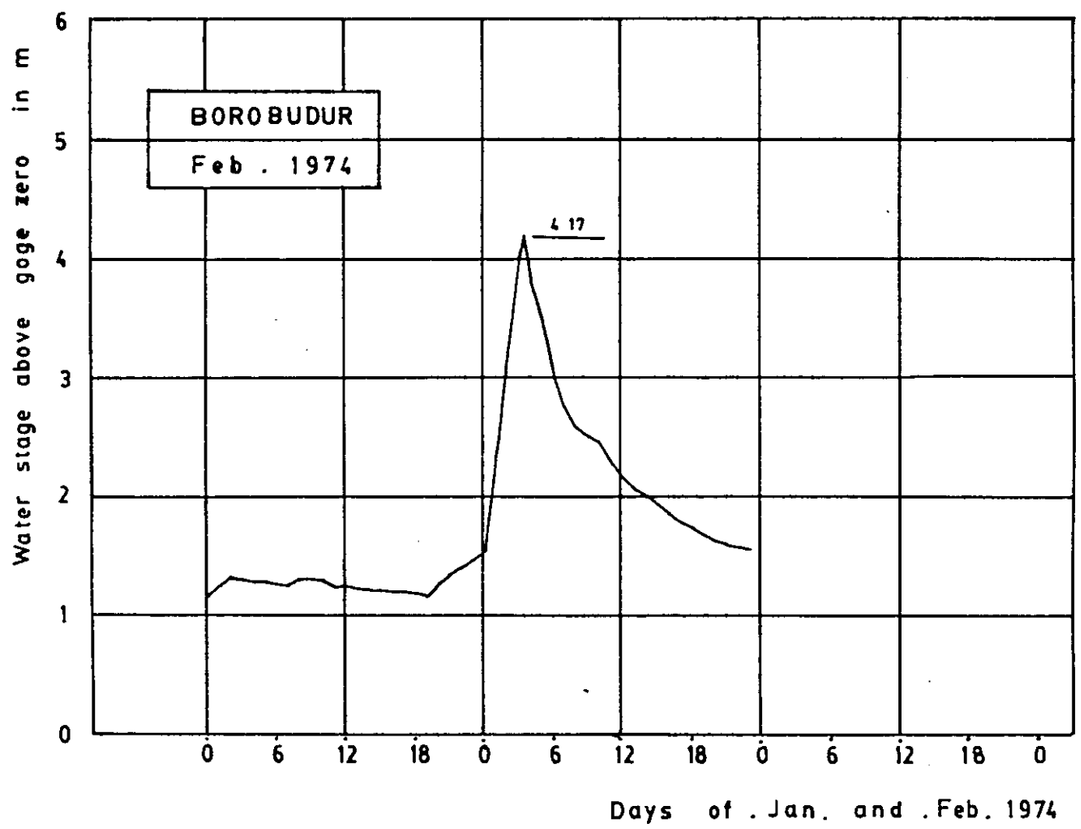

KRANGGAN
. FEB. 1973
2.48
Water stage above gage zero in m
0
1
2
3
4
5
6
0 6 12 18 0 6 12 18 0 6 12 18 0
10
11
12
Days of . Feb. 1973

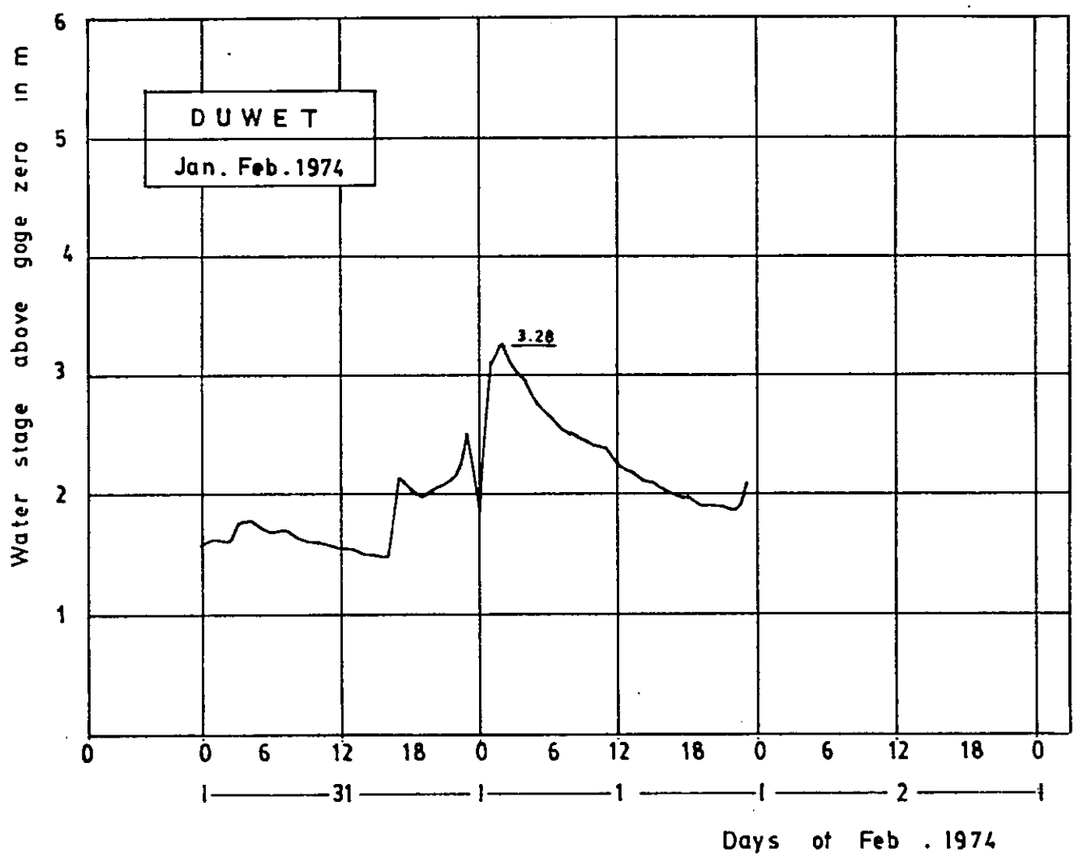

BOROBUDUR
10 . Feb. 1973
3.32
Water stage above gage zero in m
0
1
2
3
4
5
6
0 6 12 18 0 6 12 18 0 6 12 18 0
10
11
12
Days of Feb 1973

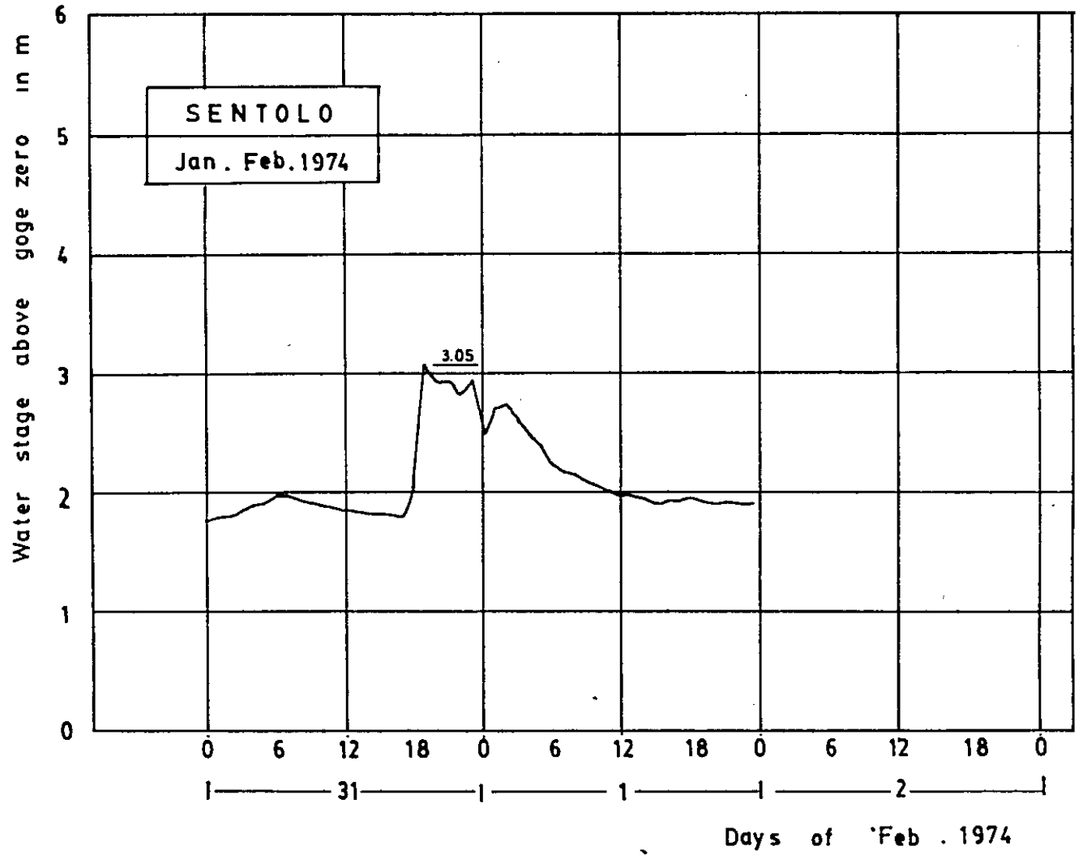

DUWET
Feb. 1973
3.37
Water stage above gage zero in m
0
1
2
3
4
5
6
0 6 12 18 0 6 12 18 0 6 12 18 0
1 10 1 11 1 12 1
Days of Feb. 1973

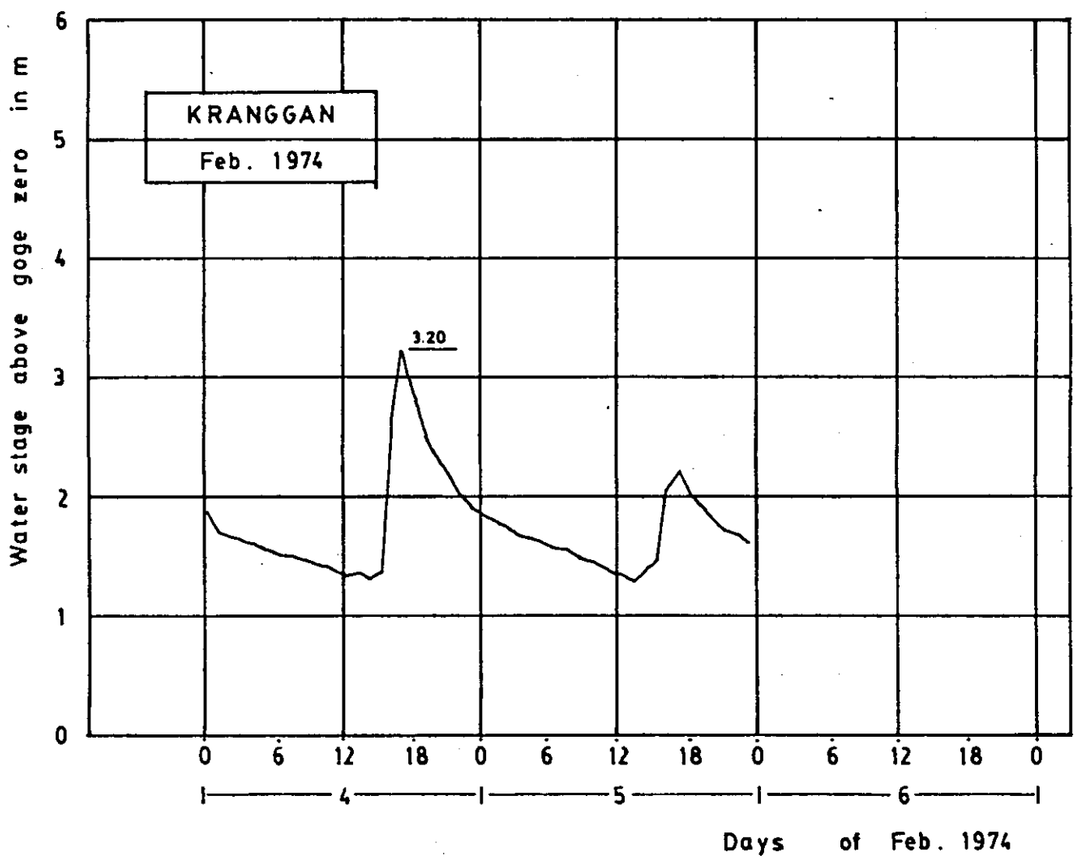

SENTRO
Feb. 1973
Water stage above gage zero in m
0
1
2
3
4
5
6
0 6 12 18 0 6 12 18 0 6 12 18 0
1 10 1 11 1 12 1
Days of Feb. 1973

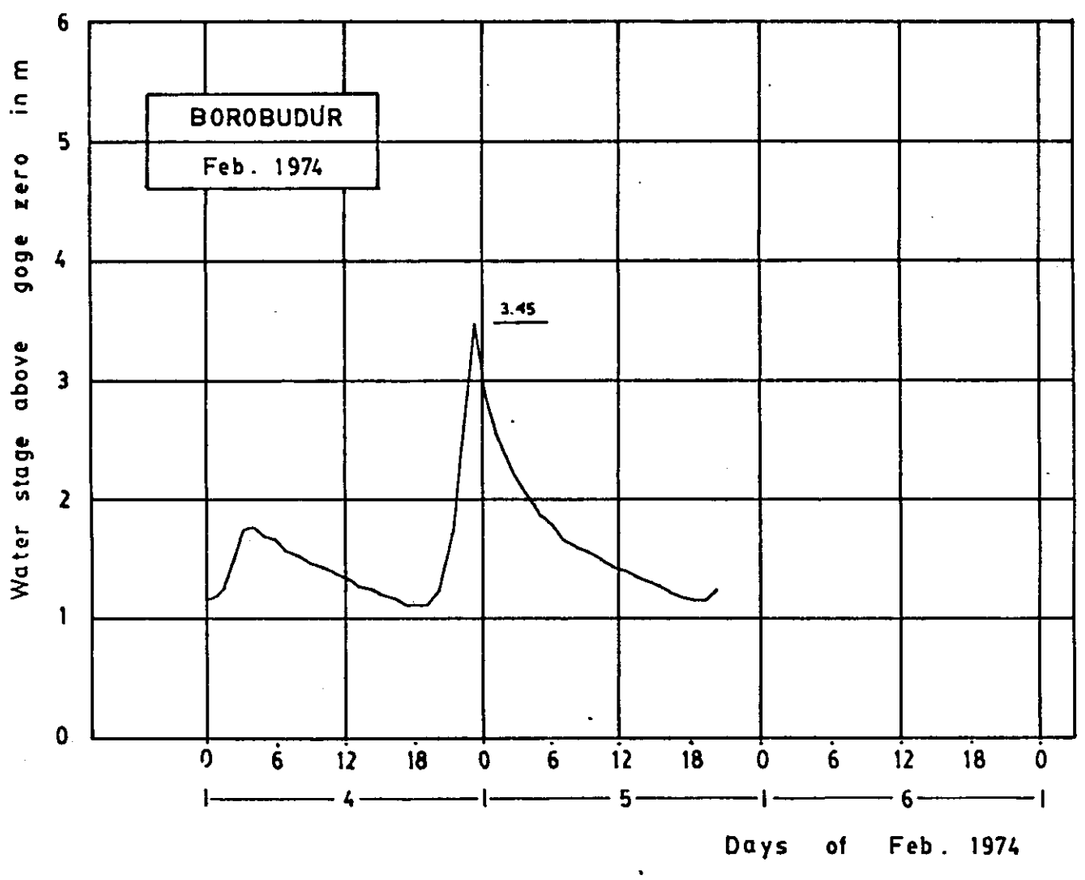

KRANGGAN
Feb . 1974.
2.90
Water stage above goge zero in m
0
1
2
3
4
5
6
0 6 12 18 0 6 12 18 0 6 12 18 0
1 31 1 1 1 2 1
Days of . Jan . and . Feb . 1974

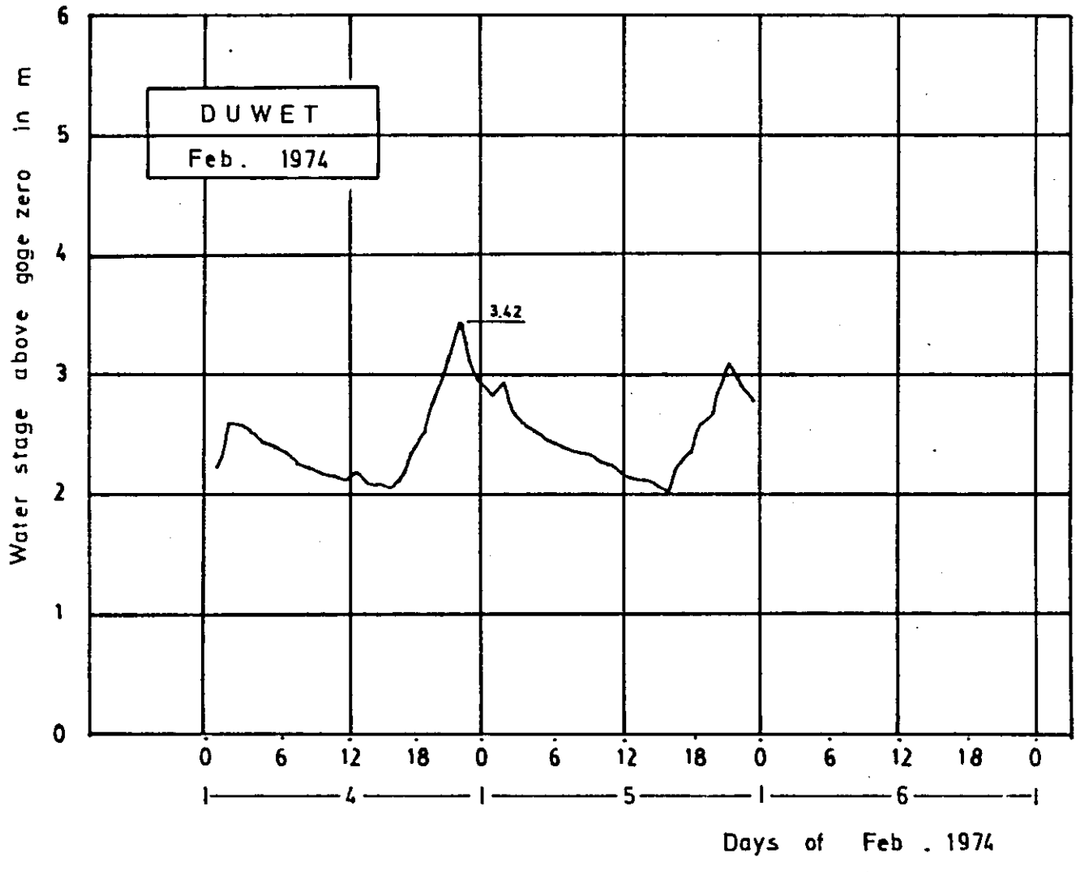

BOROBUDUR
Feb . 1974
4 17
Water stage above goge zero in m
0
1
2
3
4
5
6
0 6 12 18 0 6 12 18 0 6 12 18 0
Days of . Jan. and . Feb. 1974

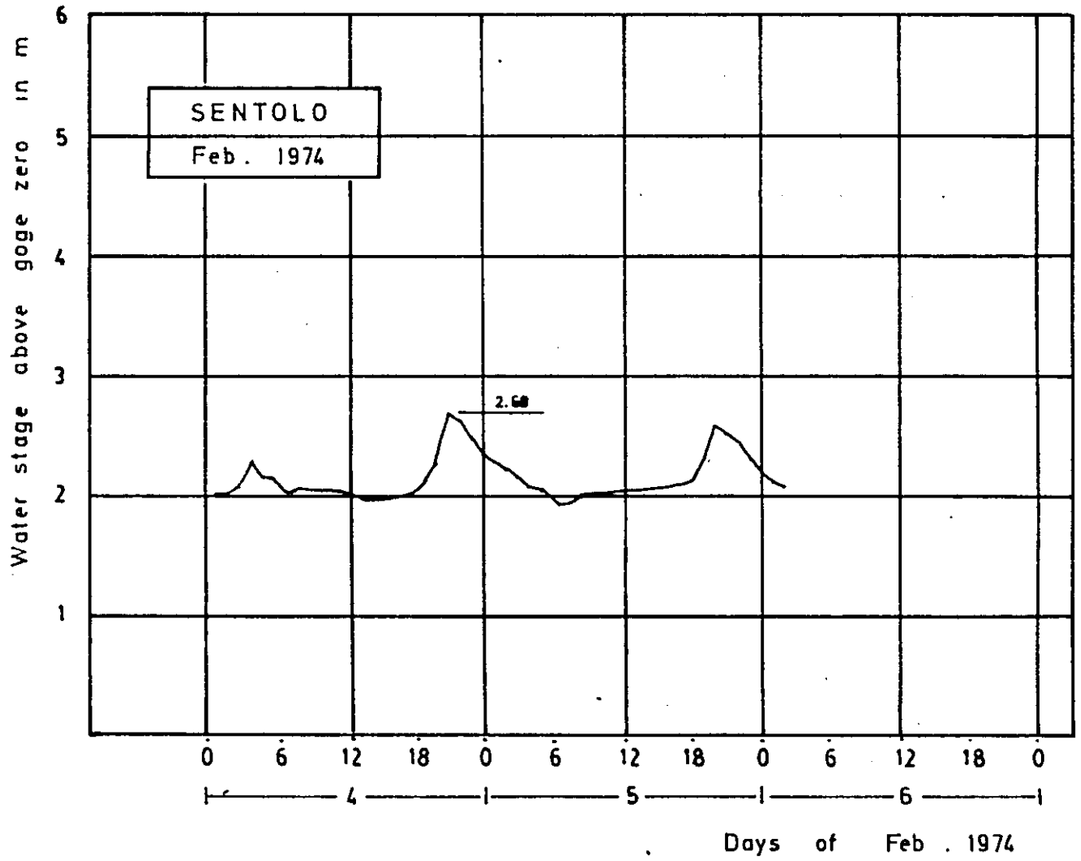

DUWET
Jan. Feb. 1974
3.28
Water stage above goge zero in m
6
5
4
3
2
1
0
0 6 12 18 0 6 12 18 0 6 12 18 0
31 1 1 2
Days of Feb. 1974

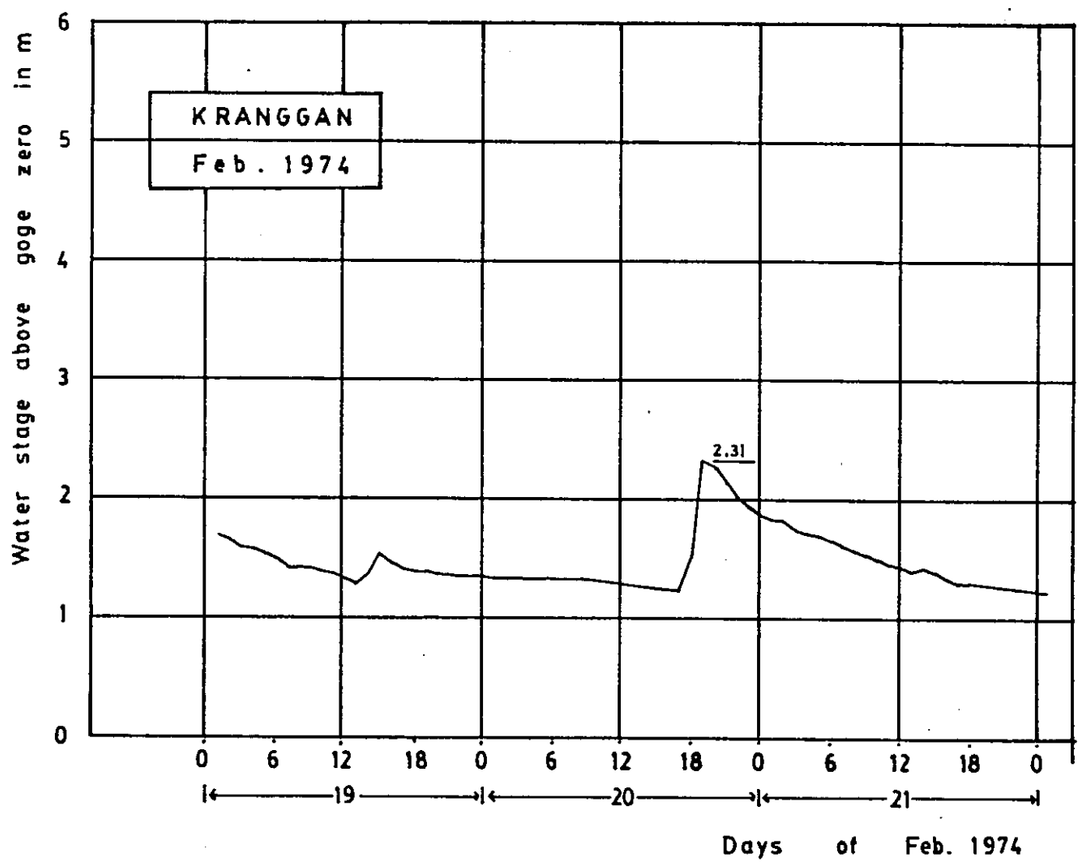

SENTOLO
Jan. Feb. 1974
3.05
Water stage above goge zero in m
6
5
4
3
2
1
0
0 6 12 18 0 6 12 18 0 6 12 18 0
31 1 2
Days of Feb. 1974

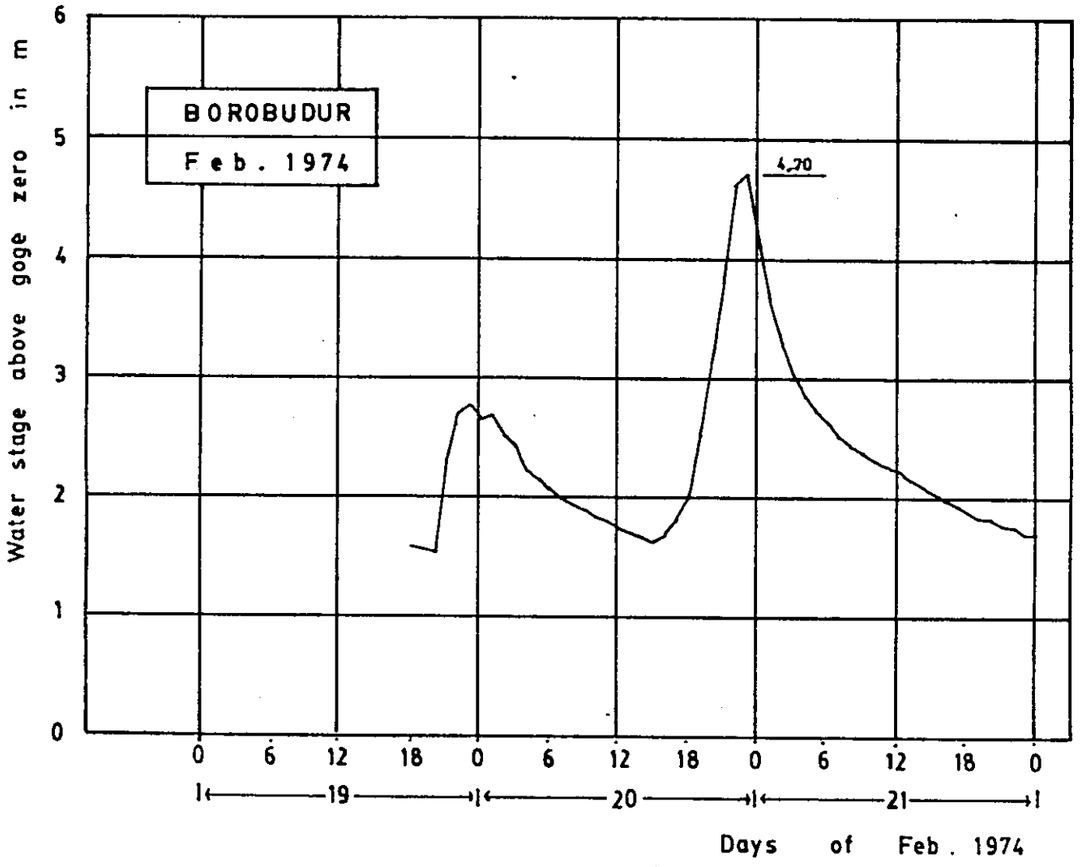

KRANGGAN
Feb. 1974
3.20
Water stage above goge zero in m
0
1
2
3
4
5
6
0 6 12 18 0 6 12 18 0 6 12 18 0
4
5
6
Days of Feb. 1974

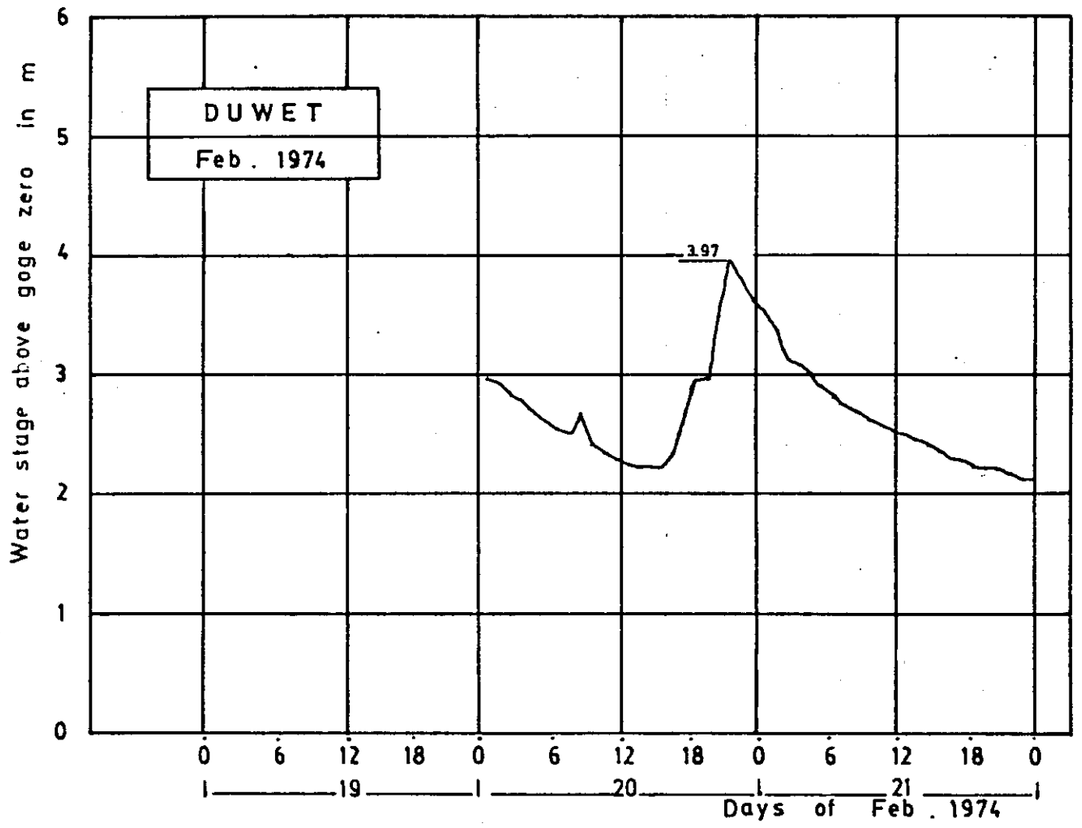

BOROBUDUR
Feb. 1974
3.45
Water stage above goge zero in m
0
1
2
3
4
5
6
0 6 12 18 0 6 12 18 0 6 12 18 0
4
5
6
Days of Feb. 1974

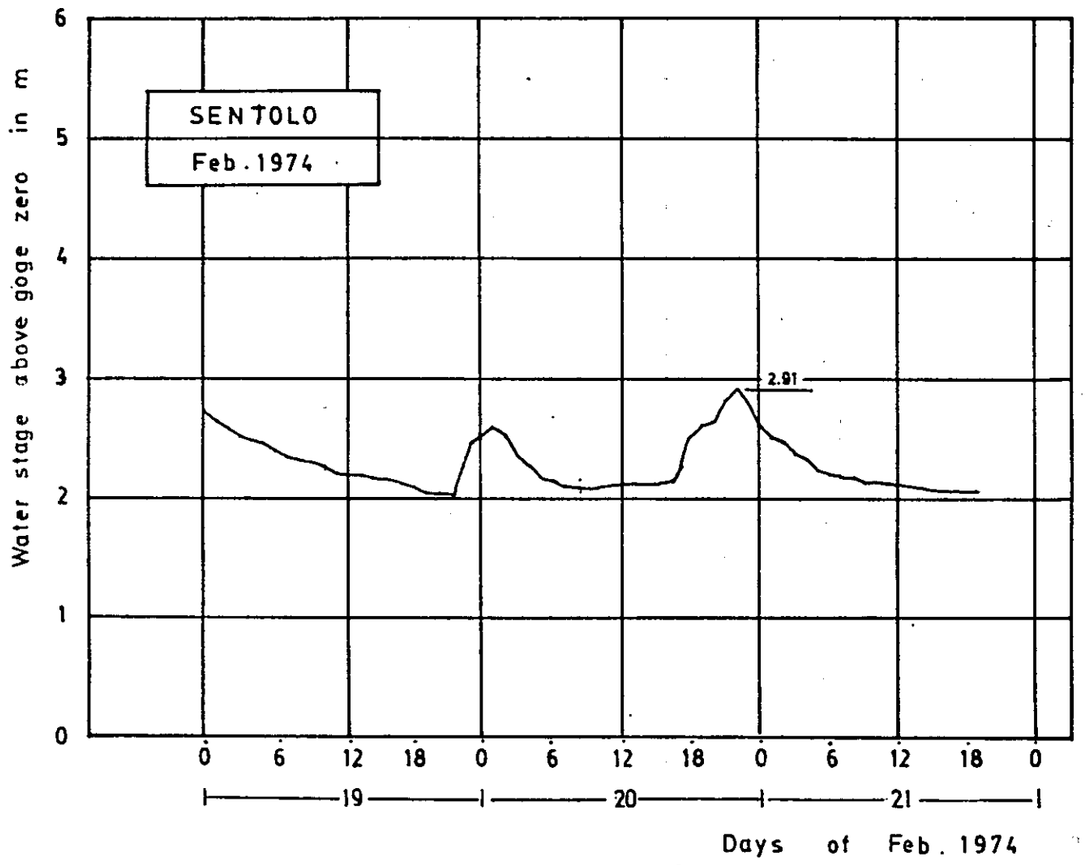

DUWET
Feb. 1974
3.42
Water stage above gage zero in m
0
1
2
3
4
5
6
0 6 12 18 0 6 12 18 0 6 12 18 0
4
5
6
Days of Feb. 1974

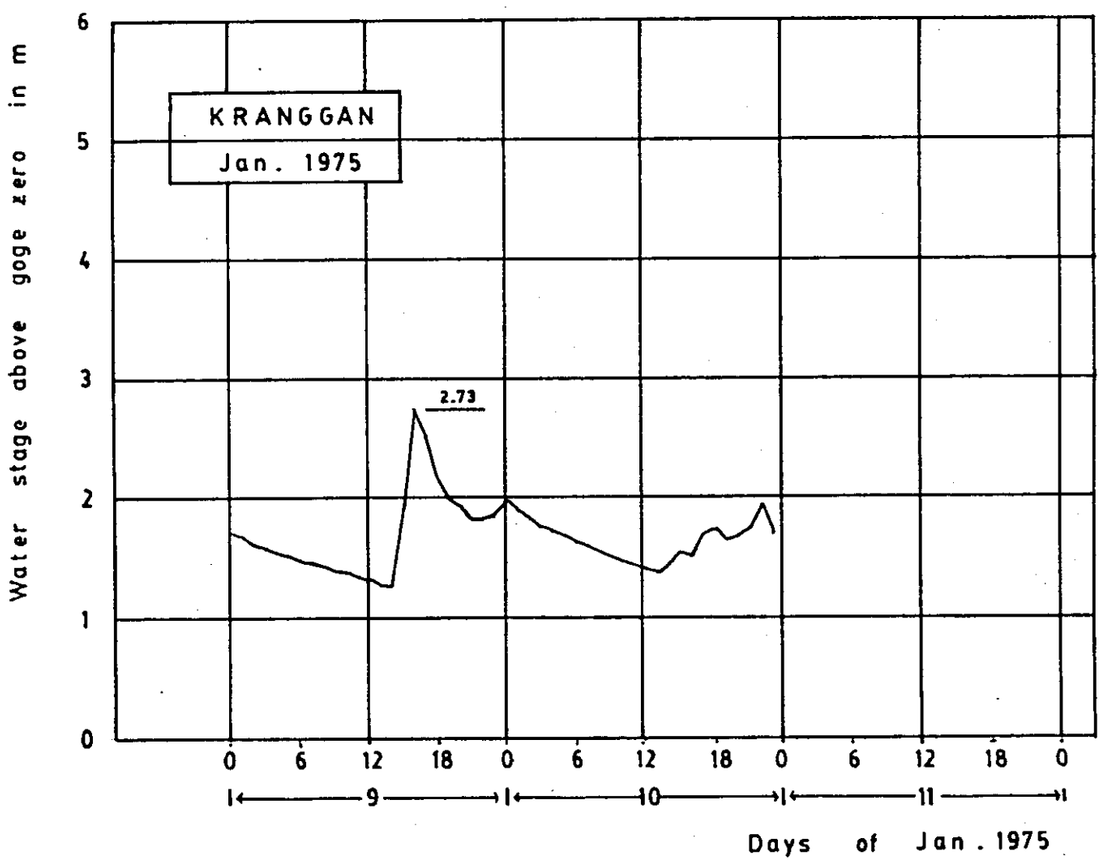

SENTOLO
Feb. 1974
2.68
Water stage above gage zero in m
1
2
3
4
5
6
0 6 12 18 0 6 12 18 0 6 12 18 0
4
5
6
Days of Feb. 1974

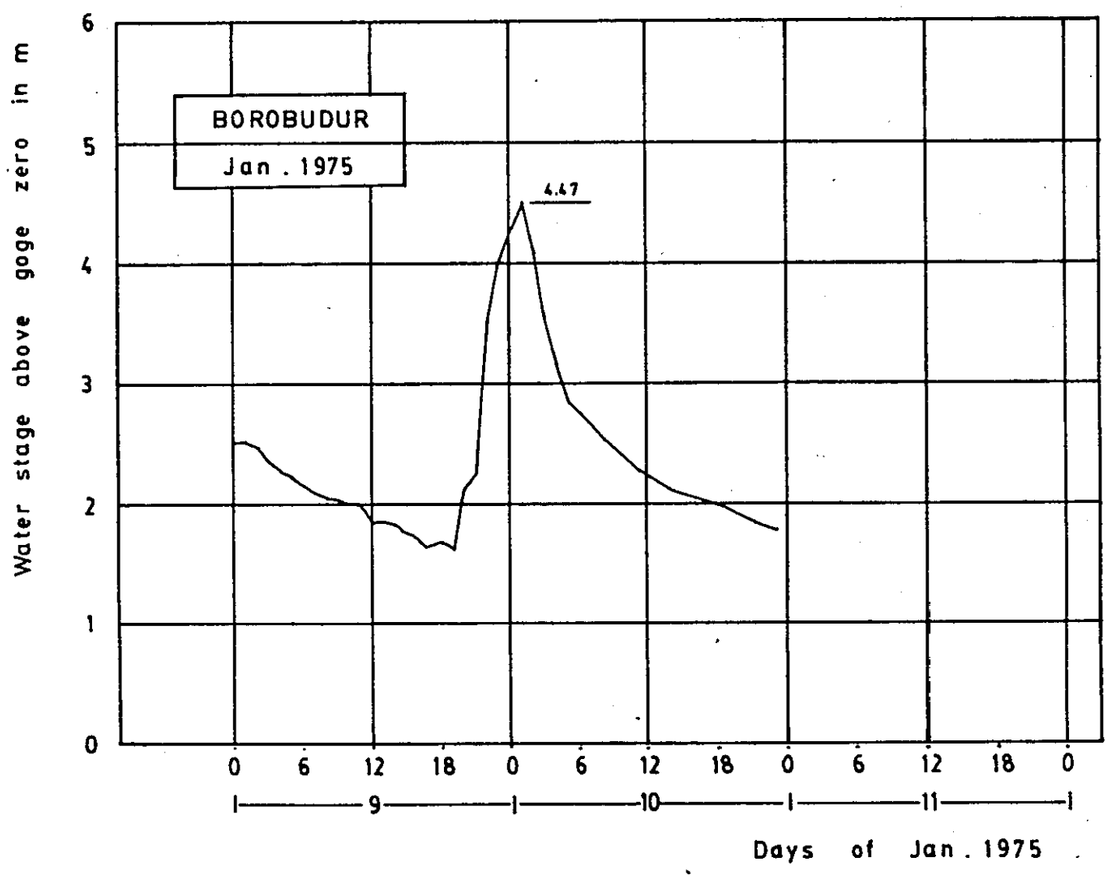

KRANGGAN
Feb. 1974
Water stage above gage zero in m
2.31
Days of Feb. 1974

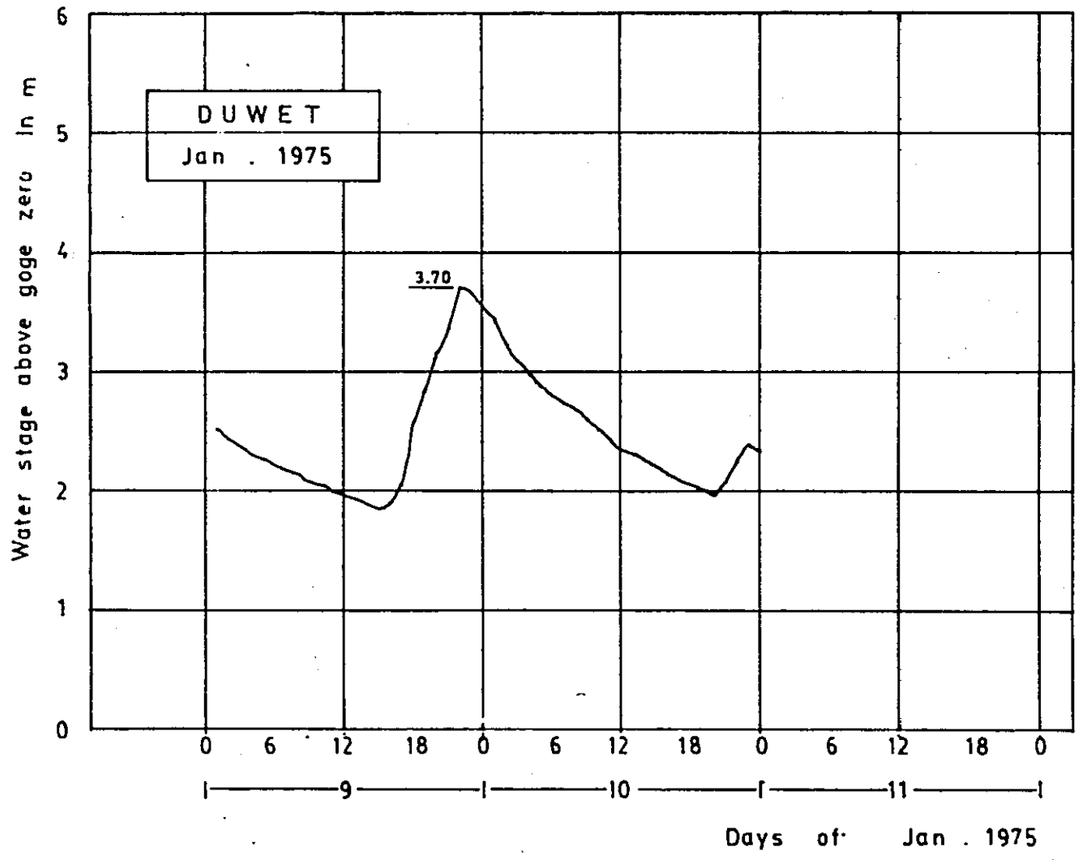

BOROBUDUR
Feb. 1974
Water stage above gage zero in m
4.70
Days of Feb. 1974

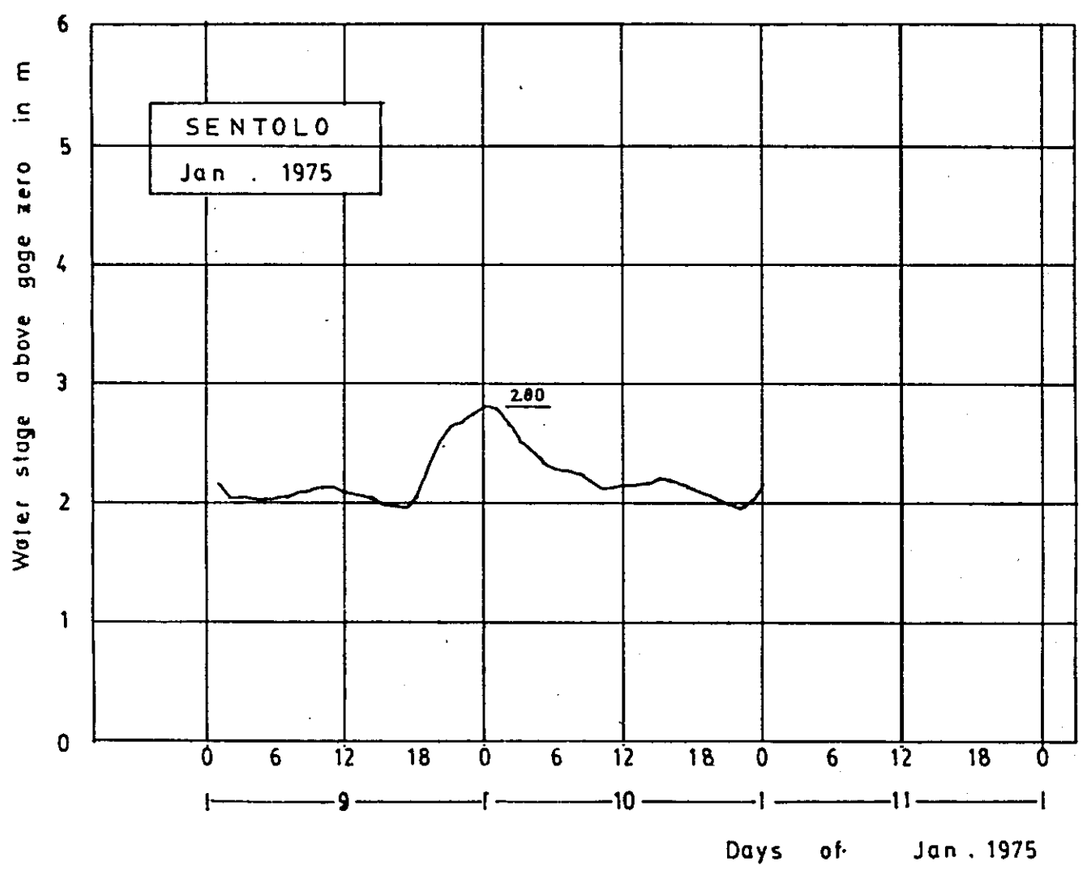

DUWET
Feb. 1974
3.97
Water stage above goge zero in m
0
1
2
3
4
5
6
0 6 12 18 0 6 12 18 0 6 12 18 0
19
20
21
Days of Feb. 1974

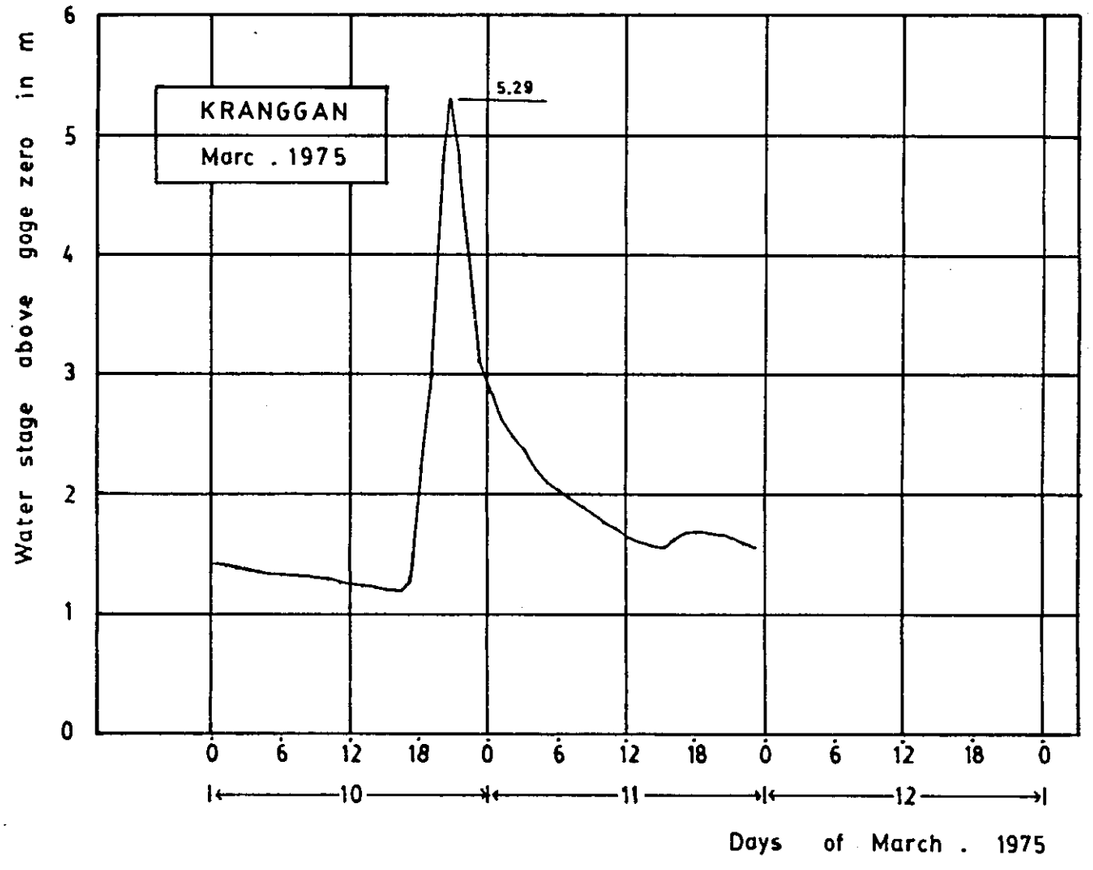

SENTOLO
Feb. 1974
2.91
Water stage above goge zero in m
0
1
2
3
4
5
6
0 6 12 18 0 6 12 18 0 6 12 18 0
19
20
21
Days of Feb. 1974

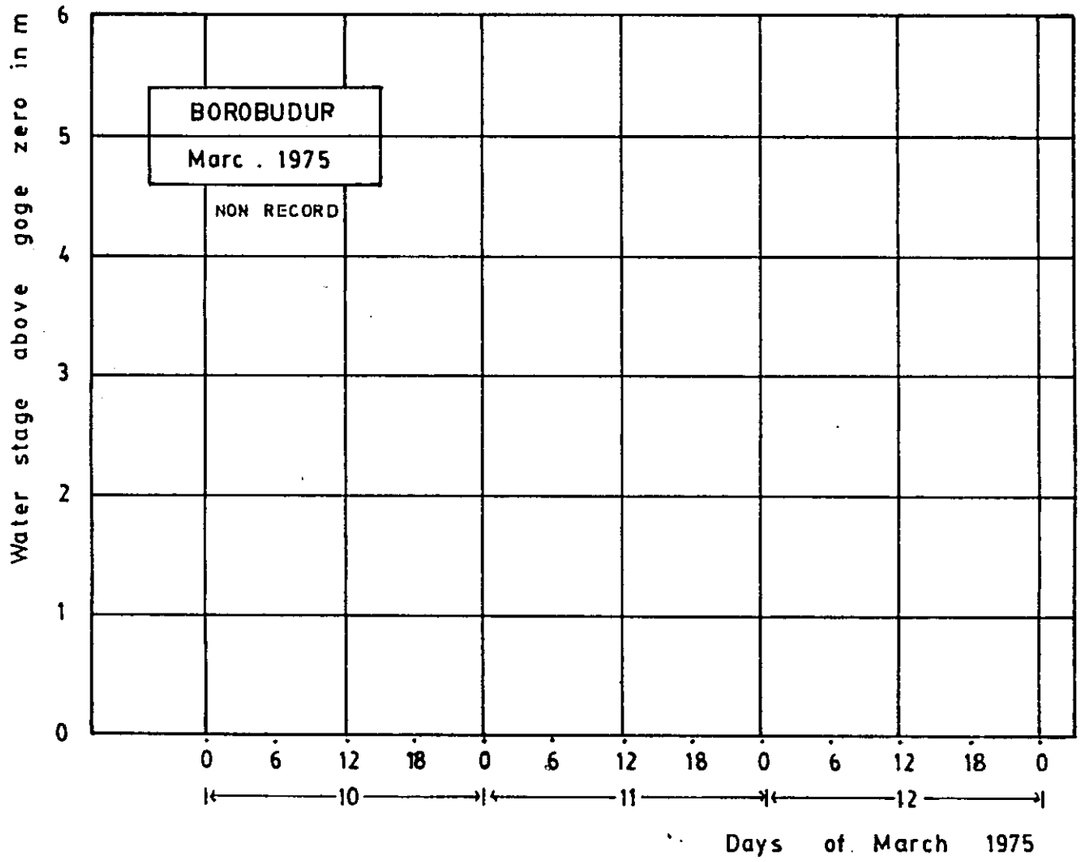

KRANGGAN
Jan. 1975
2.73
Water stage above goge zero in m
0
1
2
3
4
5
6
0 6 12 18 0 6 12 18 0 6 12 18 0
9
10
11
Days of Jan. 1975

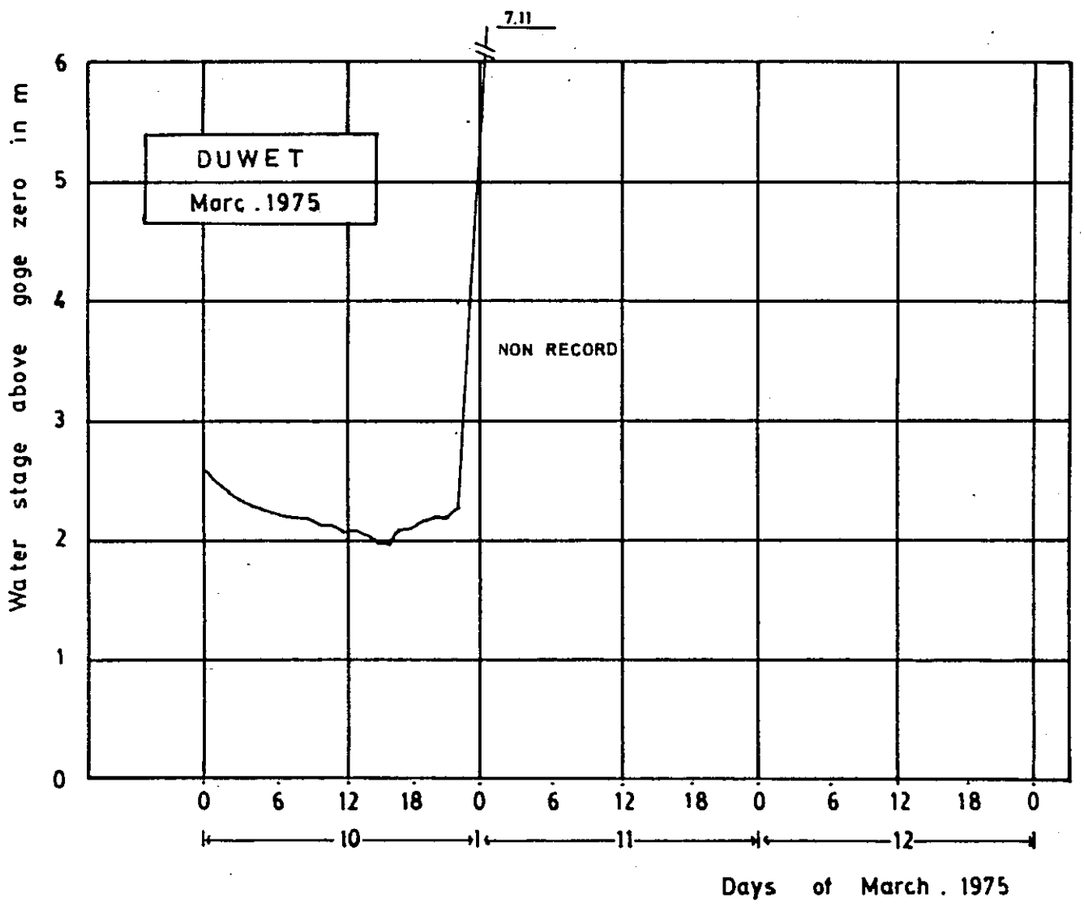

BOROBUDUR
Jan. 1975
4.47
Water stage above goge zero in m
0
1
2
3
4
5
6
0 6 12 18 0 6 12 18 0 6 12 18 0
9
10
11
Days of Jan. 1975

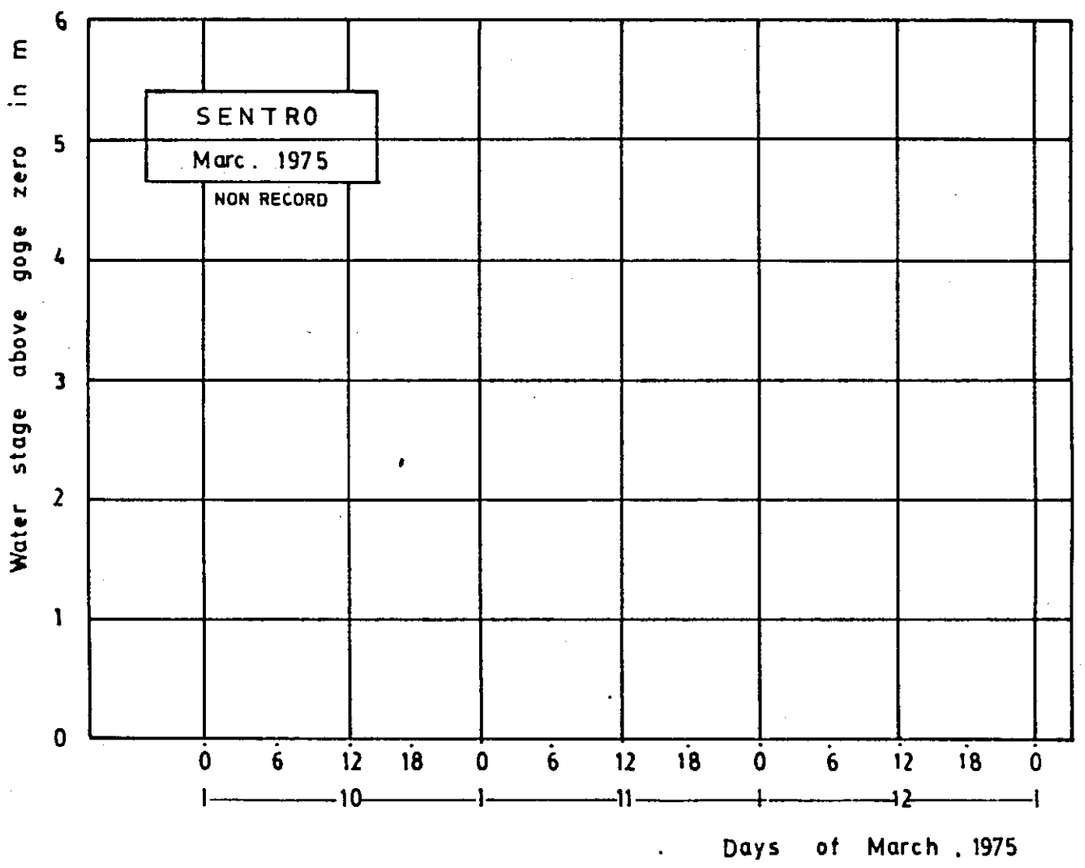

DUWET
Jan . 1975
3.70
Water stage above goge zero in m
0
1
2
3
4
5
6
0 6 12 18 0 6 12 18 0 6 12 18 0
9
10
11
Days of Jan . 1975

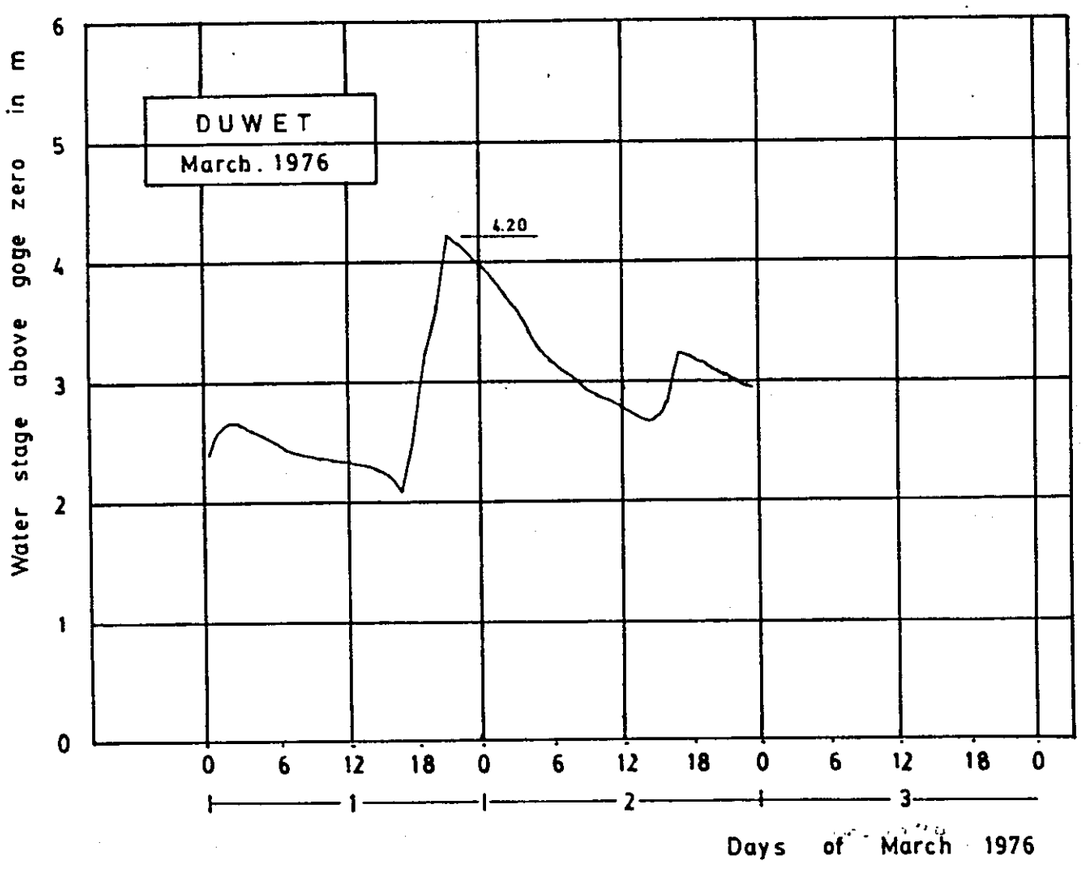

SENTOLO
Jan . 1975
2.80
Water stage above goge zero in m
0
1
2
3
4
5
6
0 6 12 18 0 6 12 18 0 6 12 18 0
9
10
11
Days of Jan . 1975

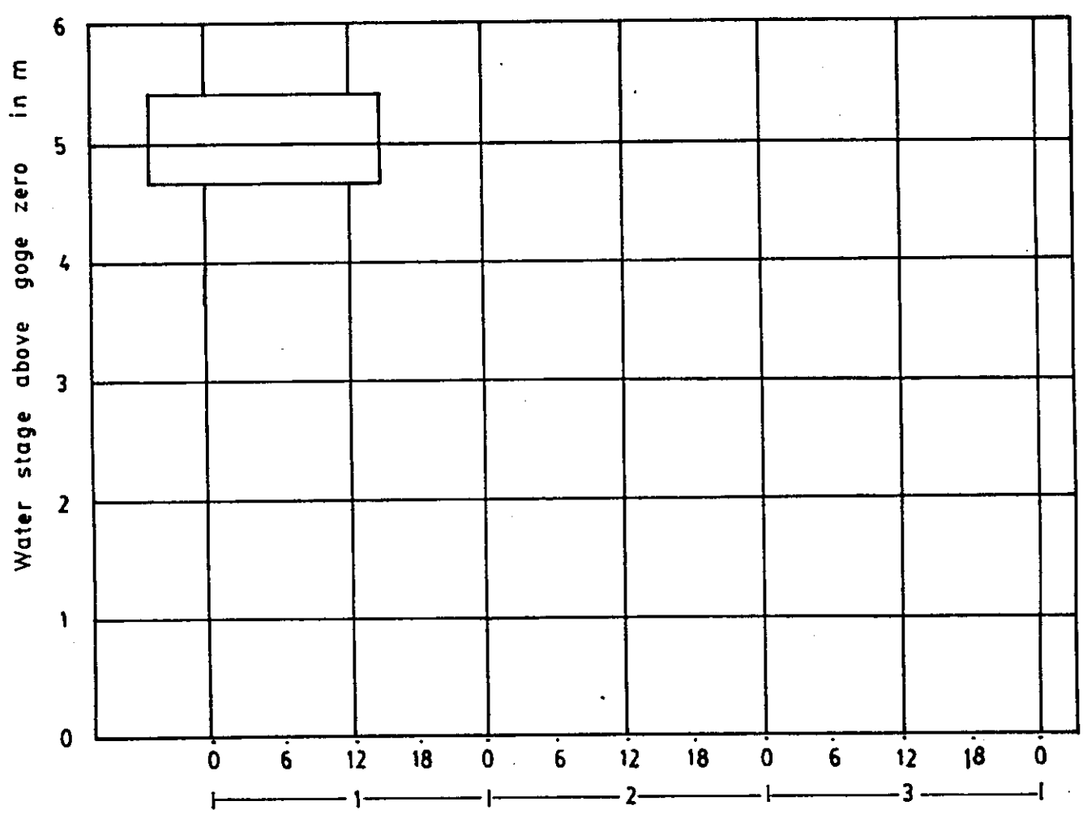

KRANGGAN
Marc . 1975
5.29
Water stage above goge zero in m
0
1
2
3
4
5
6
0 6 12 18 0 6 12 18 0 6 12 18 0
10
11
12
Days of March . 1975

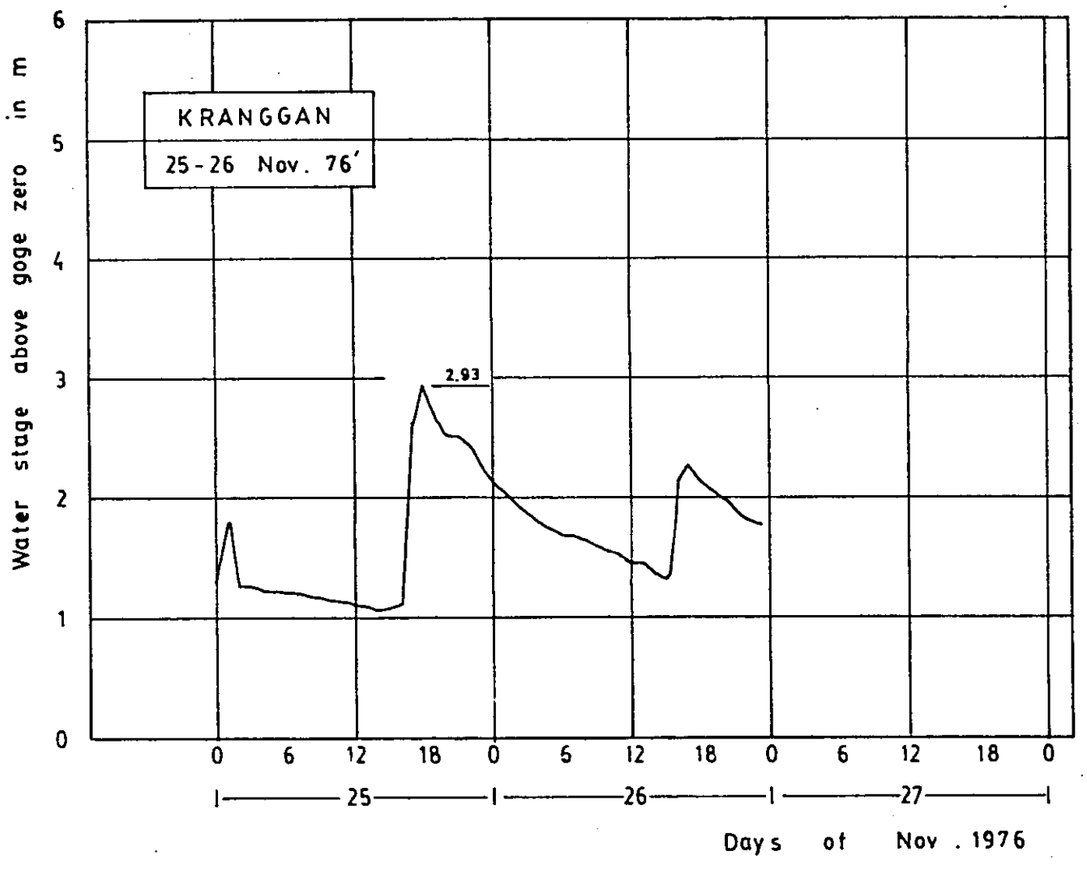

BOROBUDUR
Marc . 1975
NON RECORD
Water stage above goge zero in m
0
1
2
3
4
5
6
0 6 12 18 0 6 12 18 0 6 12 18 0
10
11
12
Days of March 1975

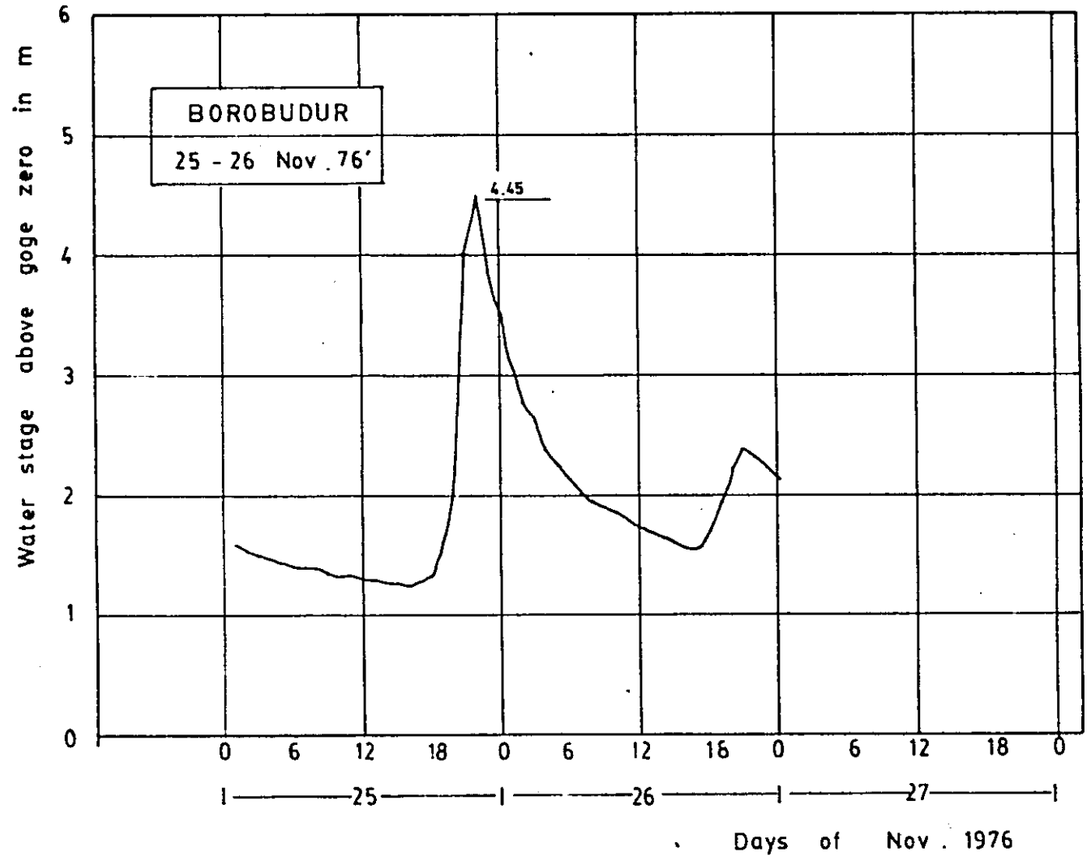

7.11
DUWET
Marc . 1975
NON RECORD
Water stage above goge zero in m
0
1
2
3
4
5
6
0 6 12 18 0 6 12 18 0 6 12 18 0
10
11
12
Days of March . 1975

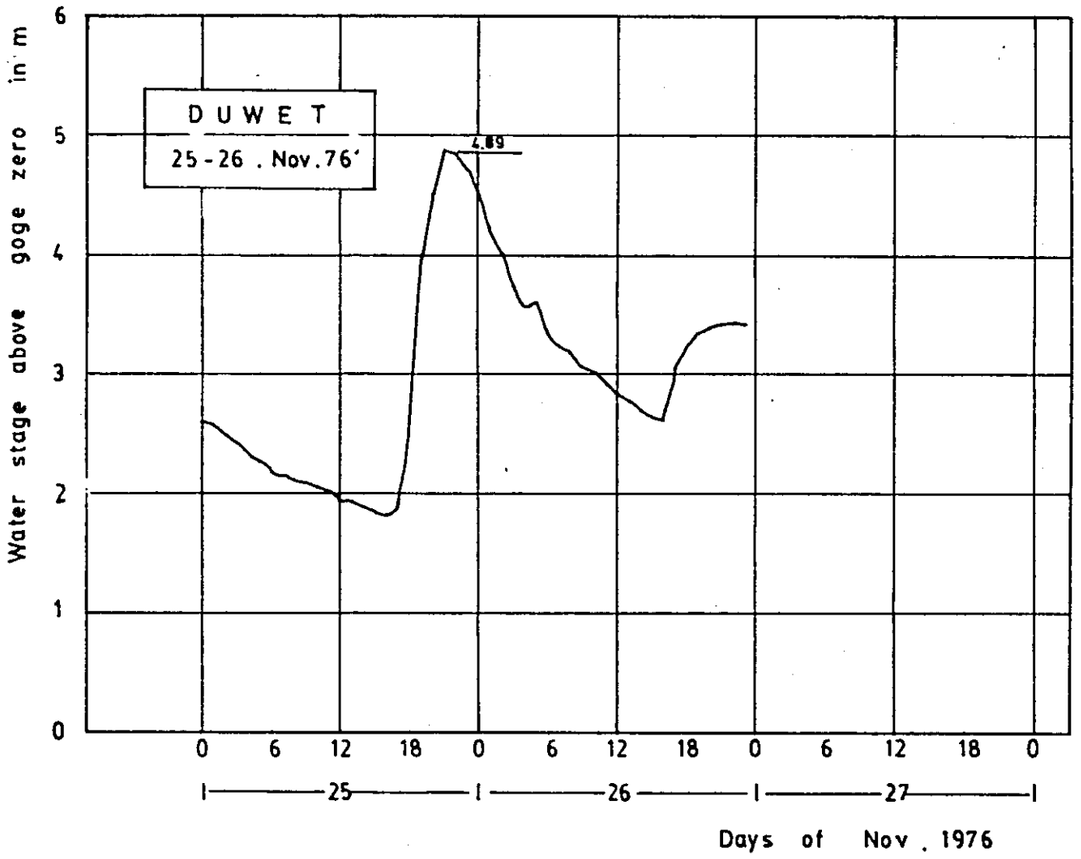

SENTRO
Marc . 1975
NON RECORD
Water stage above goge zero in m
0
1
2
3
4
5
6
0 6 12 18 0 6 12 18 0 6 12 18 0
10
11
12
Days of March . 1975

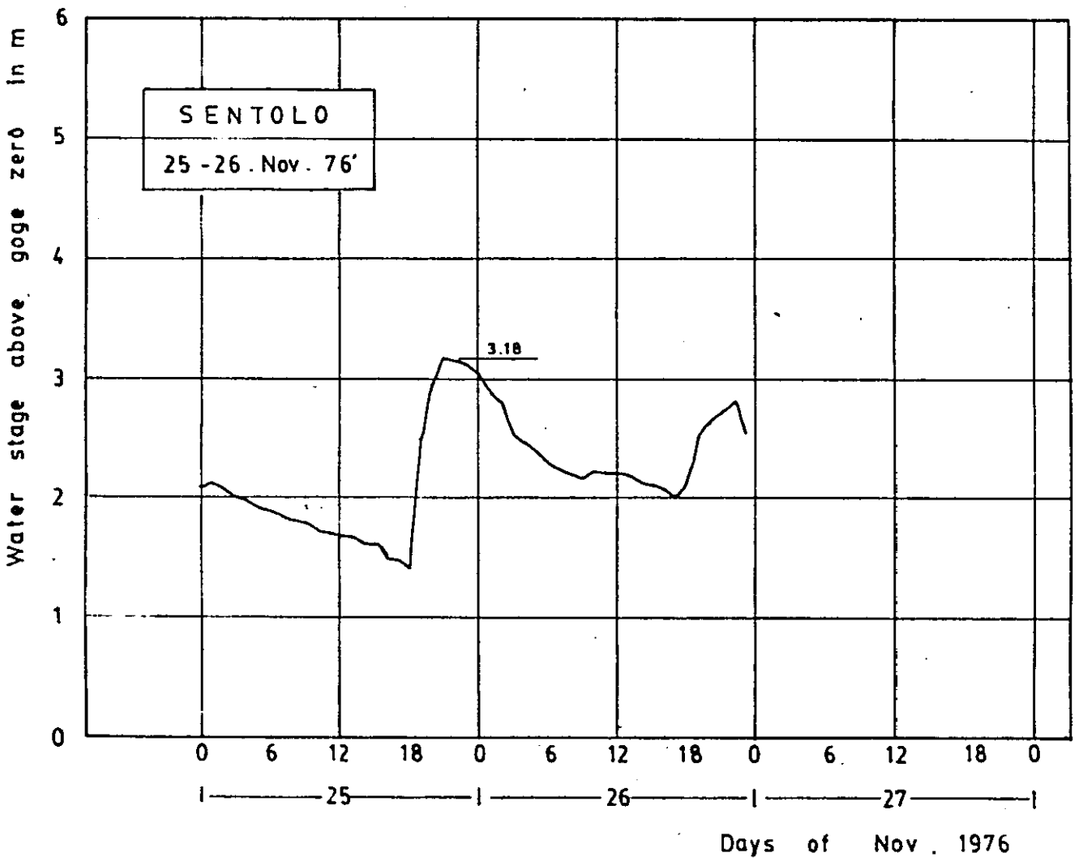

DUWET
March. 1976
4.20
Water stage above goge zero in m
0
1
2
3
4
5
6
0 6 12 18 0 6 12 18 0 6 12 18 0
1
2
3
Days of March 1976

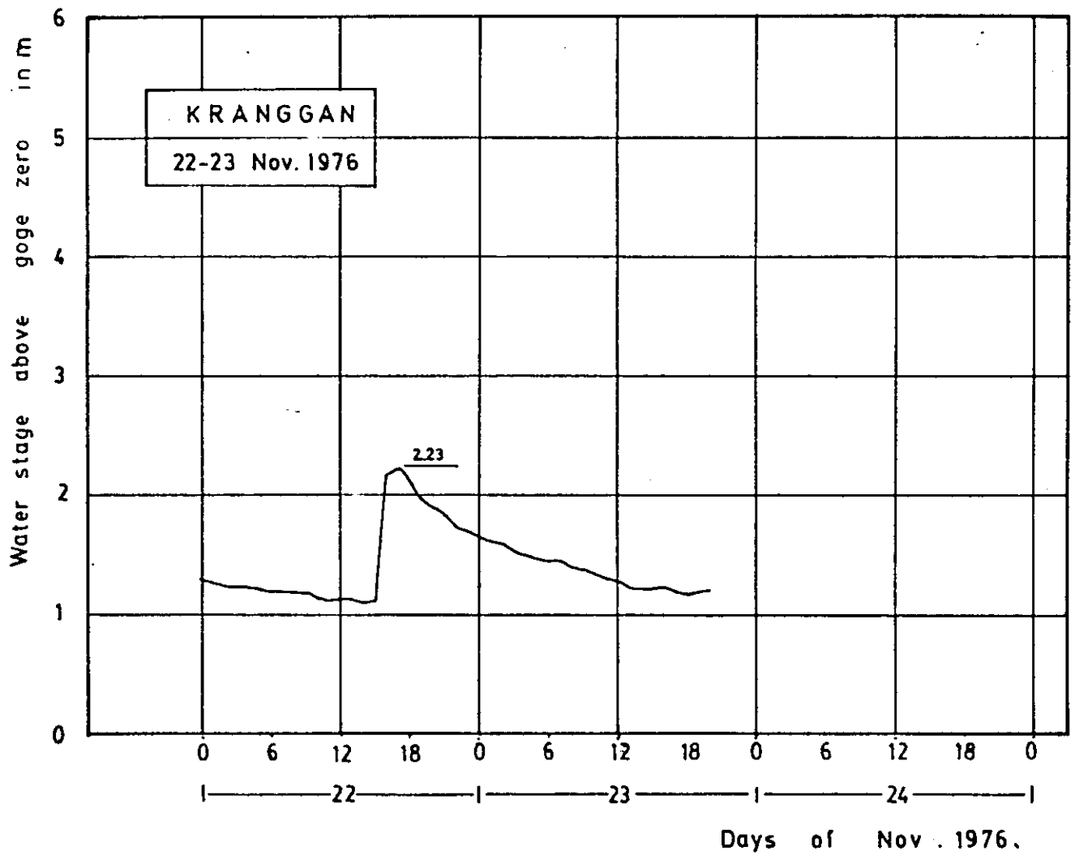

Water stage above goge zero in m
0
1
2
3
4
5
6
0 6 12 18 0 6 12 18 0 6 12 18 0
1
2
3

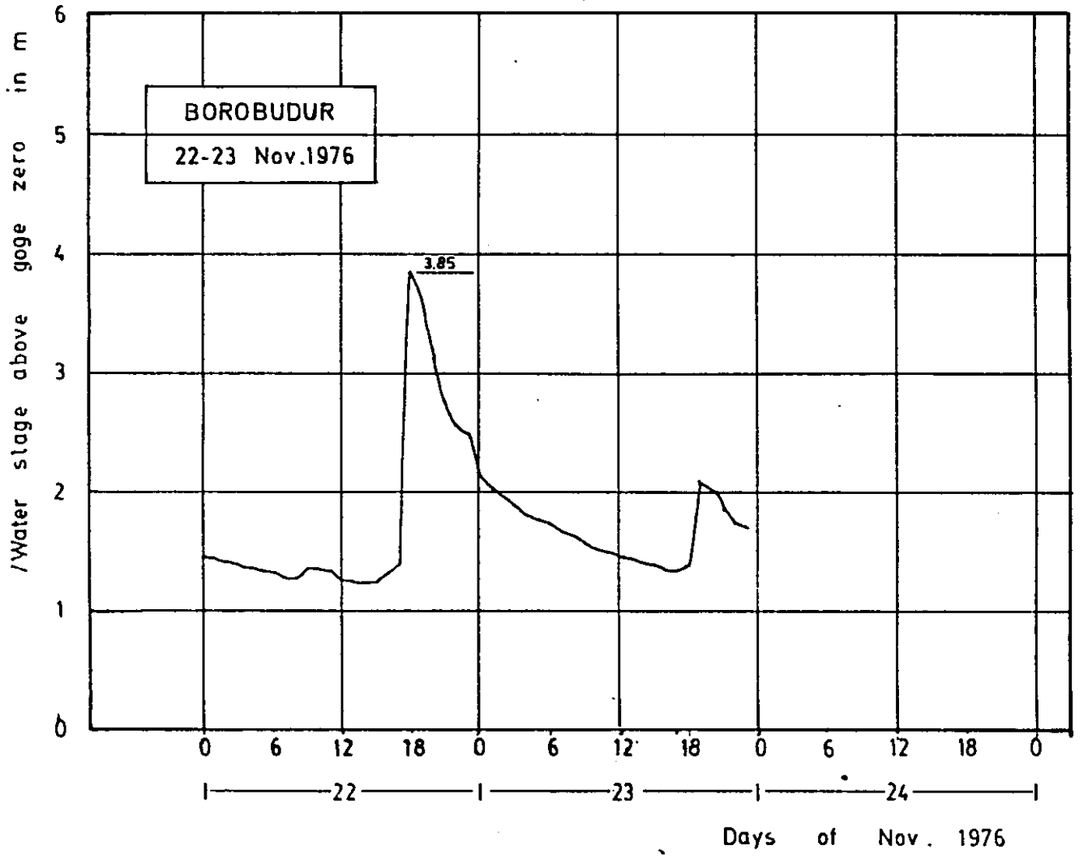

KRANGGAN
25-26 Nov. 76'
2.93
Water stage above goge zero in m
0
1
2
3
4
5
6
0 6 12 18 0 6 12 18 0 6 12 18 0
25
26
27
Days of Nov. 1976

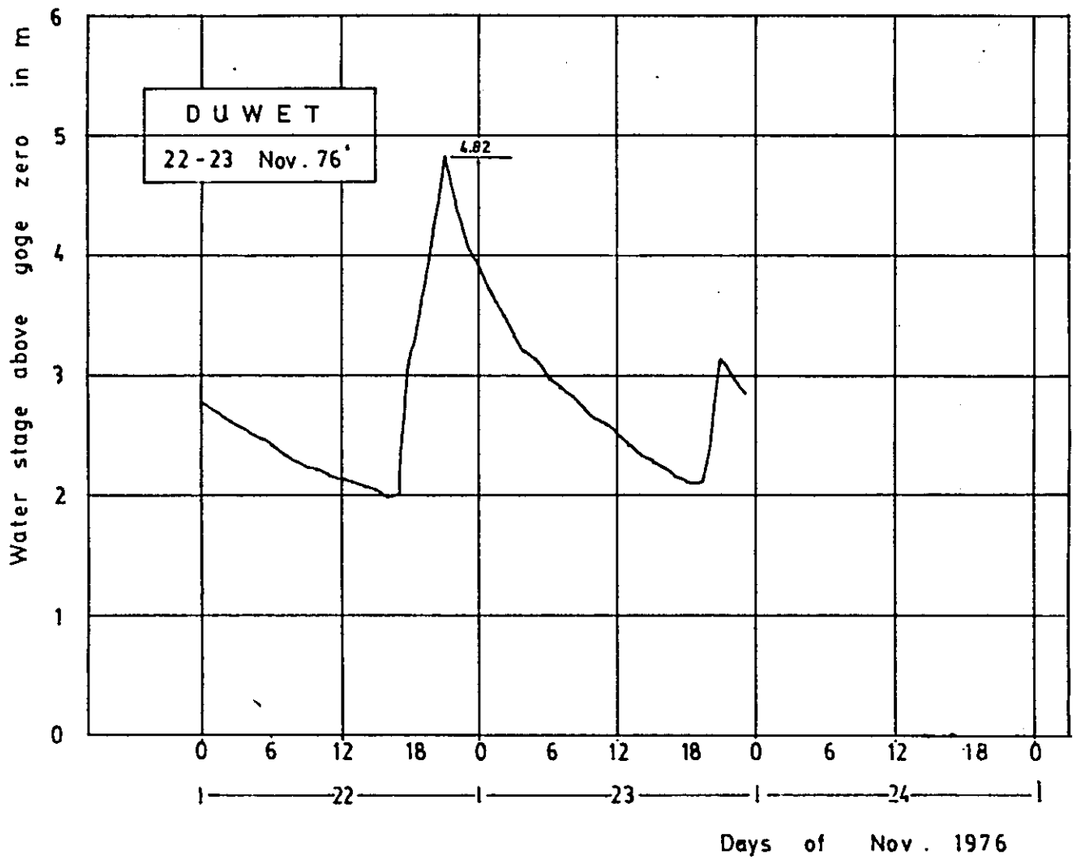

BOROBUDUR
25 - 26 Nov. 76'
4.45
Water stage above goge zero in m
0
1
2
3
4
5
6
0 6 12 18 0 6 12 18 0 6 12 18 0
25
26
27
Days of Nov. 1976

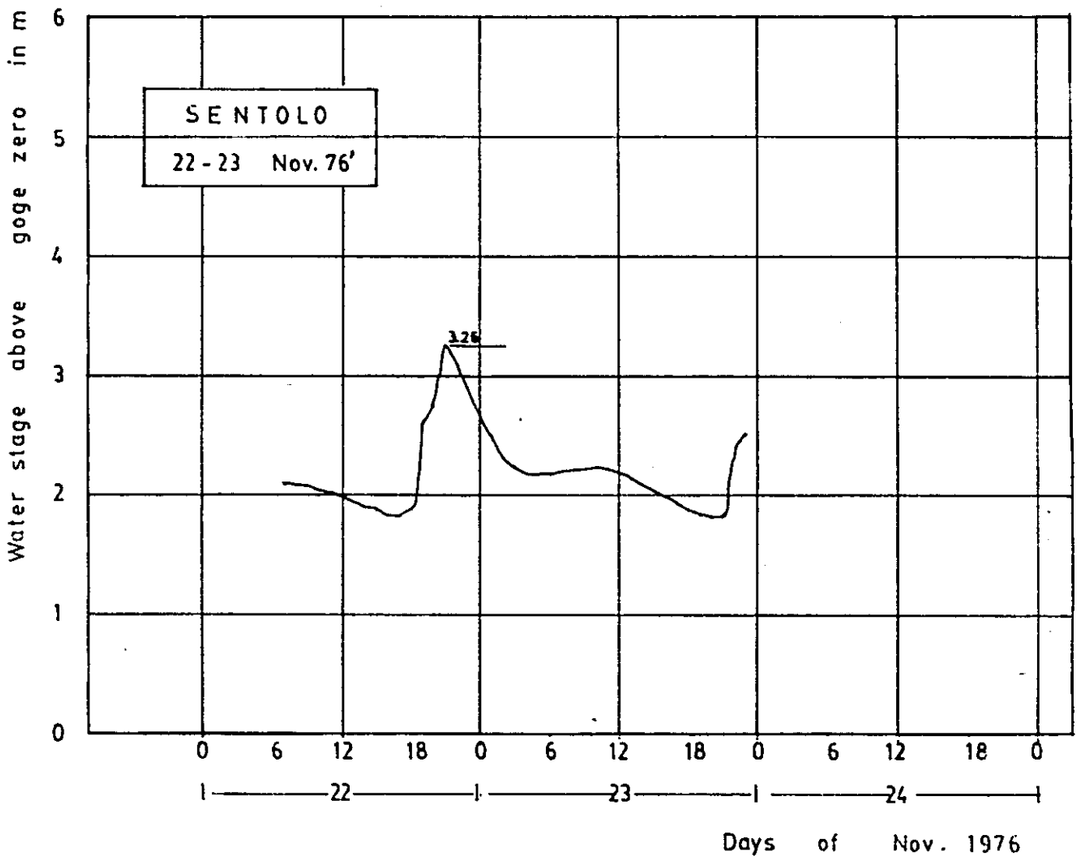

DUWET
25-26 . Nov.76'
4.89
Water stage above goge zero in m
0
1
2
3
4
5
6
0 6 12 18 0 6 12 18 0 6 12 18 0
25
26
27
Days of Nov . 1976

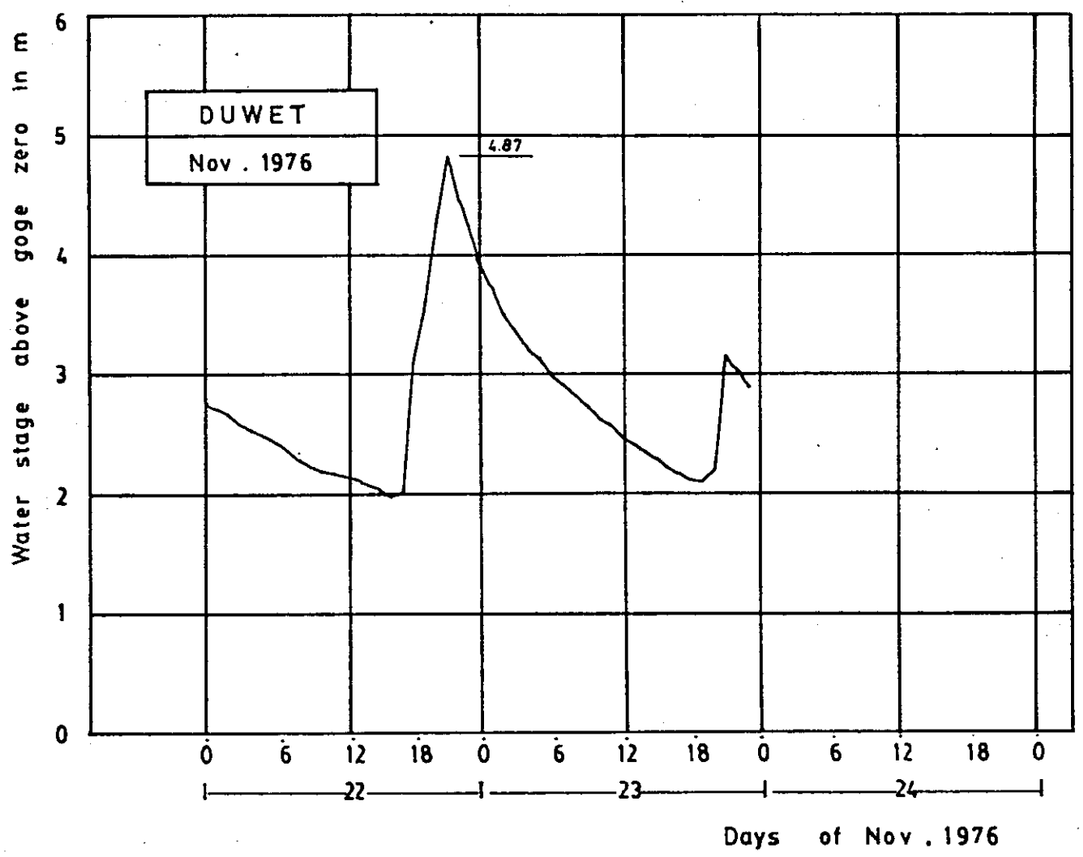

SENTOLO
25-26 . Nov. 76'
3.18
Water stage above goge zero in m
0
1
2
3
4
5
6
0 6 12 18 0 6 12 18 0 6 12 18 0
25
26
27
Days of Nov . 1976

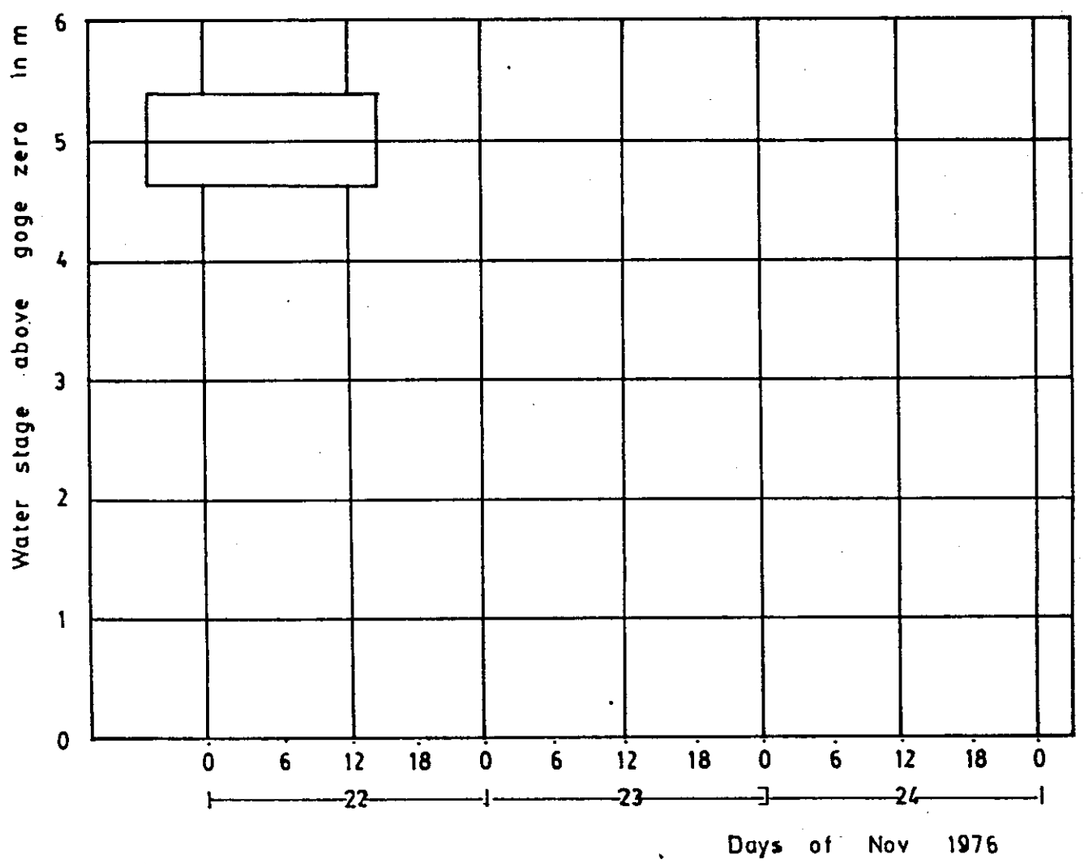

KRANGGAN
22-23 Nov. 1976
2.23
Water stage above goge zero in m
0
1
2
3
4
5
6
0 6 12 18 0 6 12 18 0 6 12 18 0
22
23
24
Days of Nov. 1976.

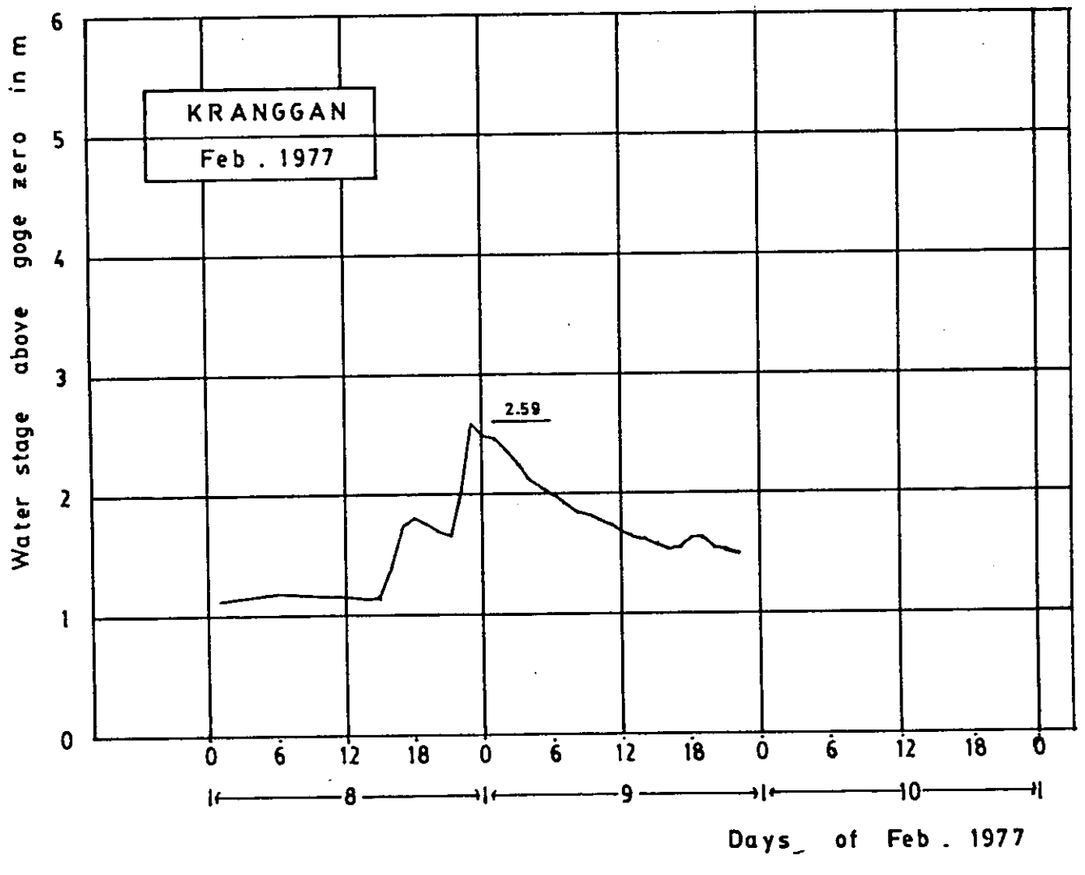

BOROBUDUR
22-23 Nov.1976
3.85
/Water stage above goge zero in m
0
1
2
3
4
5
6
0 6 12 18 0 6 12 18 0 6 12 18 0
22
23
24
Days of Nov. 1976


DUWET
22-23 Nov. 76'
4.82
Water stage above goge zero in m
0
1
2
3
4
5
6
0 6 12 18 0 6 12 18 0 6 12 18 0
22
23
24
Days of Nov. 1976


SENTOLO
22-23 Nov. 76'
3.26
Water stage above goge zero in m
0
1
2
3
4
5
6
0 6 12 18 0 6 12 18 0 6 12 18 0
22
23
24
Days of Nov. 1976


DUWET
Nov . 1976
4.87
Water stage above goge zero in m
0
1
2
3
4
5
6
0 6 12 18 0 6 12 18 0 6 12 18 0
22
23
24
Days of Nov . 1976


Water stage above goge zero in m
0
1
2
3
4
5
6
0 6 12 18 0 6 12 18 0 6 12 18 0
22
23
24
Days of Nov 1976


KRANGGAN
Feb . 1977
Water stage above goge zero in m
2.59
0
1
2
3
4
5
6
0 6 12 18 0 6 12 18 0 6 12 18 0
8
9
10
Days of Feb . 1977

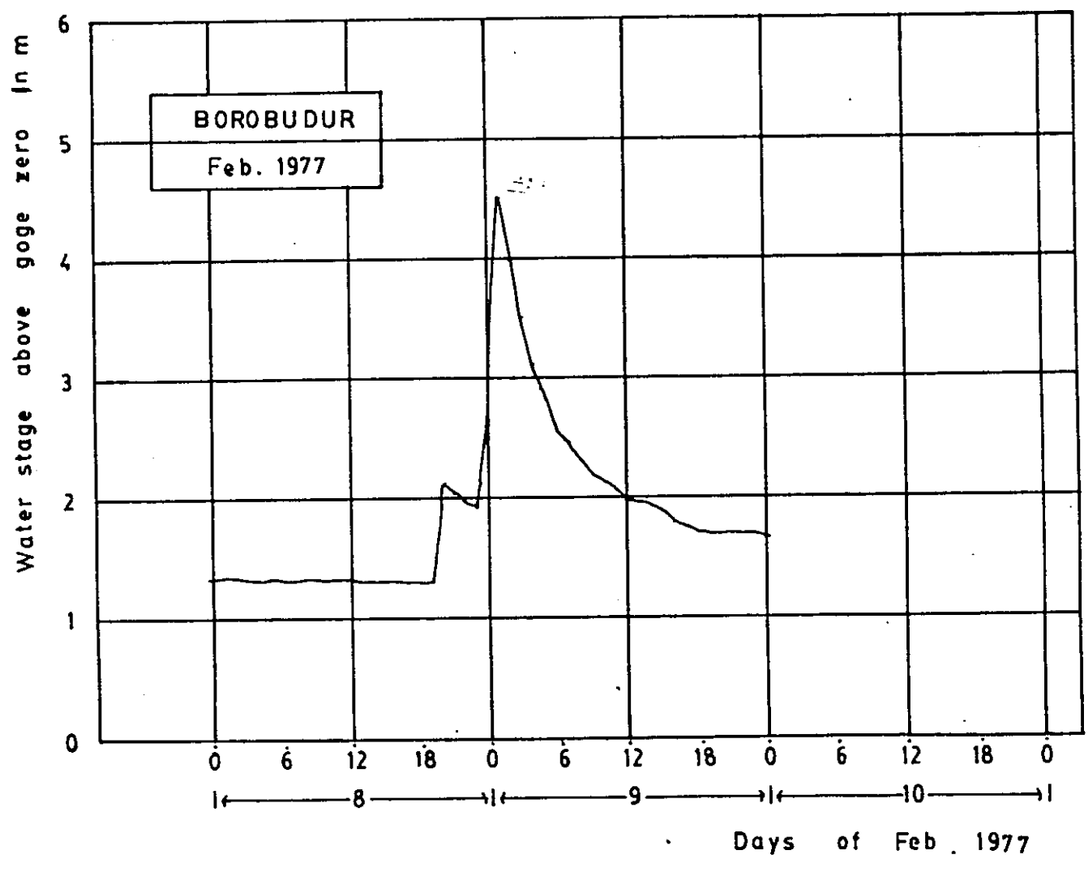
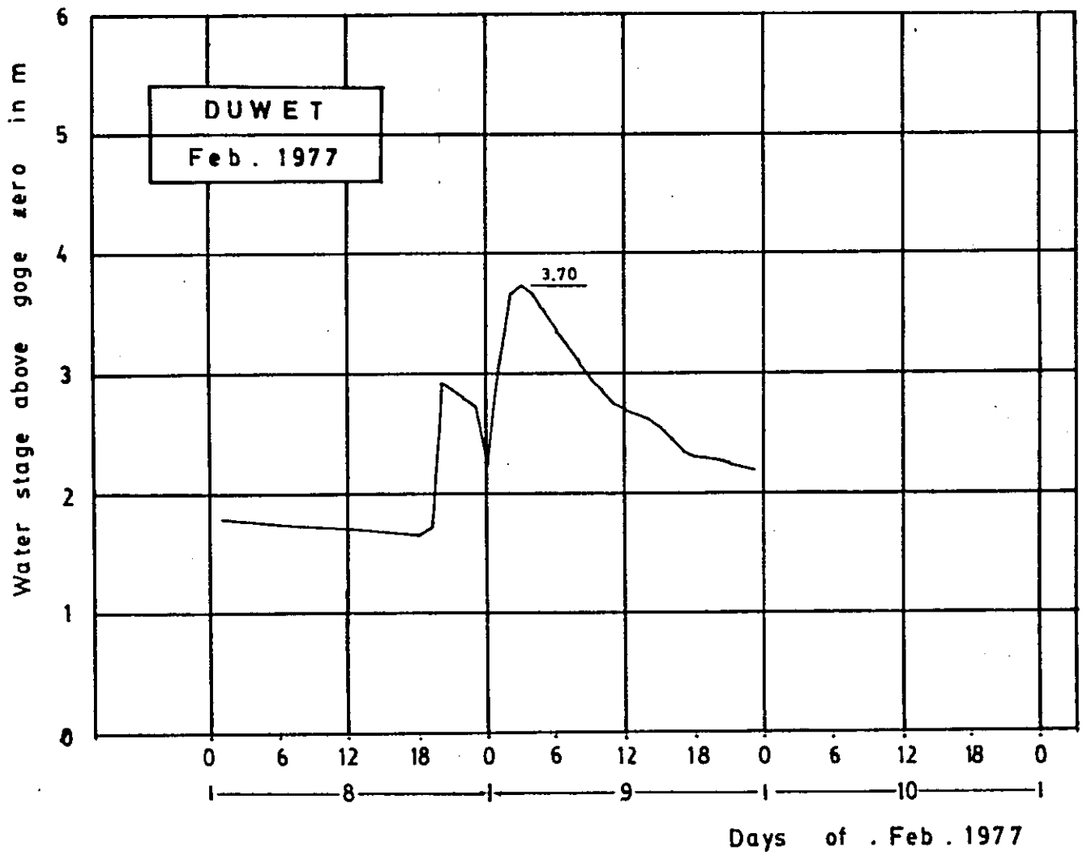

BOROBUDUR
Feb. 1977
Water stage above goge zero in m
0
1
2
3
4
5
6
0 6 12 18 0 6 12 18 0 6 12 18 0
8
9
10
Days of Feb . 1977

FIG. FLOOD STAGE HYDROGRAPH IN THE PROGO RIVER.



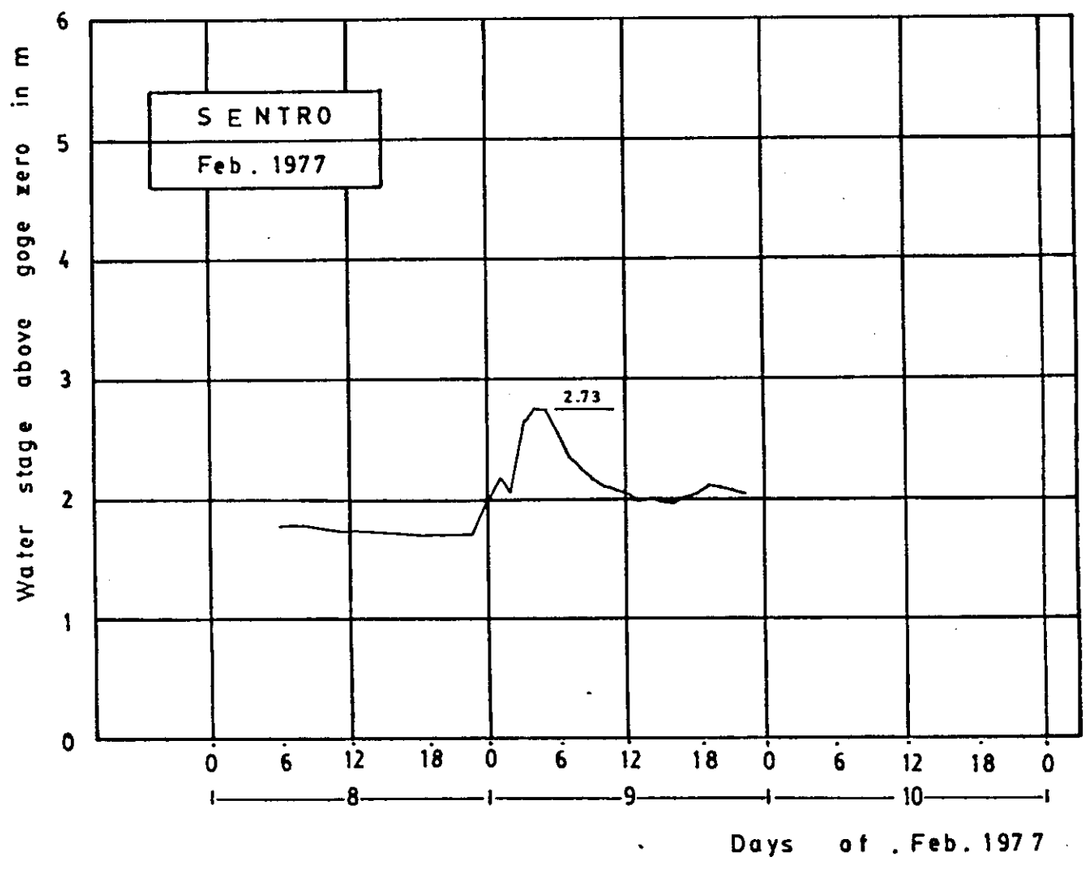
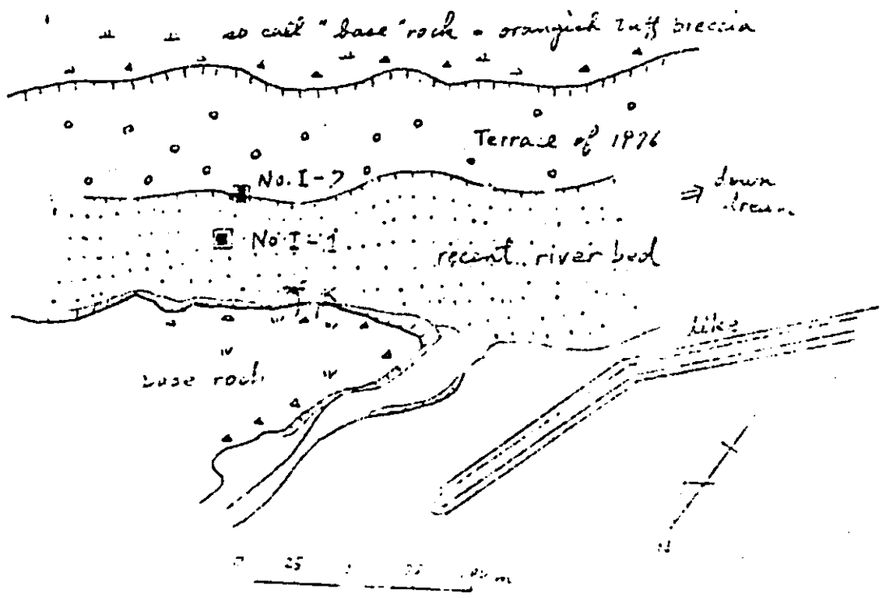
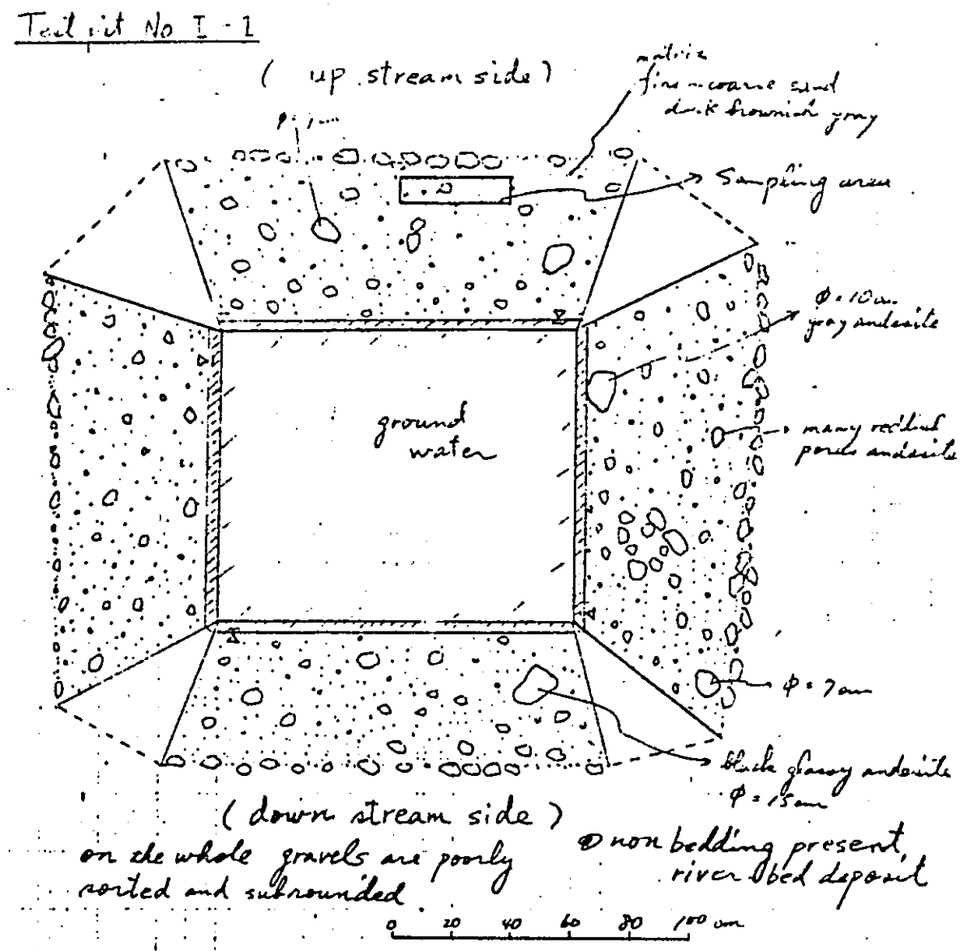


FIG. 29


so call "base" rock - orangish tuff breccia
Terrace of 1976
No. I-2
No. I-1
down stream
recent river bed
base rock
lake


Test pit No I-1
(up stream side)
native fine-coarse sand dark brownish gray
Sampling area
φ=10cm gray andesite
many vesicular porous andesite
ground water
φ=7cm
black glassy andesite φ=15cm
(down stream side)
on the whole gravels are poorly sorted and subrounded
non bedding present, river bed deposit
0 20 40 60 80 100 cm

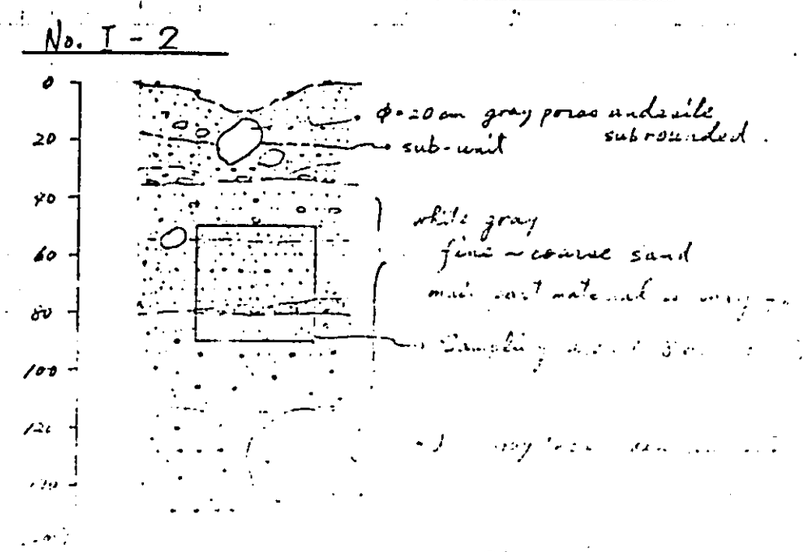
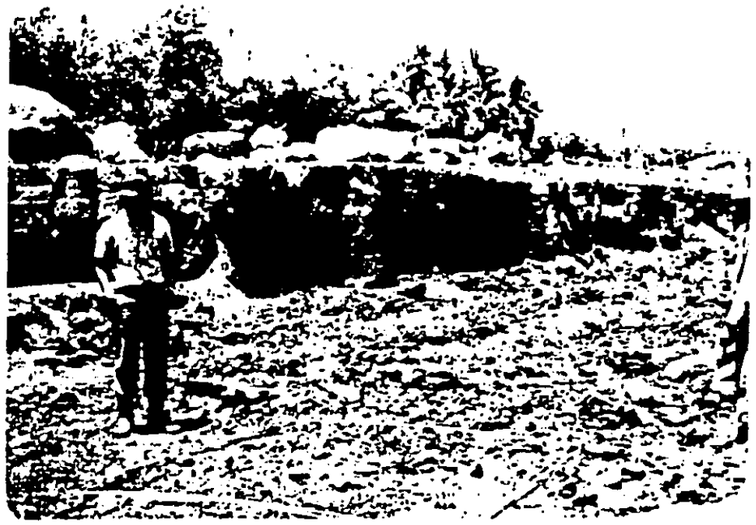
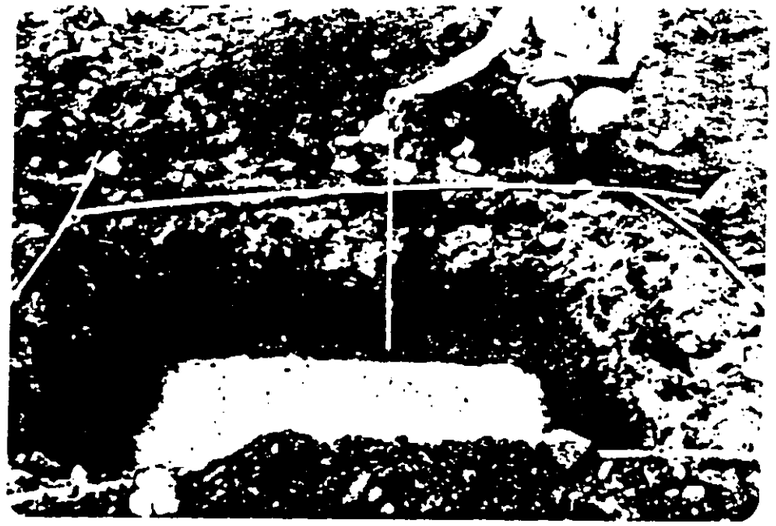

No. I-2
0
20
40
60
80
100
120
φ=20cm gray porous andesite subrounded
sub-unit
white gray fine-coarse sand

Photo of Test pit No. I



neighboring situation of test pit No. I.
front terrace is deposit of 1976



Test pit section of up-stream side later dig out. Depth to underground water surface is about 55 cm.

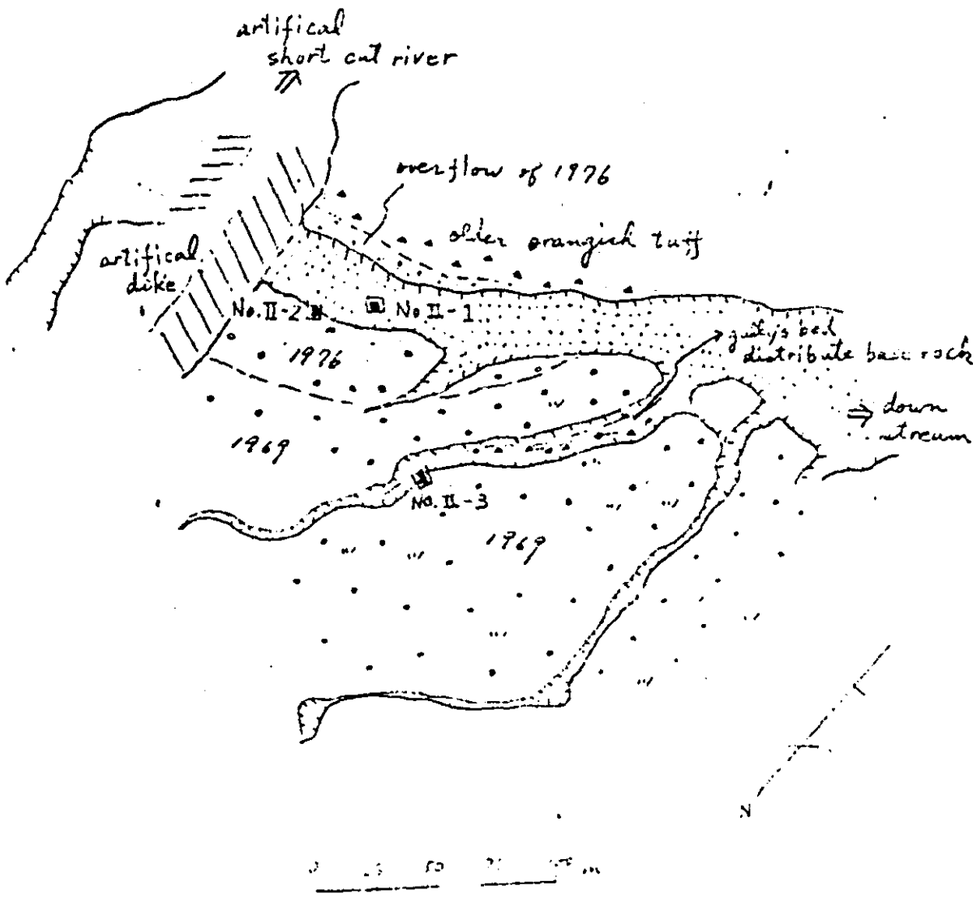
Surface of No. I-1, this point is surface of recent river bed

Test pit section of down stream side later dig out. Section shows non bedding condition.

measurement work of gravel. measurement carried out more than 10 cm.

Terrace (deposit) section of 1976 and sampling point (No. I-2)

FIG, 30


artifical
short cut river
overflow of 1976
older orangish tuff
artifical
dike
No. II-2
No. II-1
1976
gully's bed
distribute base rock
down
stream
1969
No. II-3
1969

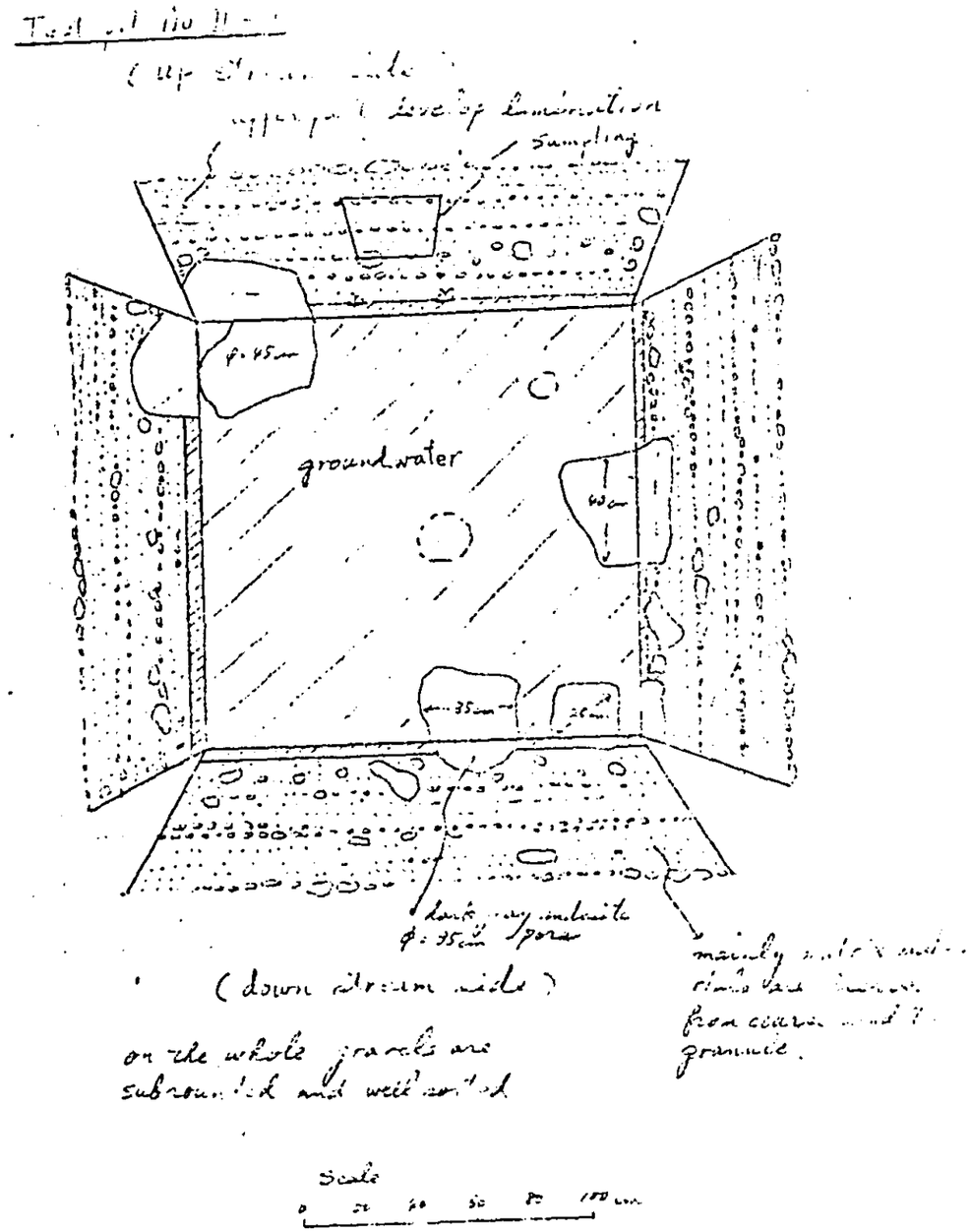
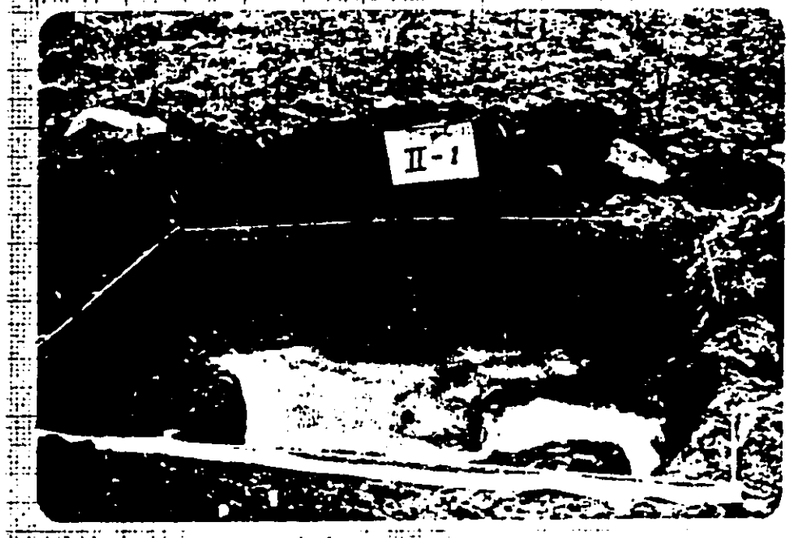

sampling
ground water
(down stream side)
on the whole gravels are
subrounded and well sorted
Scale

Photo of test pit No. II.

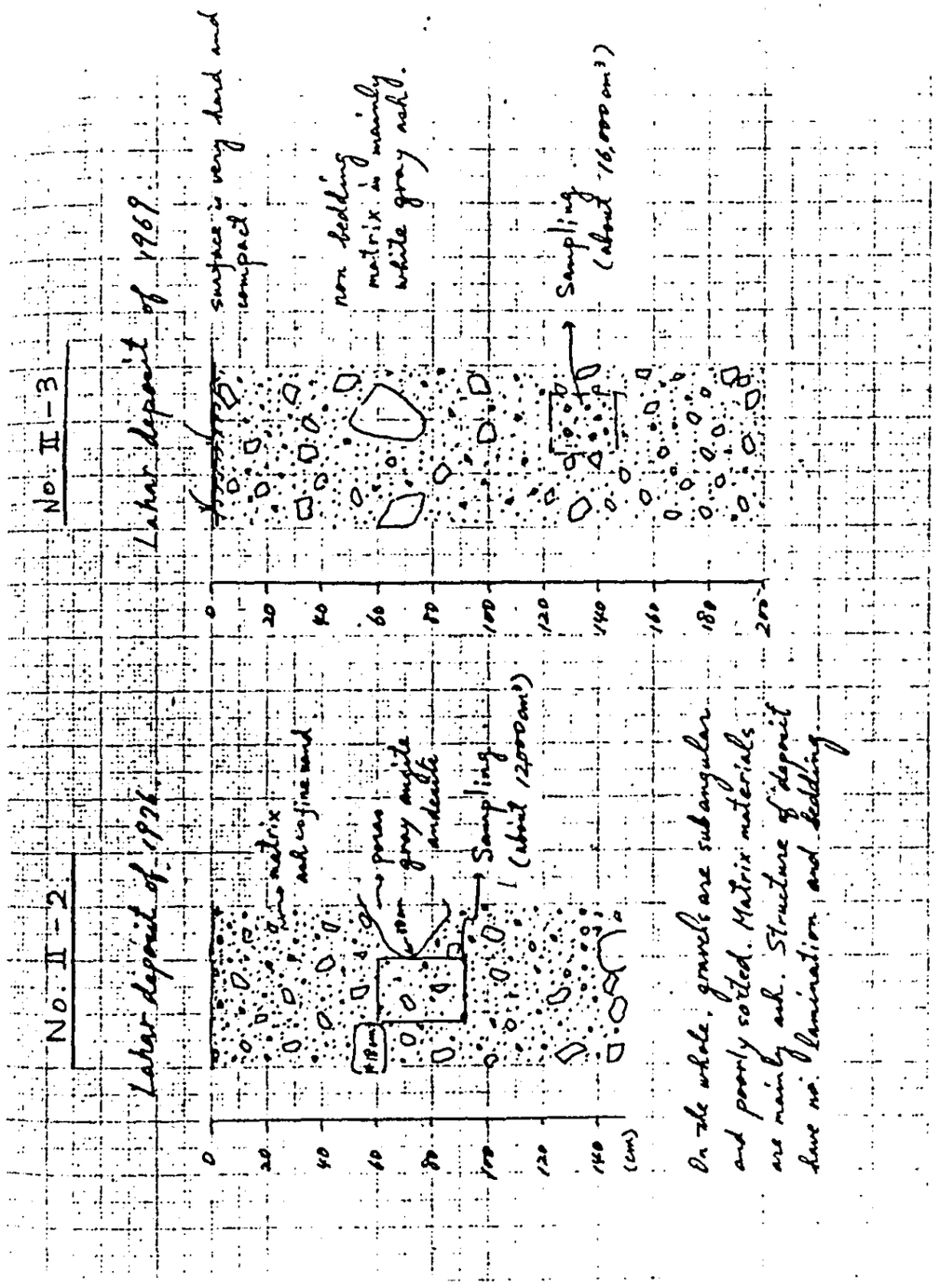
neighboring situation of test pit No.II.
front yellowish tuff breccia (so called base rock)
is covered by over flow gravels of 1976.

surface condition of river bed.

up-stream side. section shows existance
of subrounded boulder gravel.



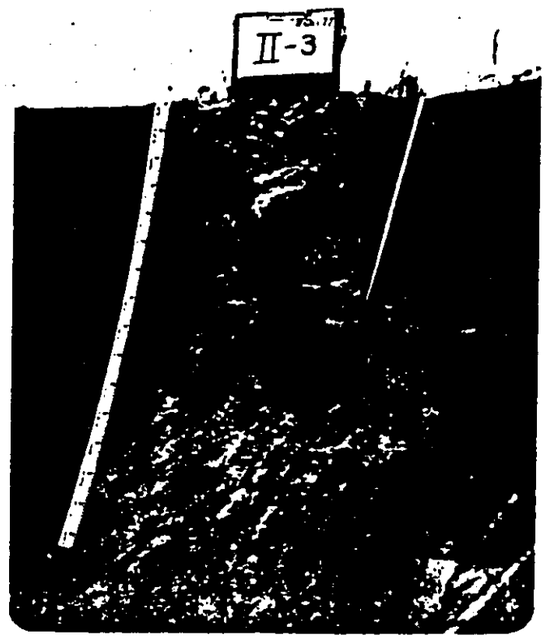
down stream side.



Terrace section of 1976.

Sampling work.

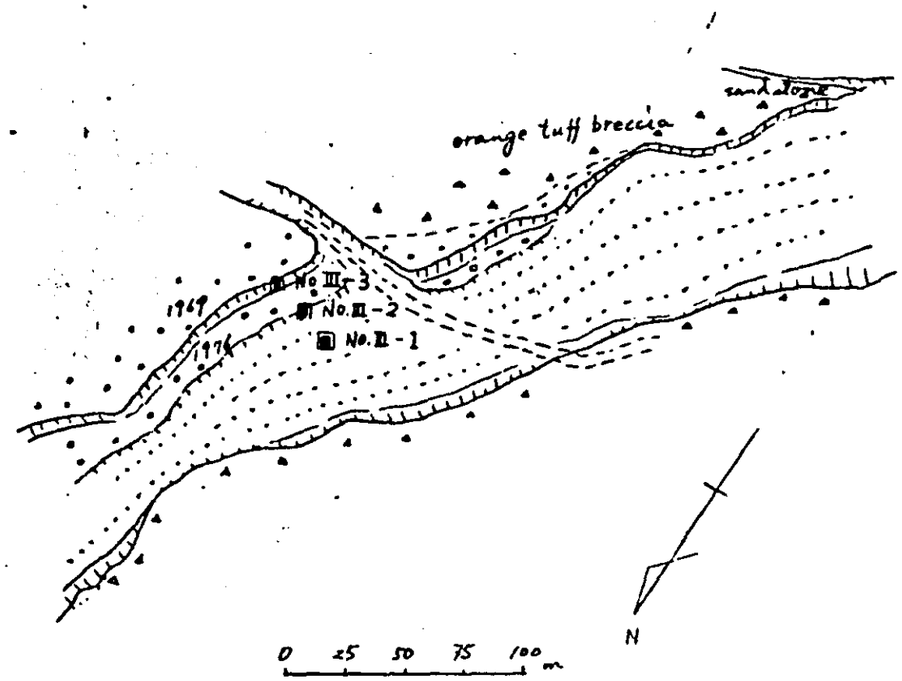
elimination work of compaction surface of 1969 (Lahar deposit).



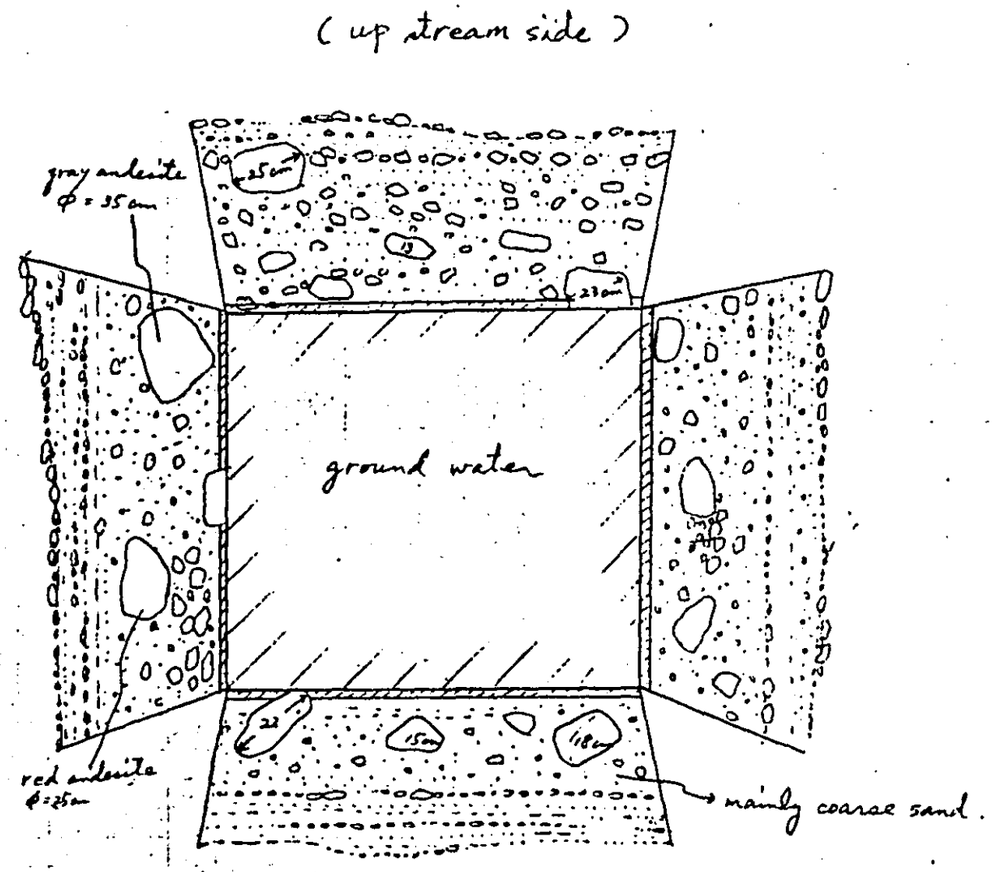
Section of lahar deposit of 1969.

It shows predominance ash and sub-angular gravel.

FIG. 31



Test pit NO. II 1.



(Down stream side)

About 20 cm from surface show flow structure, but under part have no bedding. Gravels are mainly subrounded.

Scale

0 20 40 60 80 100 cm

Photo of Test pit No III.

Digging work of test pit No.III. Front Terraces are deposit of 1969 and 1976.

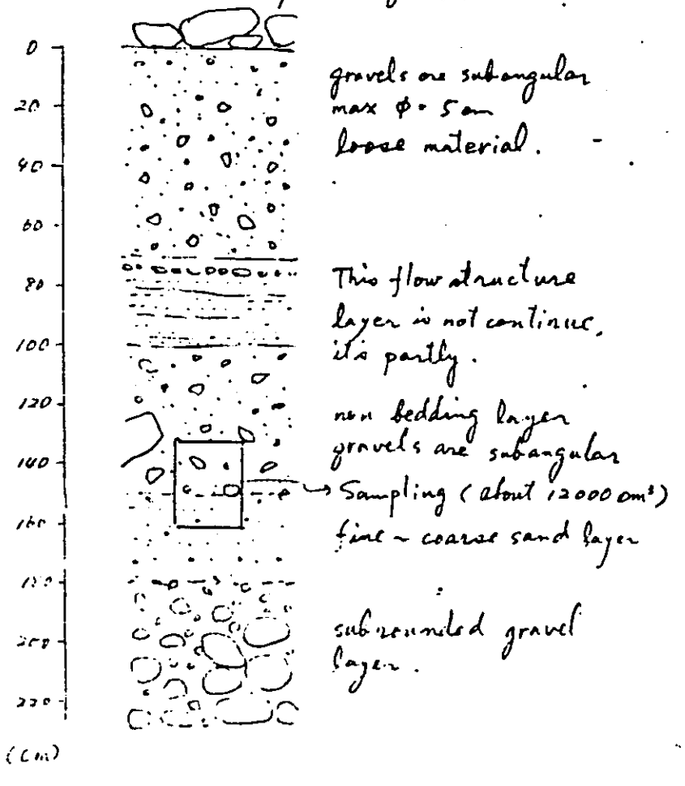
surface condition of river bed.

upper stream side. Mainly gravels are subrounded.

down stream side.

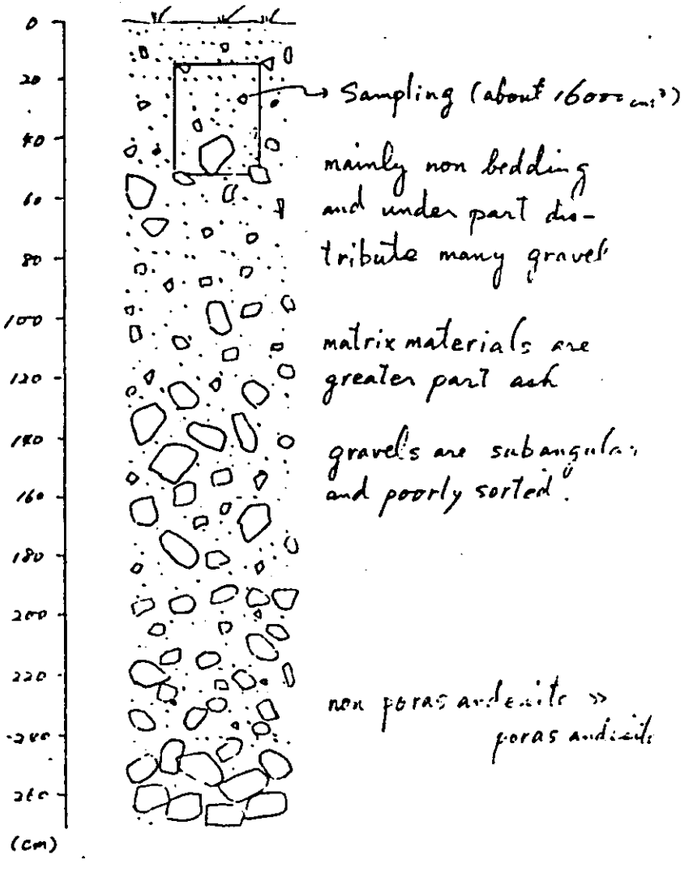
No. III - 2

Lahar deposit of 1976



No. III - 3

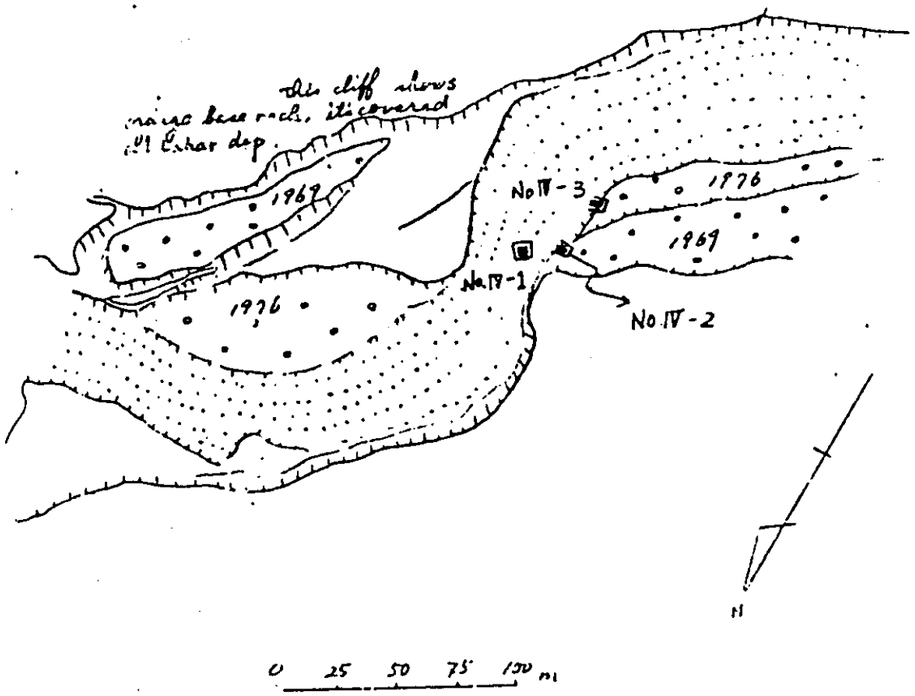
Lahar deposit of 1969



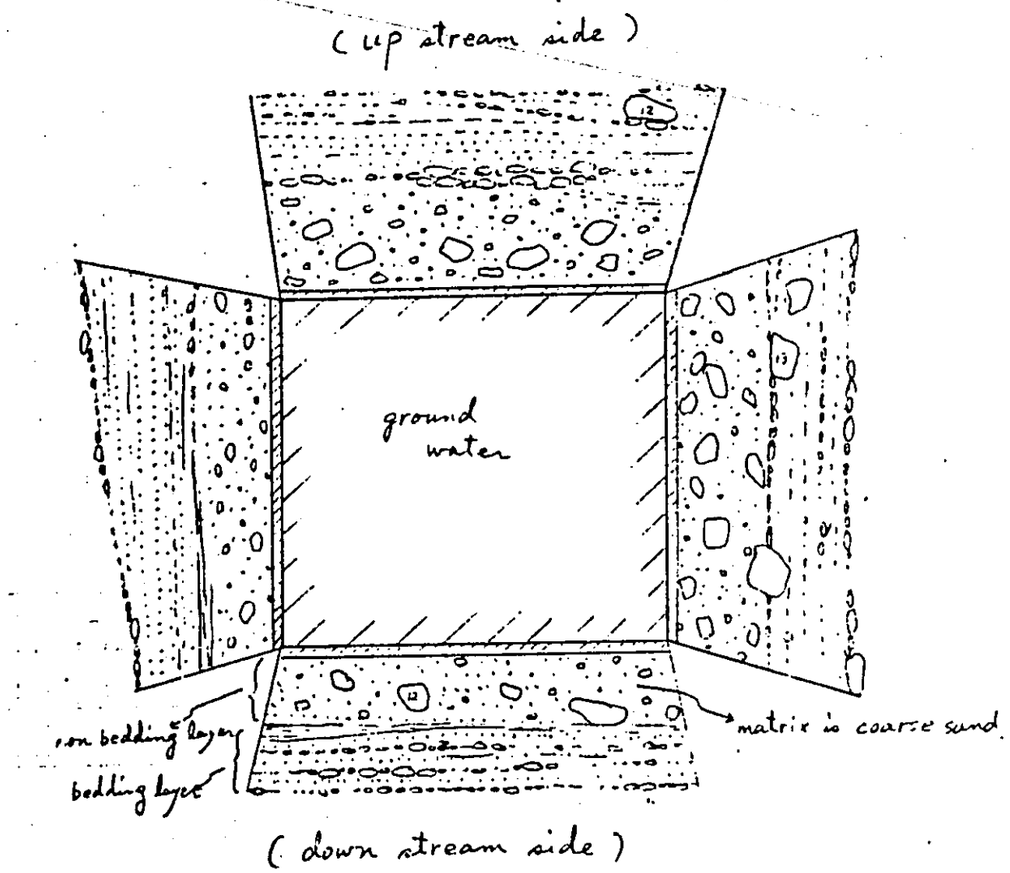
III - 2
Deposit section of 1976. This section distributes two sandy layer.

non bedding deposit of 1969. The [illegible] gravel is subangular.

FIG 32



.. Test pit No. IV - 1.



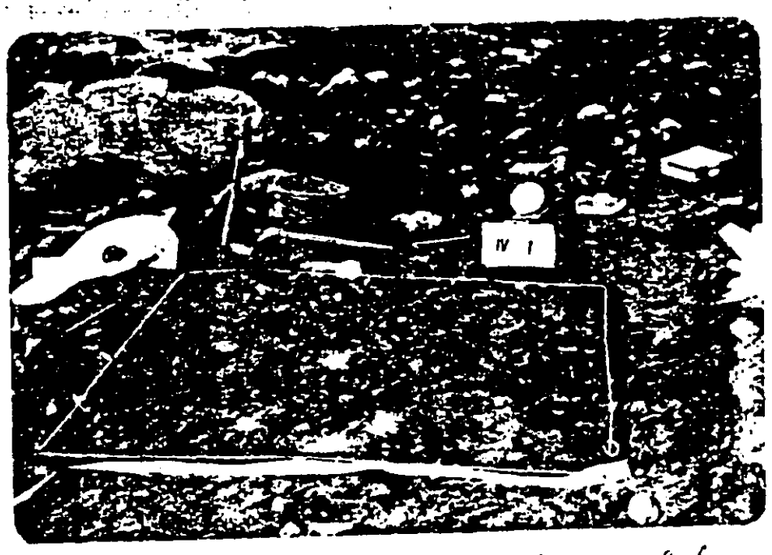
20 ~ 30 cm from surface develop lamination and bedding.

Scale

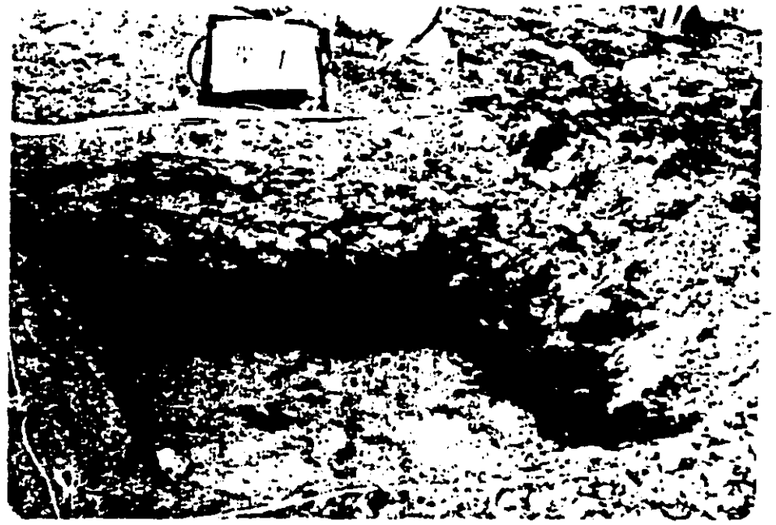
0 20 40 60 80 100 cm

photo of Test pit No. IV

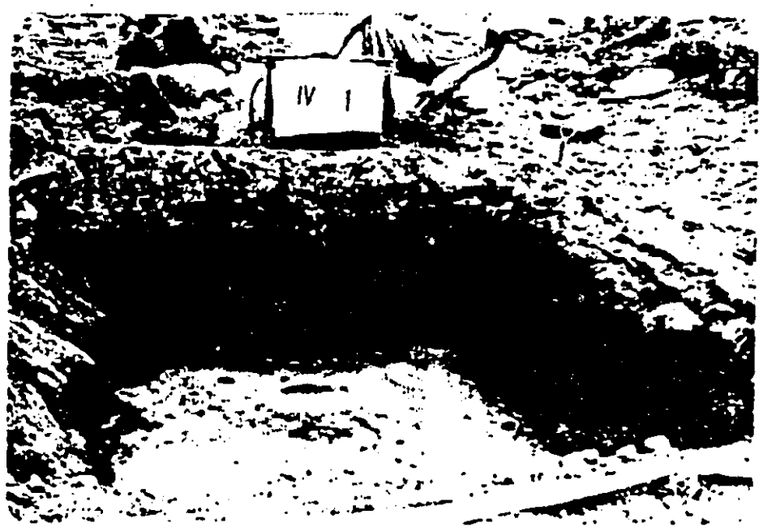
Surrounding condition of test pit No. IV.
Front lower terrace is deposit of 1976.
Deposit of 1969 distribute behind of Mr. Sumartono.



Surface condition of present river bed.



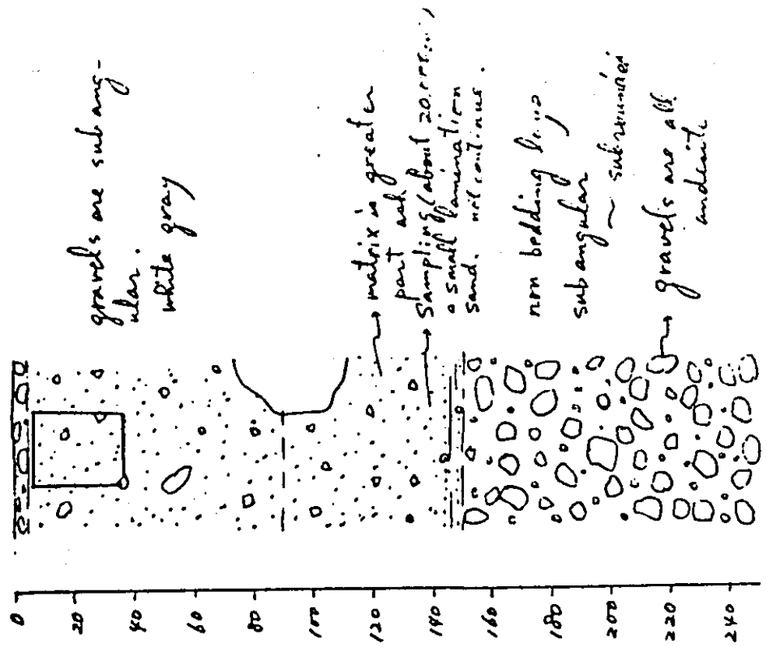
Up stream side. Section shows clear flow structure (lamination).



down stream side. mainly distribute fine ~ coarse sand.

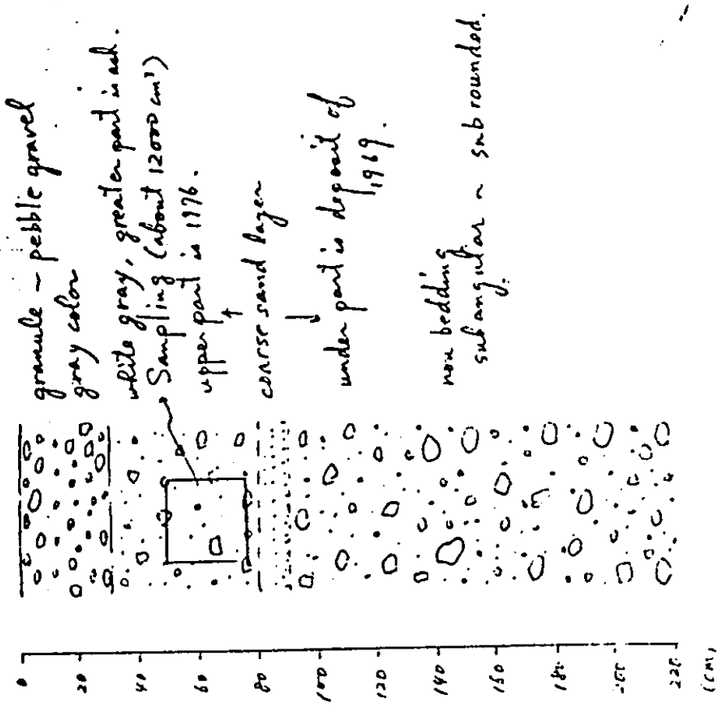
No. IV-3

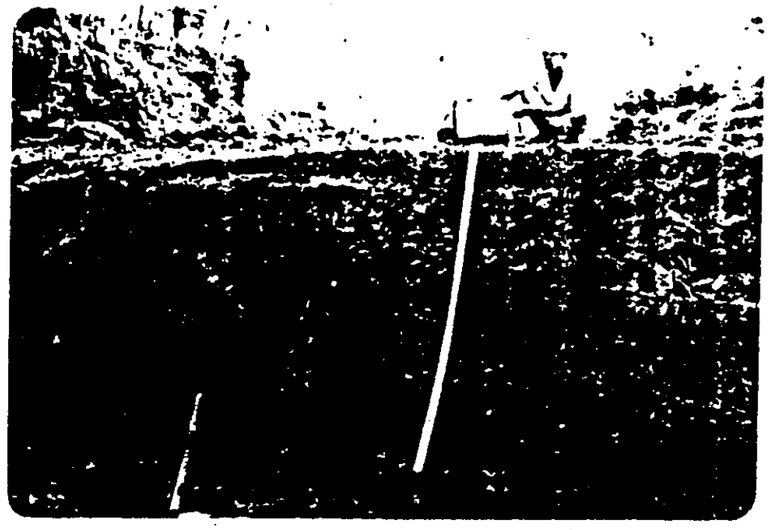
Lahar deposit of 1969.



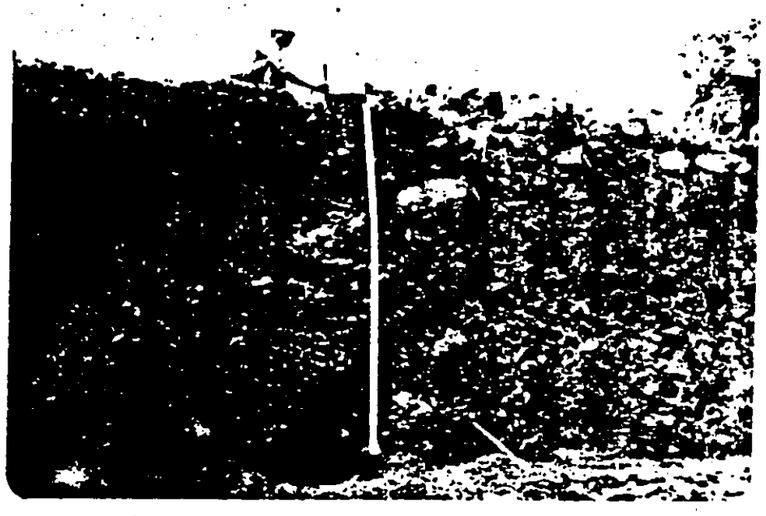
No. IV-2

Lahar deposit of 1976 and 1969.



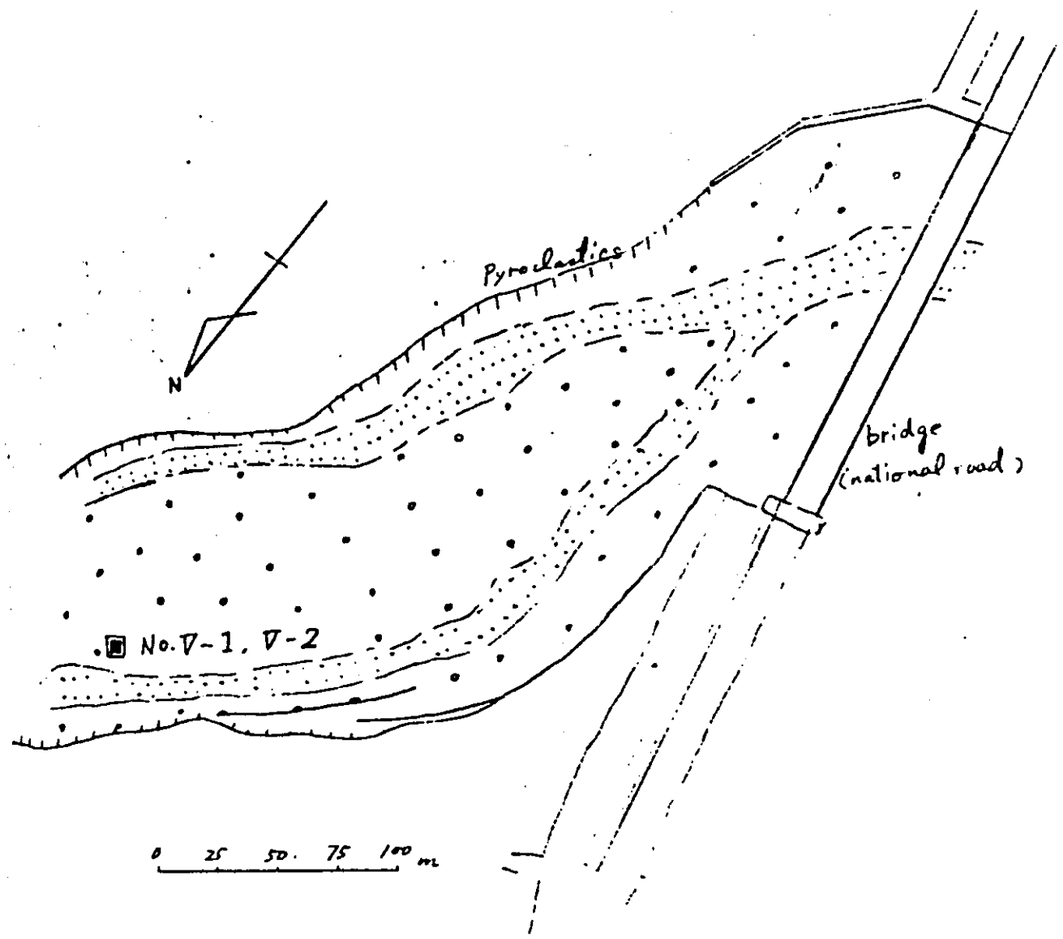


Upper part (about 1m) is deposit of 1976..
Lower part (") is " of 1969.
Sampling is took from upper part.

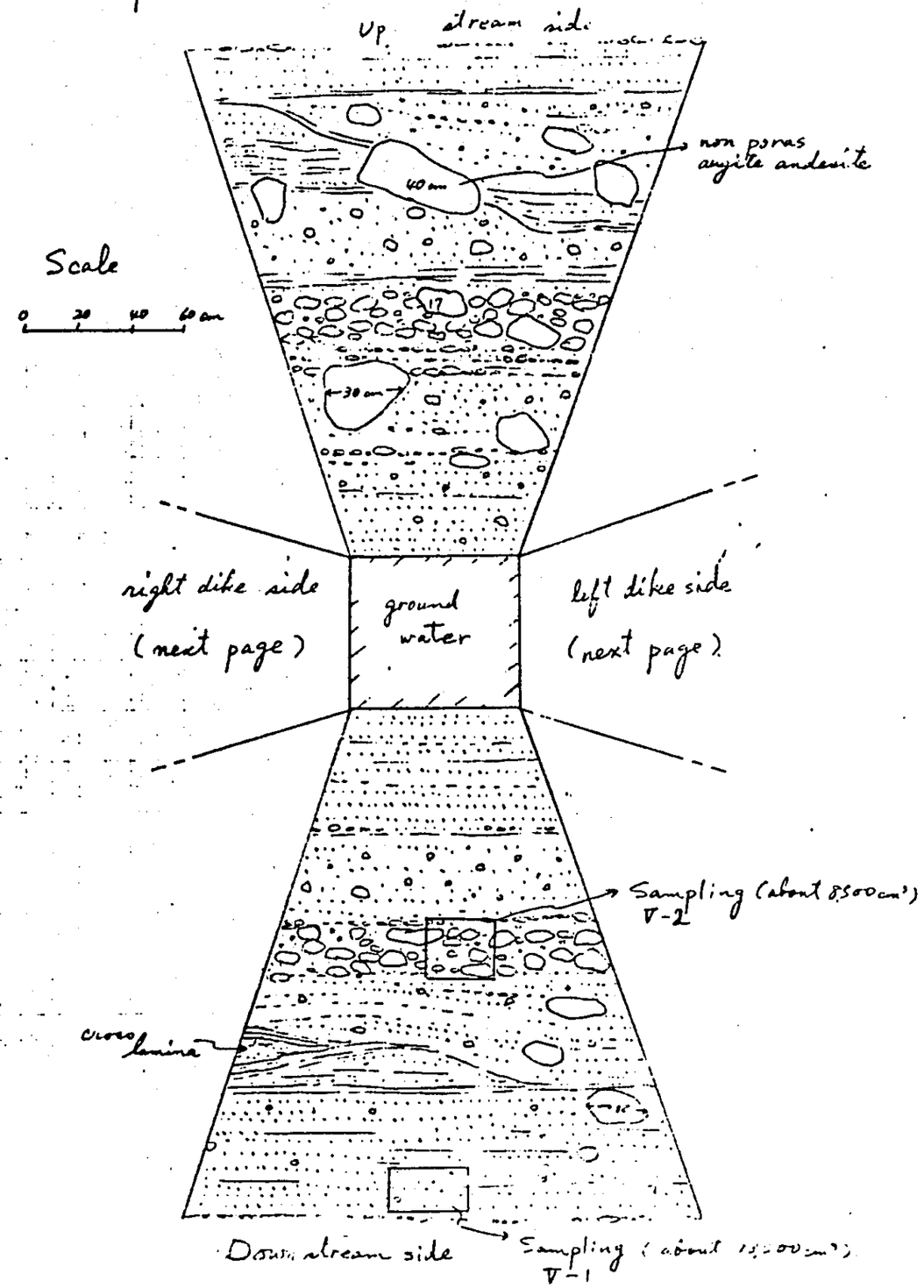


Deposit section of 1969.

FIG. 33



Test pit No V



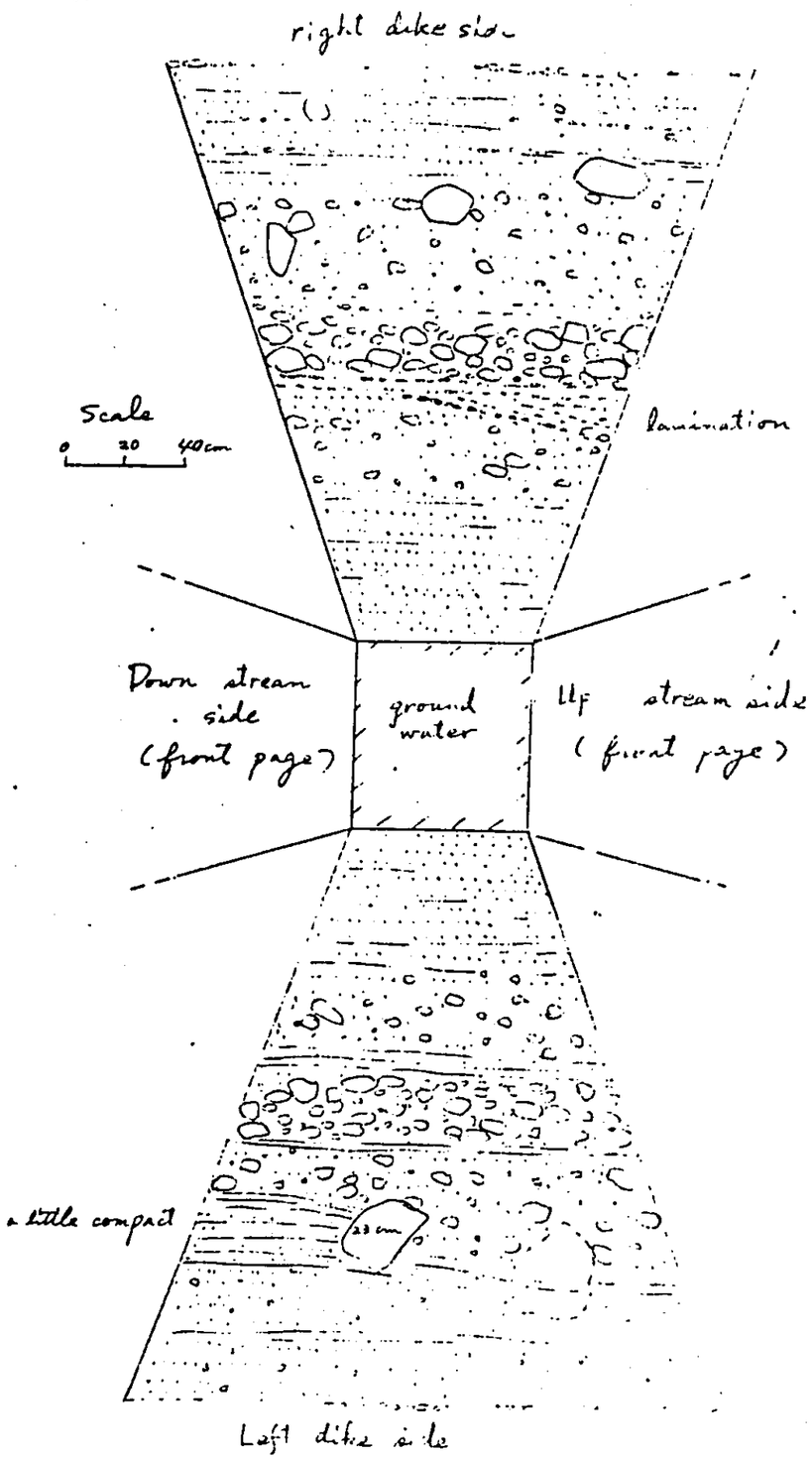
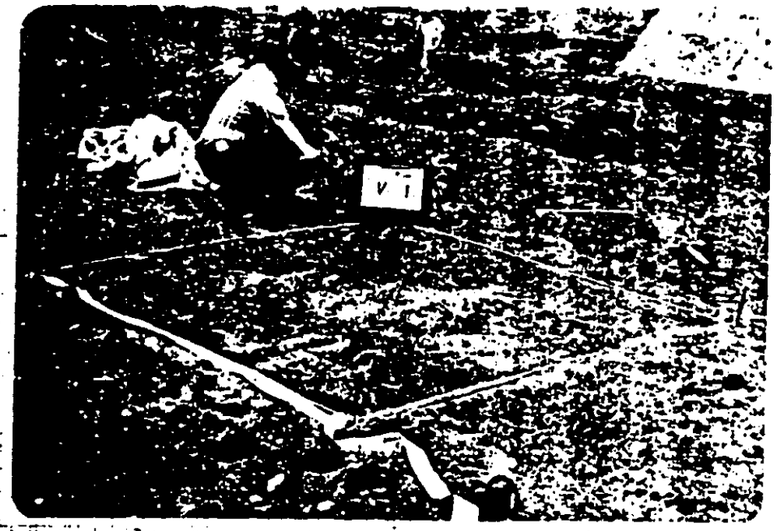


Photo of test pit NO.V



neighboring condition of test pit NO.V and surface situation. This test pit is deposit of 1976.

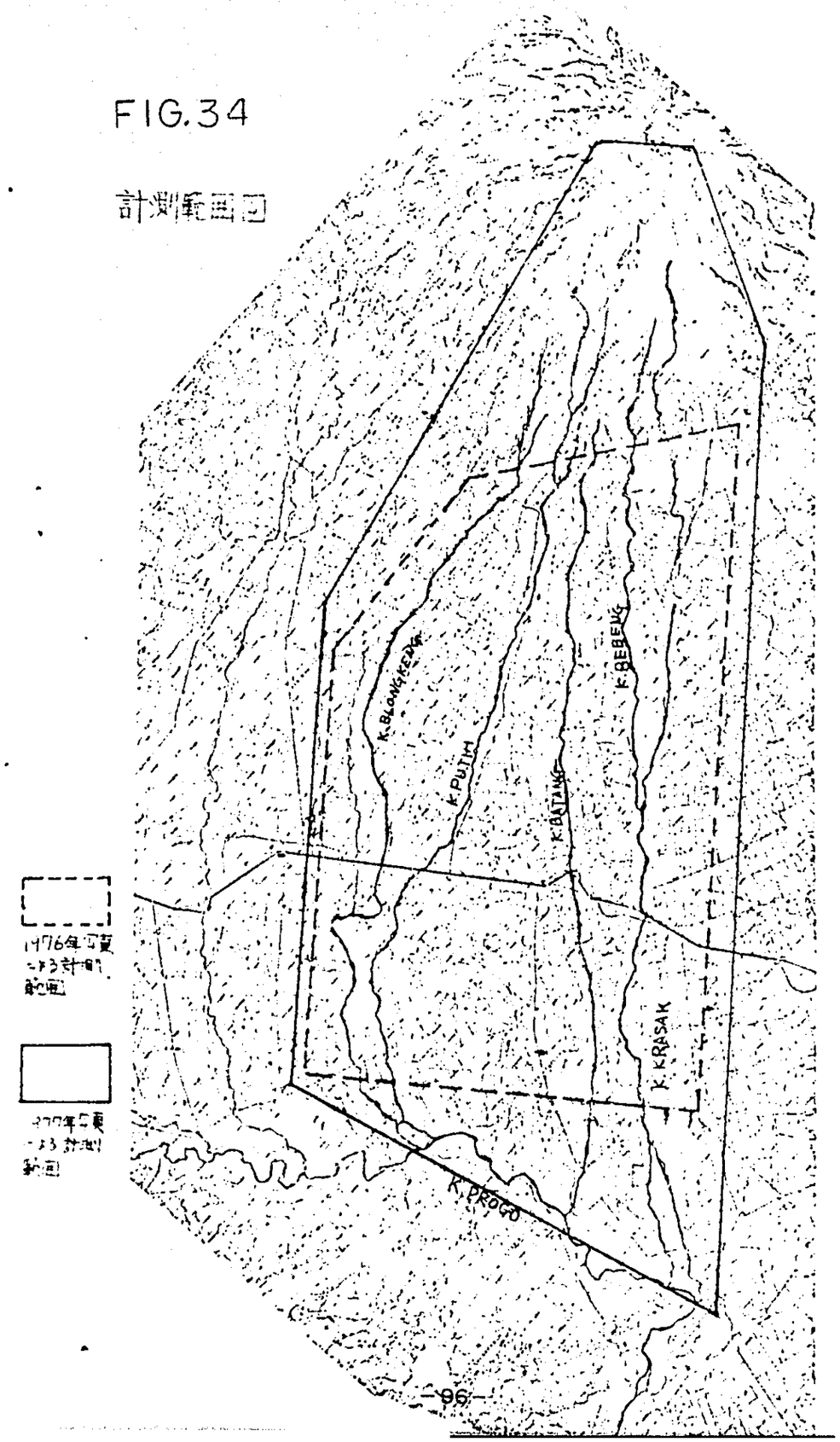
Upper stream side section later dig out.

Left side section.
Section shows clear bedding and lamination.

Right side section.
Depth to under-ground water is about 2 m.

FIG.34

計測範囲図



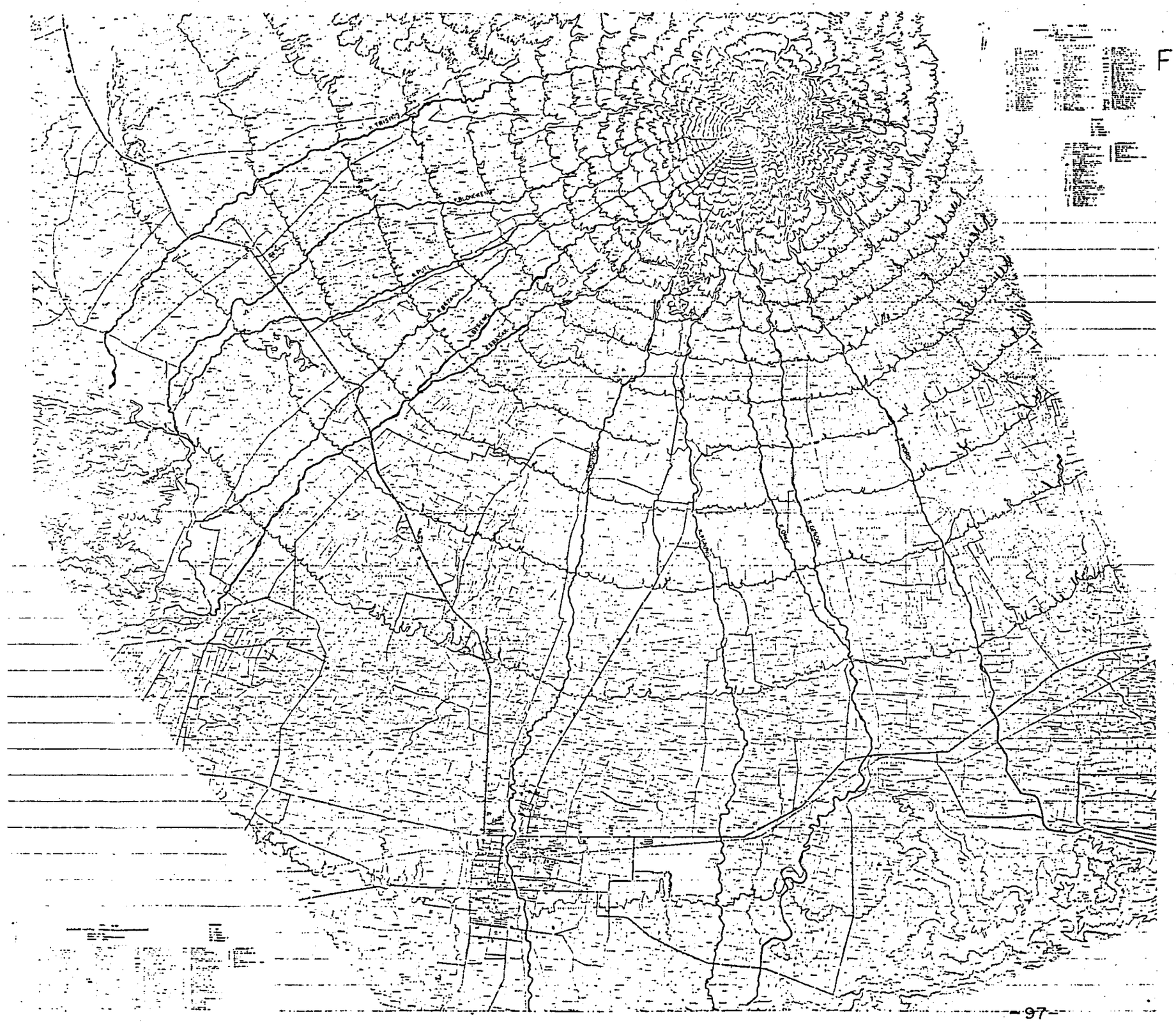


FIG.35

FIG. 36 LONGITUDINAL SECTION OF RIVERS (II)

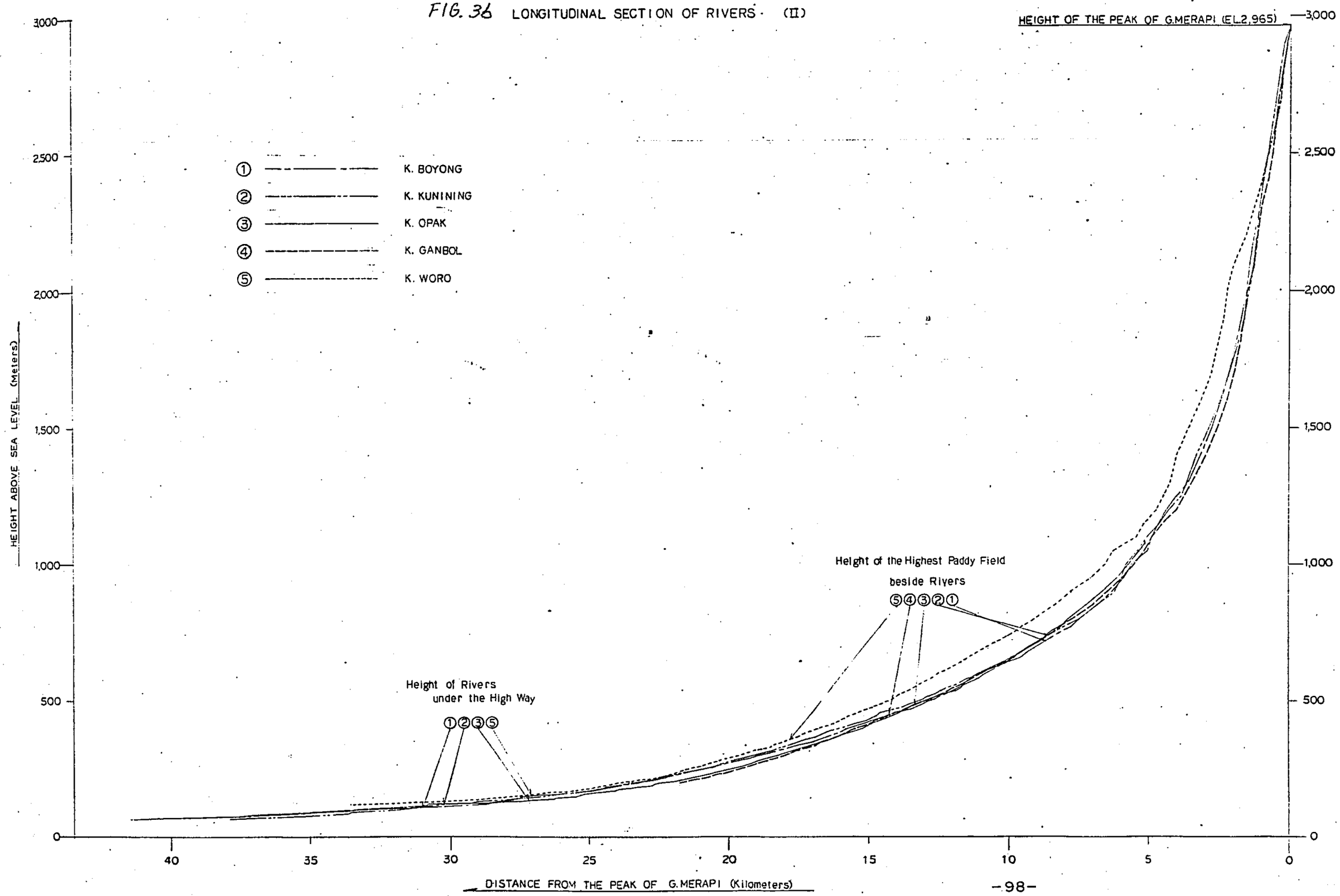


FIG.37 LONGITUDINAL SECTION OF RIVERS (I)

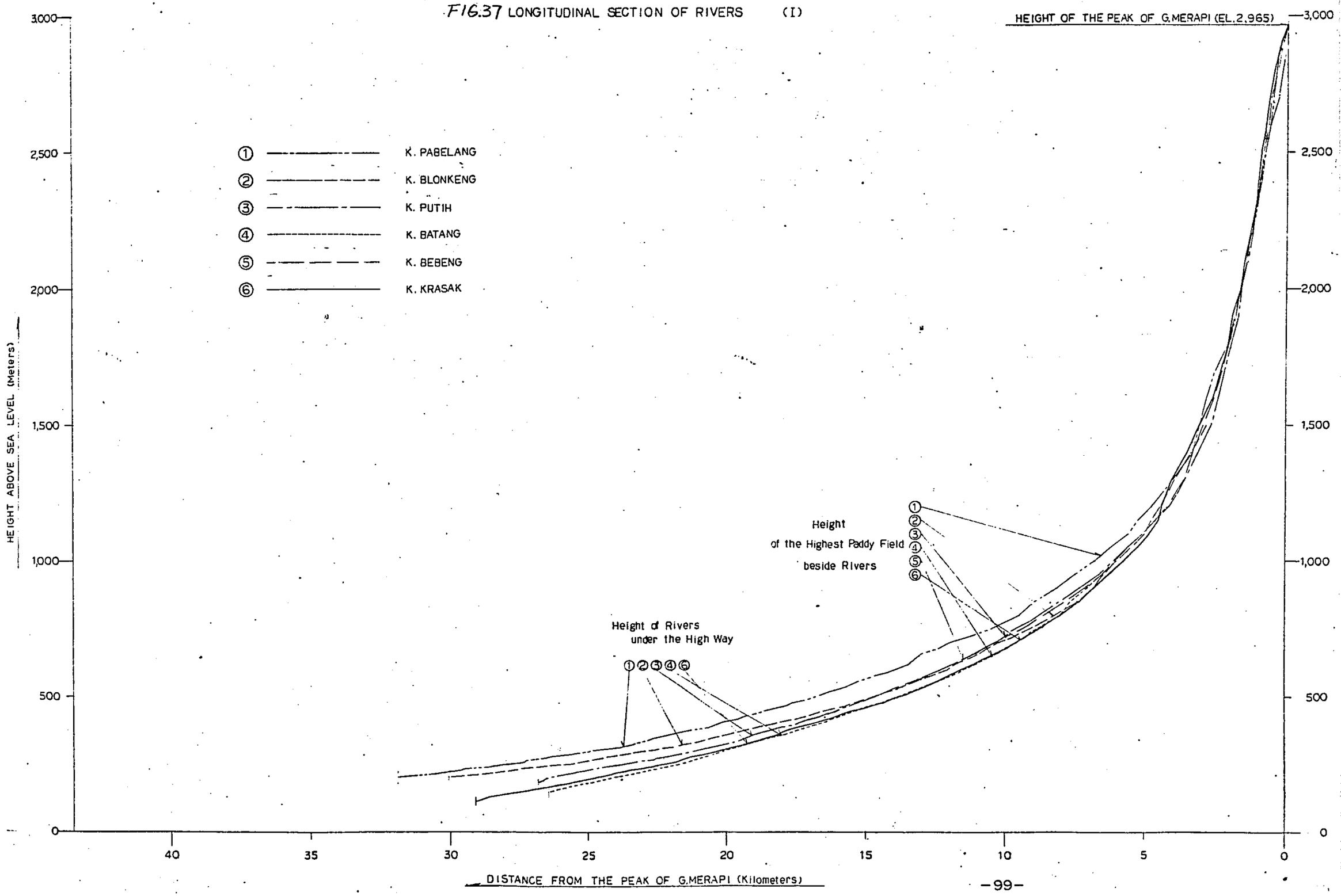


FIG. 38 **LONGITUDINAL PROFILE of K.BATANG**

SCALA : ↑ 1 : 4000

→ 1 : 20000

——— river bed

- - - - - estimated pre existed volcano surface

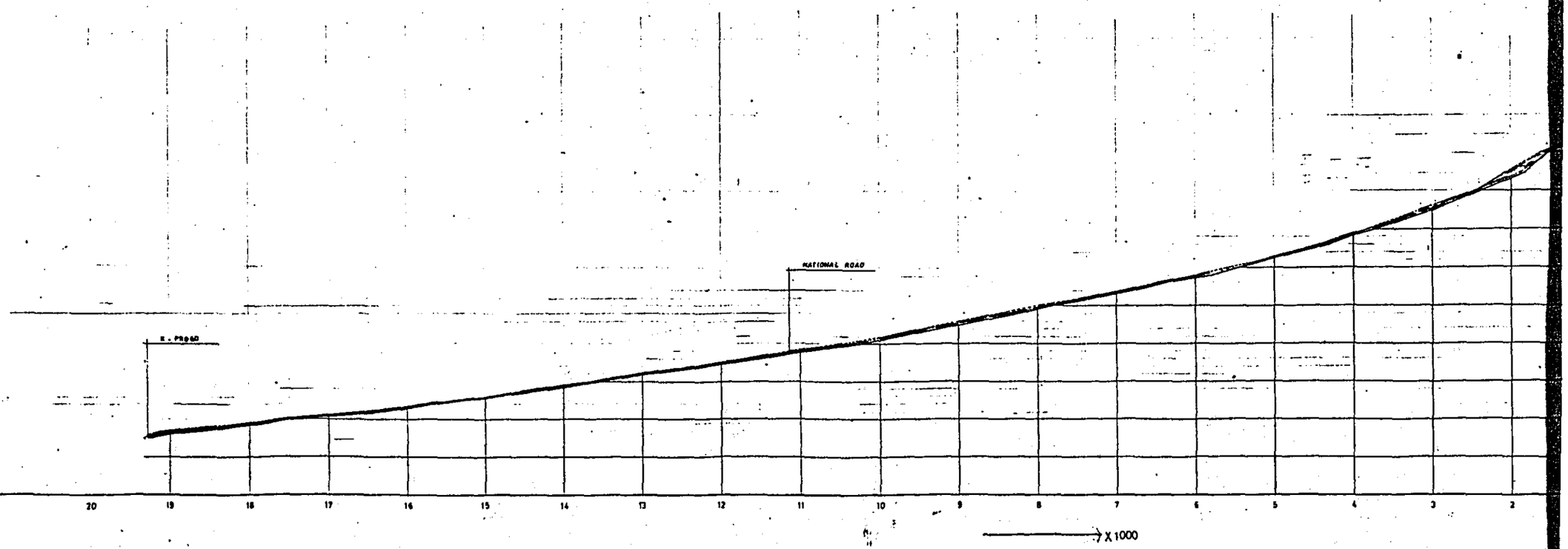


FIG. 38

LONGITUDINAL PROFILE of K.BATANG

SCALA : ↑ 1 : 4000

→ 1 : 20000

——— river bed

------ *estimated pre existed volcano surface*

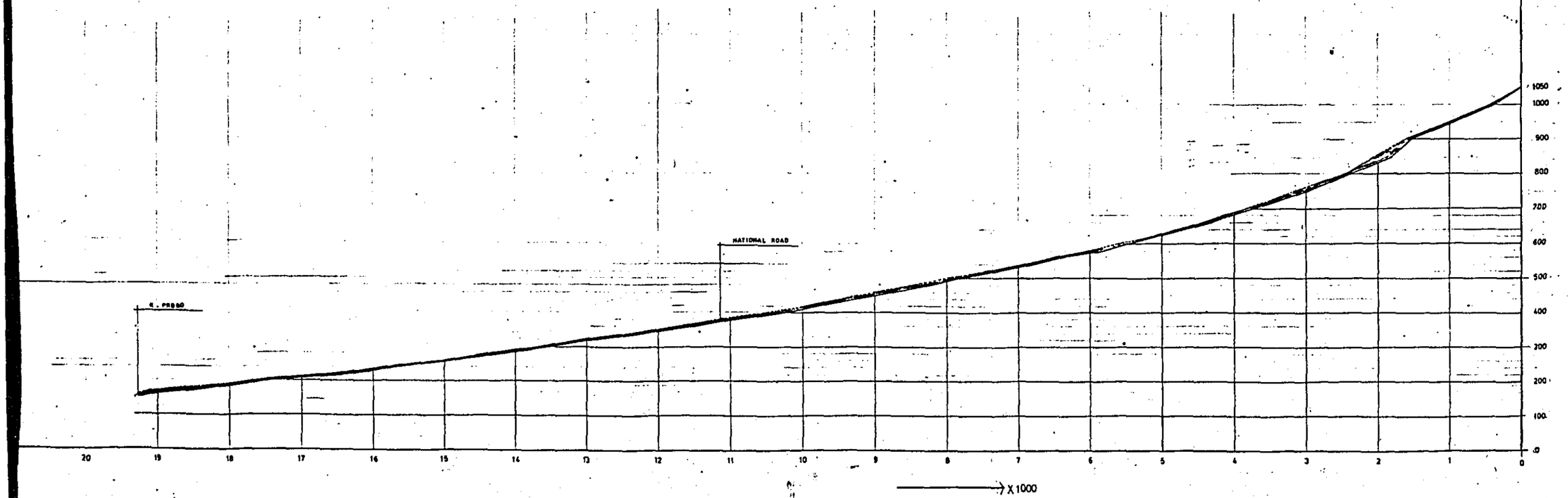


FIG.39. LONGITUDINAL PROFILE of K.PUTIH

SCALA : ↑ 1:4000
→ 1:20000
——— : river bed
- - - - : estimated pre-existed volcano surface

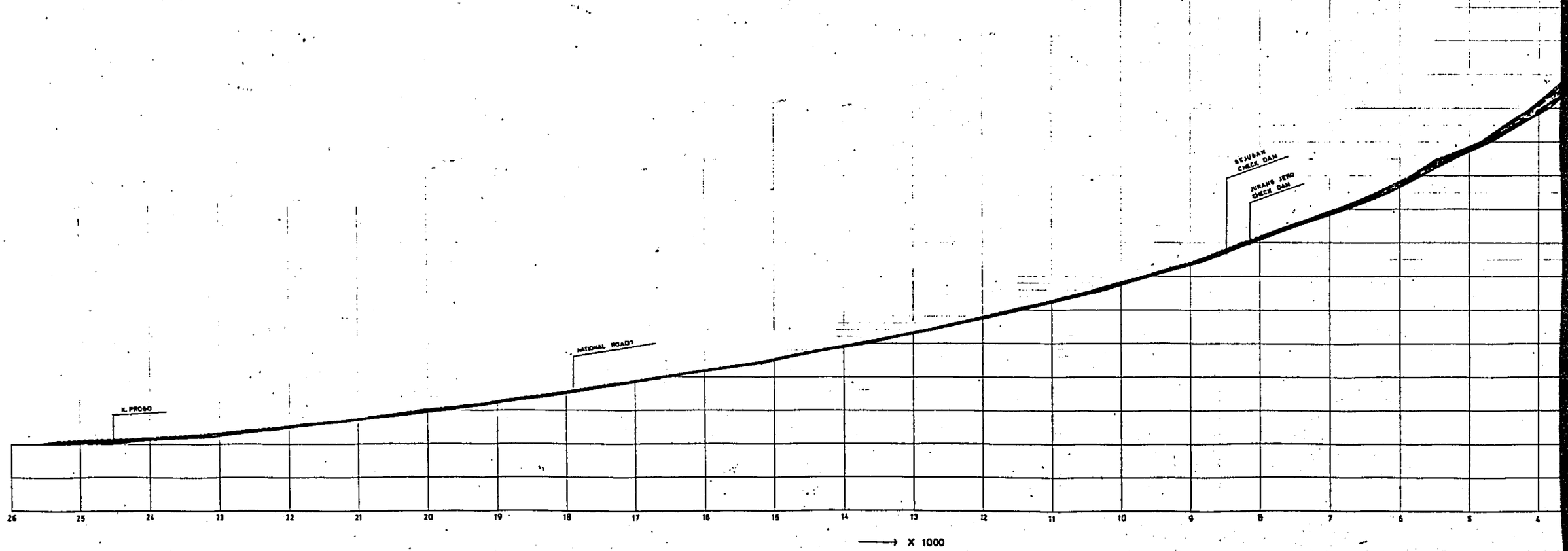


FIG.39 LONGITUDINAL PROFILE of K.PUTIH

SCALA : ↑ 1:4000
→ 1:20000
——— : river bed
- - - - : estimated pre-existed volcano surface

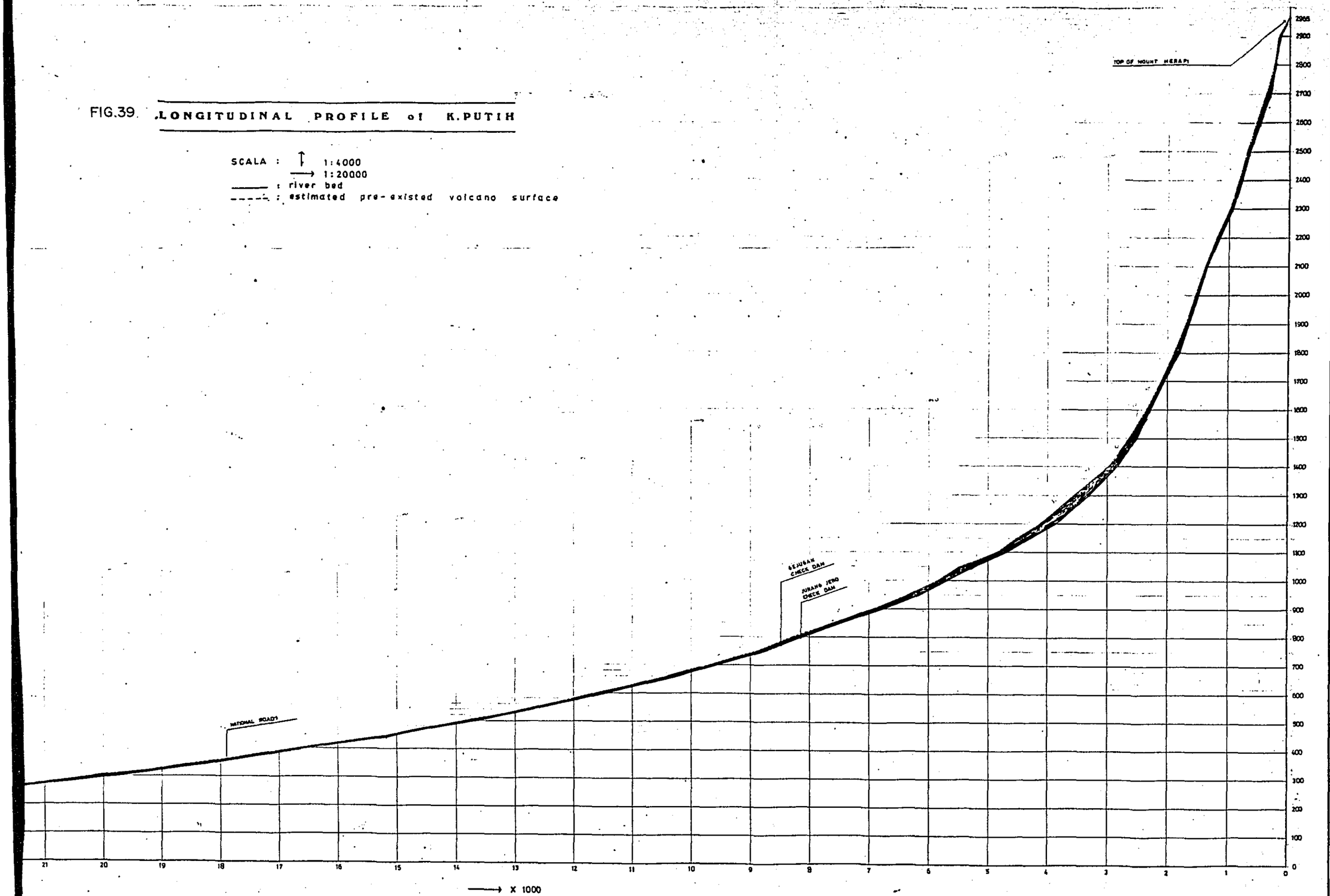


FIG. 40

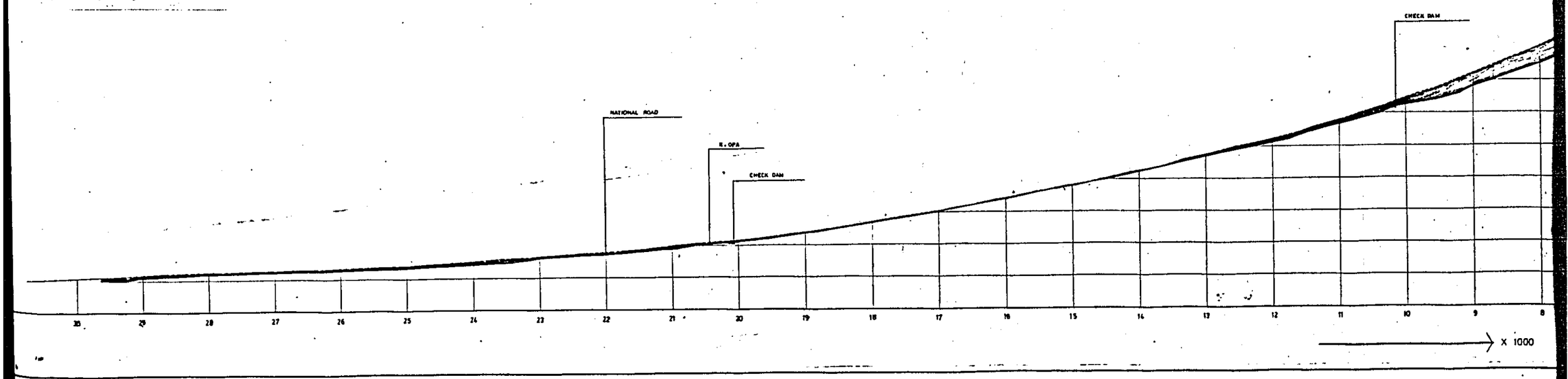
LONGITUDINAL PROFILE of K. GENDOL

SCALA : ↑ 1 : 4000

→ 1 : 20000

—— river bed

—— estimated pre existed volcano surface



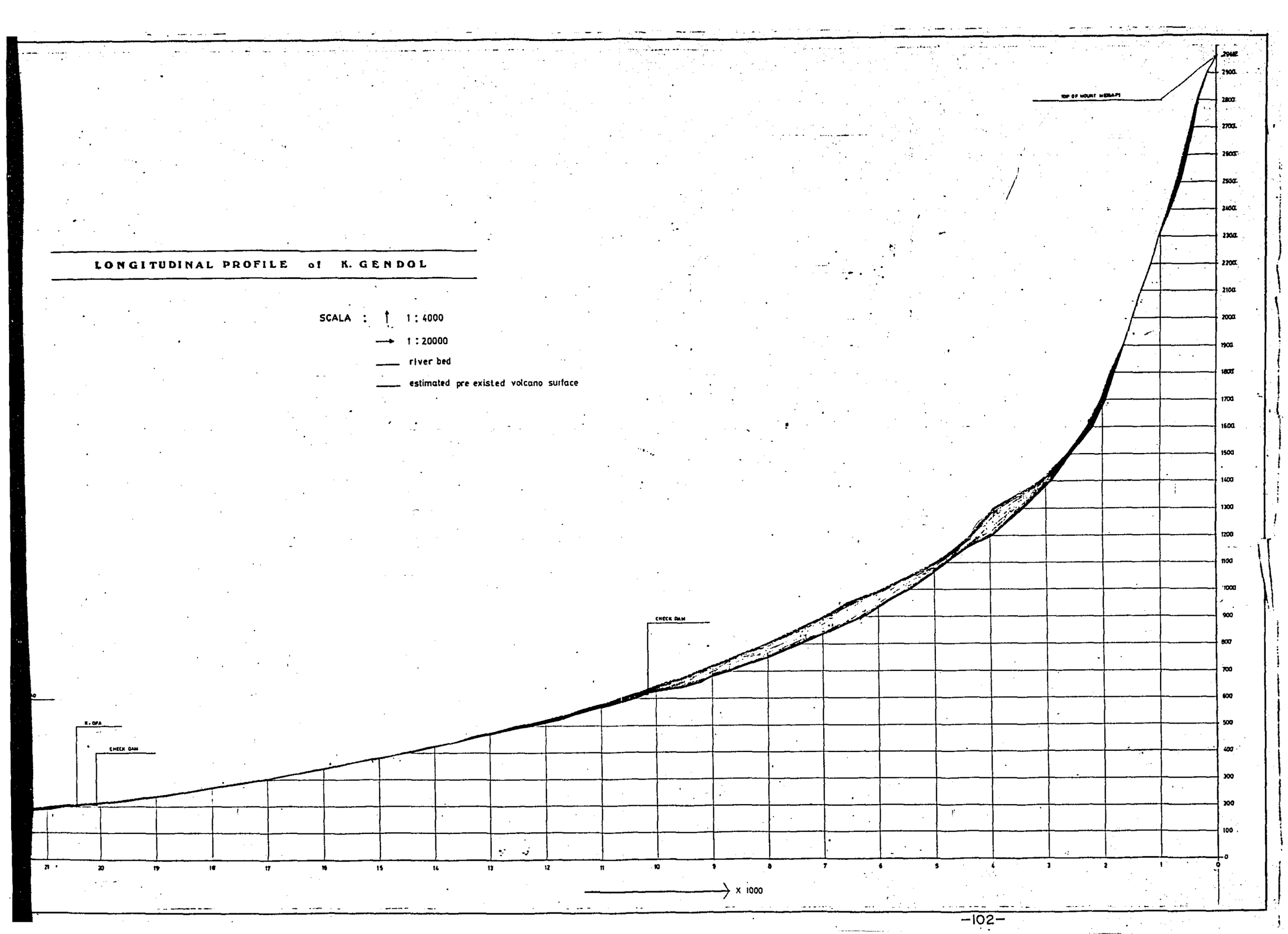
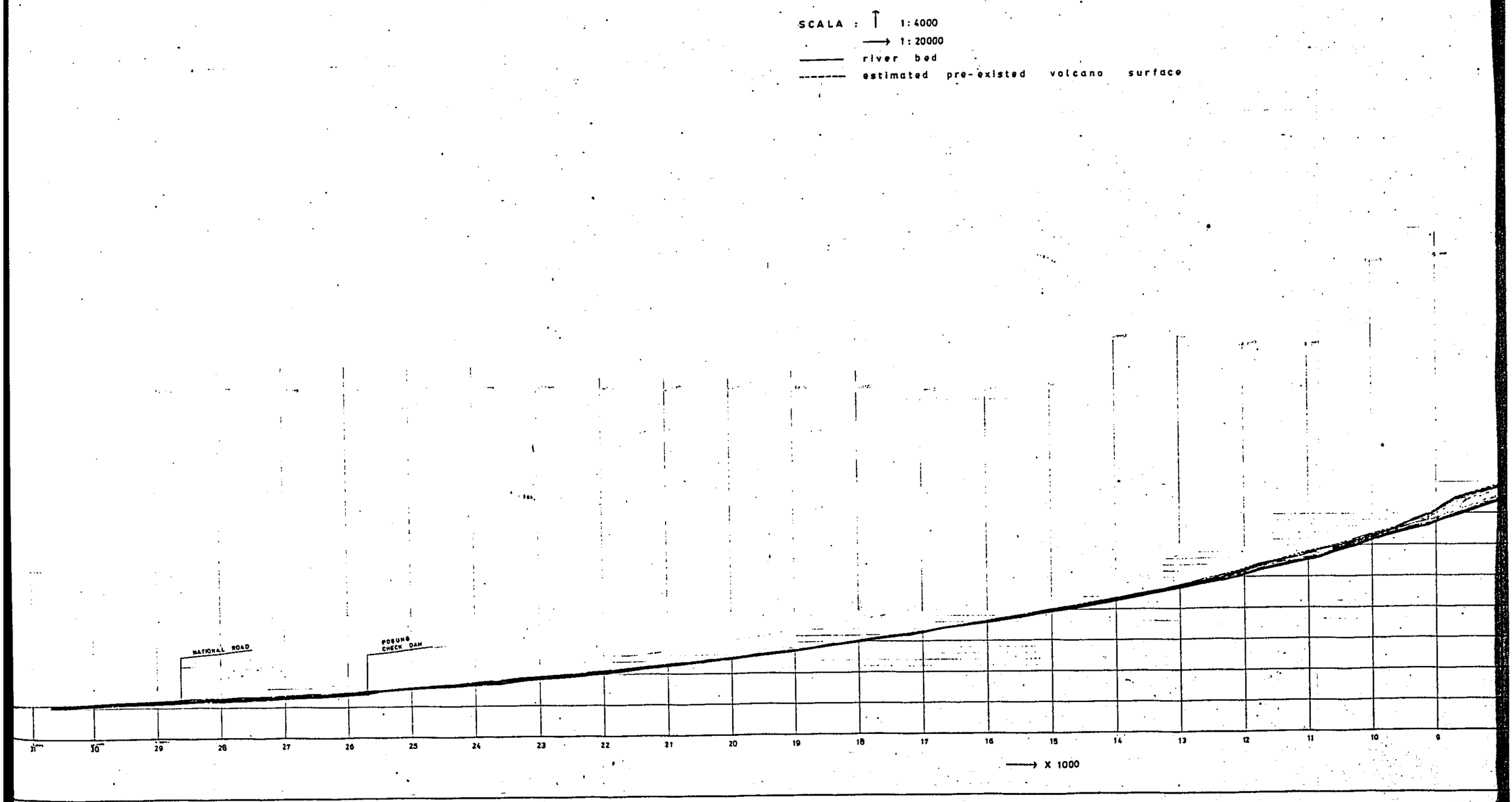

LONGITUDINAL PROFILE of K. GENDOL
SCALA : 1 : 4000
1 : 20000
river bed
estimated pre existed volcano surface
TOP OF MOUNT MERAPI
CHECK DAM
CHECK DAM
X 1000

FIG.41 LONGITUDINAL PROFILE of K. BOYONG



G.41

LONGITUDINAL PROFILE of K. BOYONG

SCALA : ↑ 1:4000
→ 1:20000
——— river bed
------- estimated pre-existed volcano surface

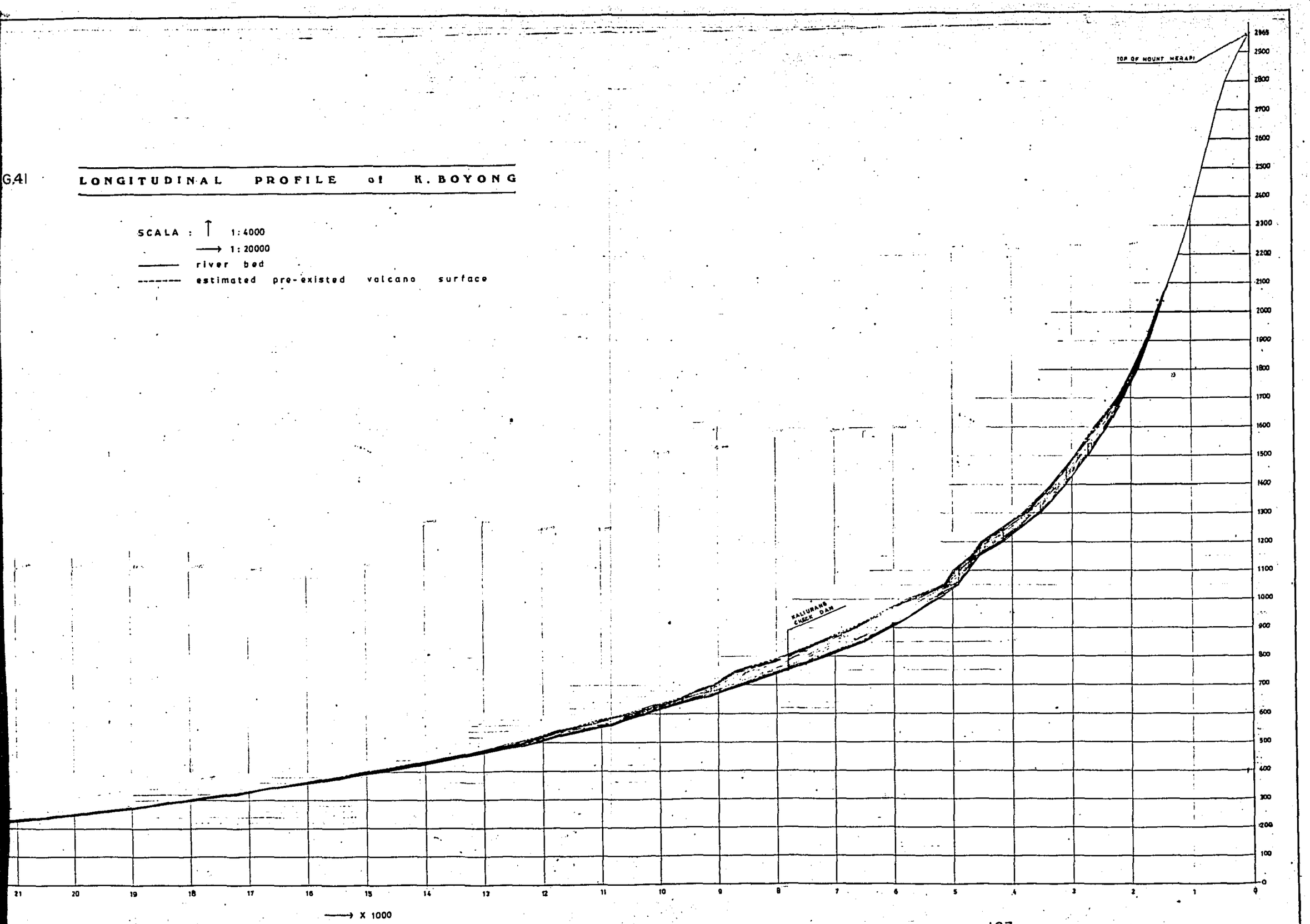


FIG. 42 LONGITUDINAL PROFILE of K. PABELAN

SCALA : ↑ 1 : 4000
→ 1 : 20000

——— river bed
------ estimated pre - existed volcano surface

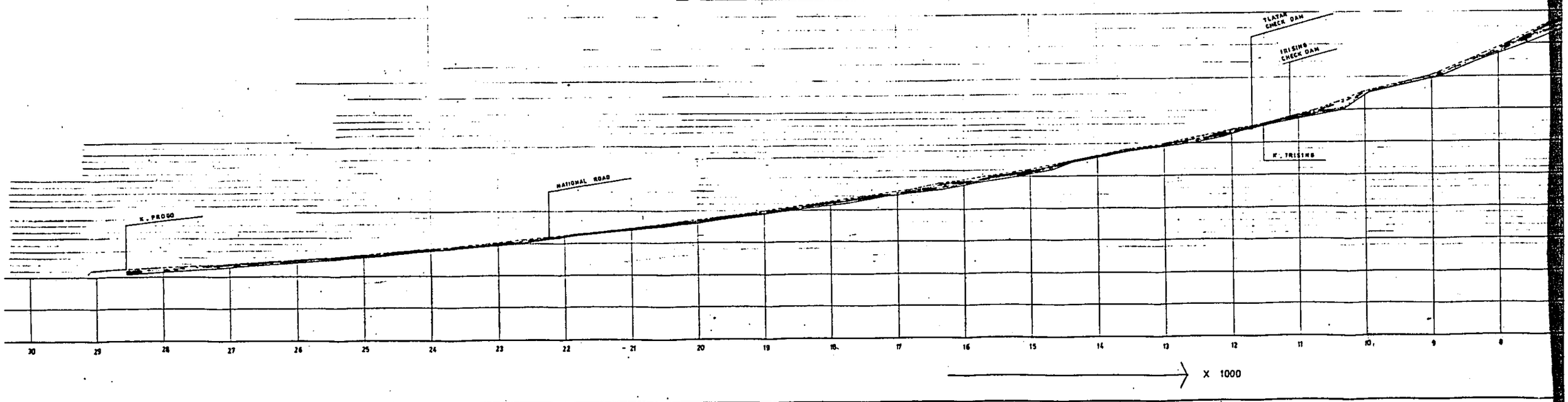


FIG. 42 LONGITUDINAL PROFILE of K. PABELAN

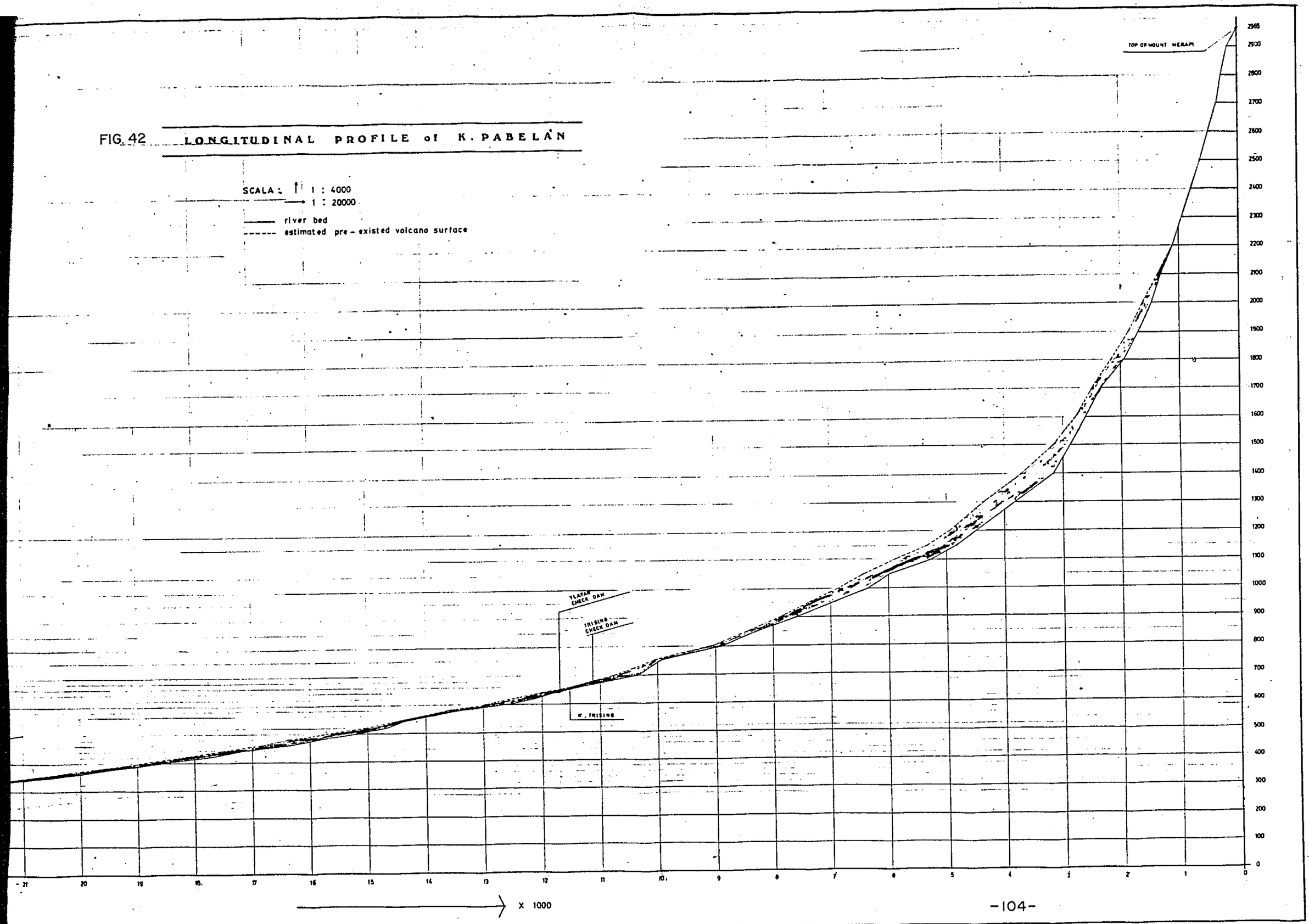


FIG.43 **LONGITUDINAL PROFILE of K. BLONGKENG**

SCALA : | 1 : 4000
—— 1 : 20000
——— river bed
------ estimated pre-existed volcano surface

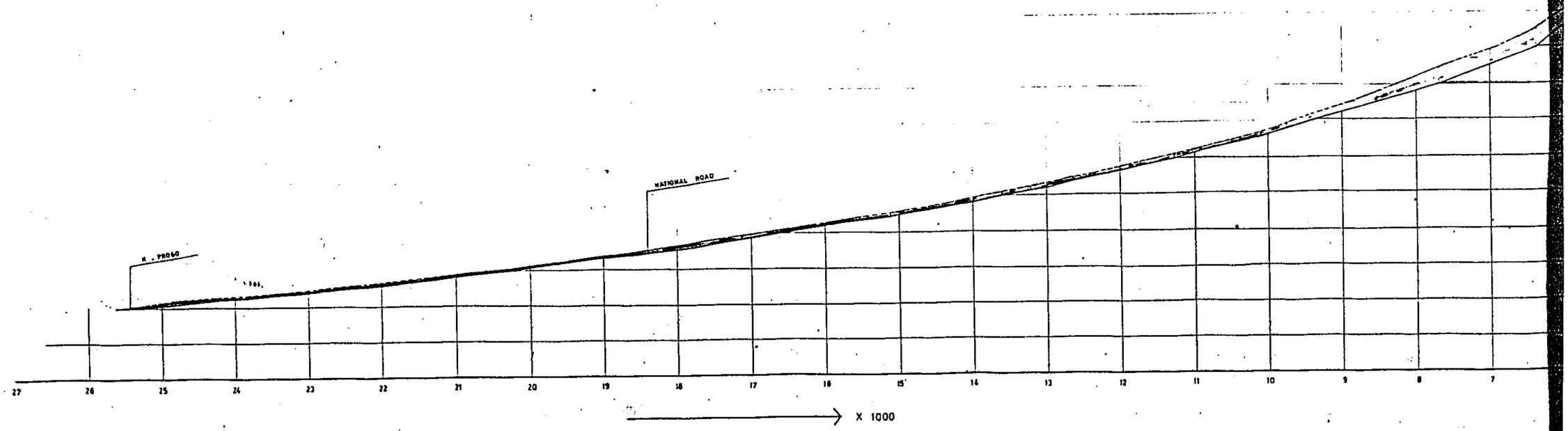


FIG.43 **LONGITUDINAL PROFILE of K. BLONGKENG**

SCALA : 1 : 4000
1 : 20000
river bed
estimated pre-existed volcano surface

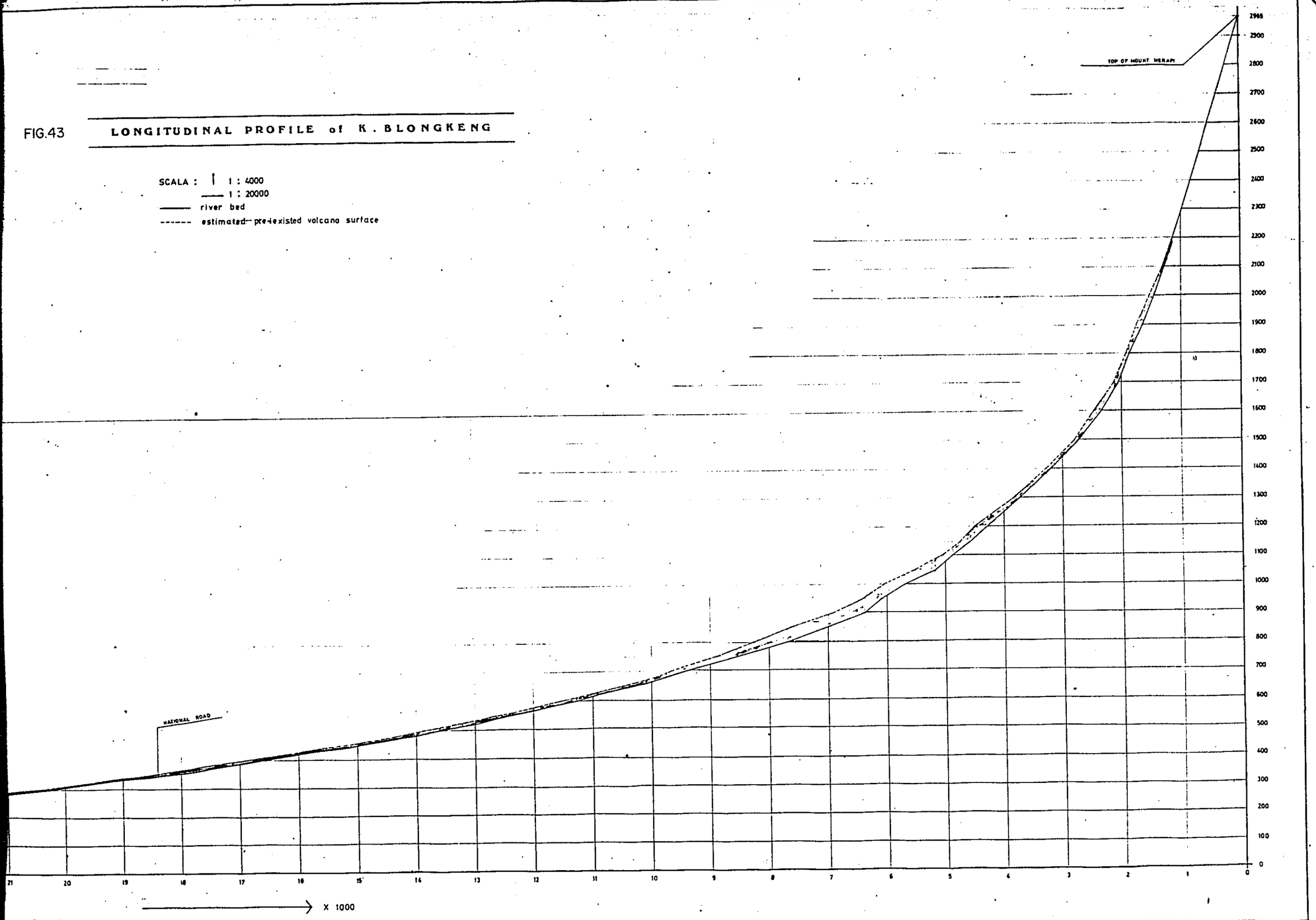


FIG. 44 **LONGITUDINAL PROFILE of K. KRASAK**

SCALA : 1 1:4000
→ 1:20000

——— river bed

------- estimated pre-existed volcano surface

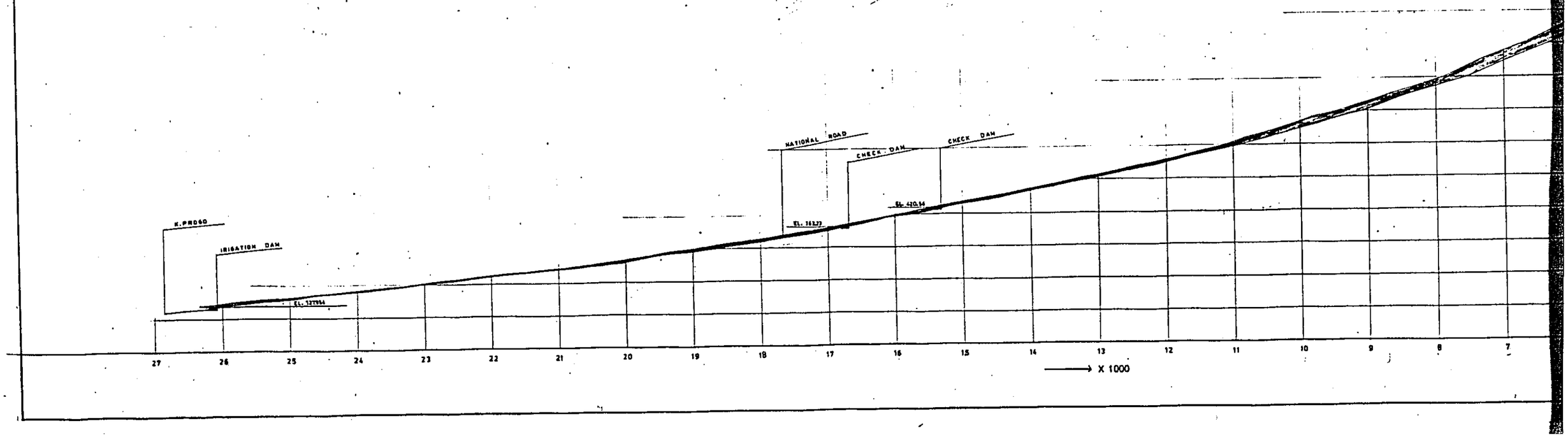


FIG. 44 **LONGITUDINAL PROFILE of K. KRASAK**

SCALA : 1 1:4000
→ 1:20000
——— river bed
------- estimated pre-existed volcano surface

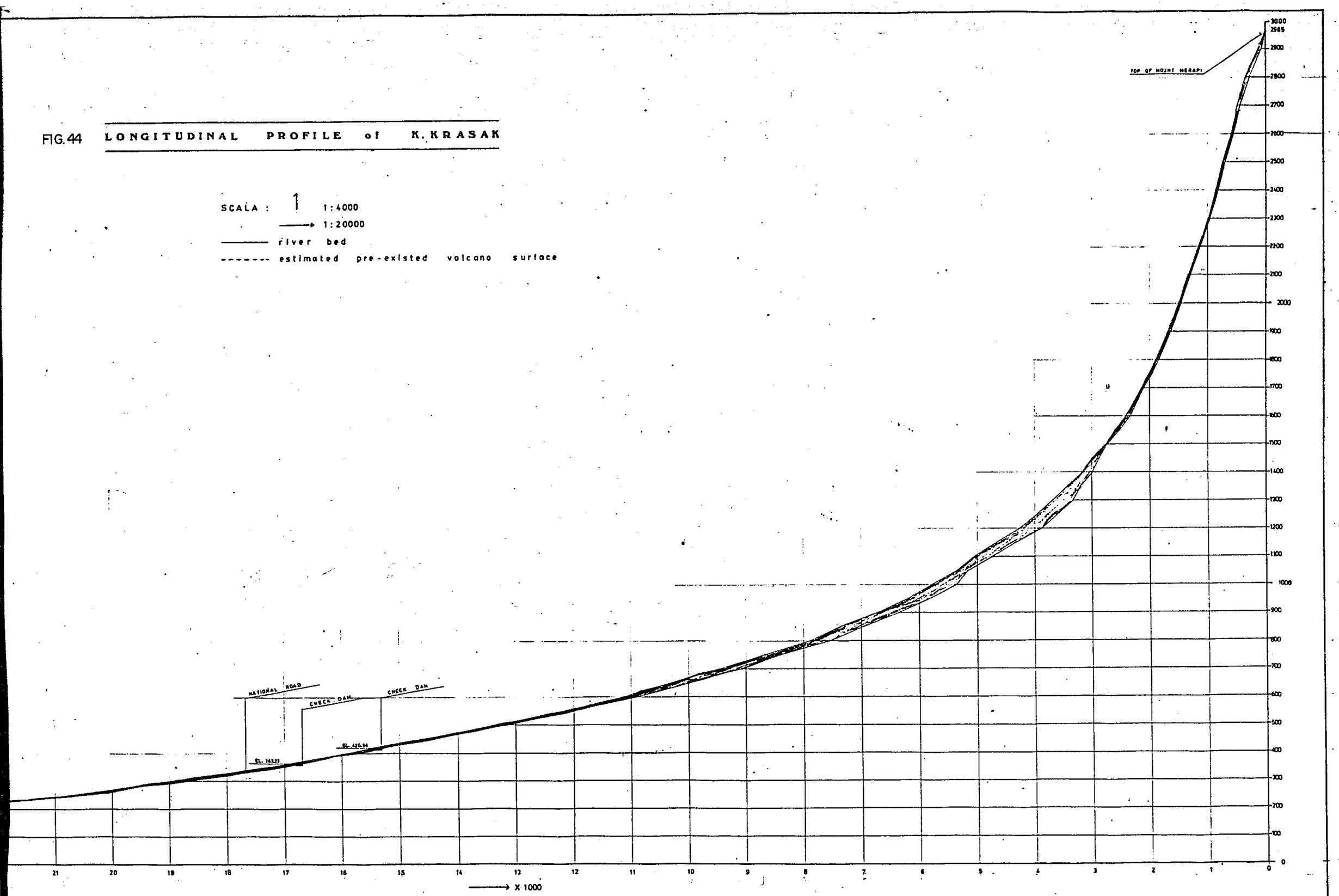


FIG.45 **LONGITUDINAL PROFILE of K. WORO**

SCALA : 1 : 4000
1 : 20000

river bed
estimated pre-existed volcano surface

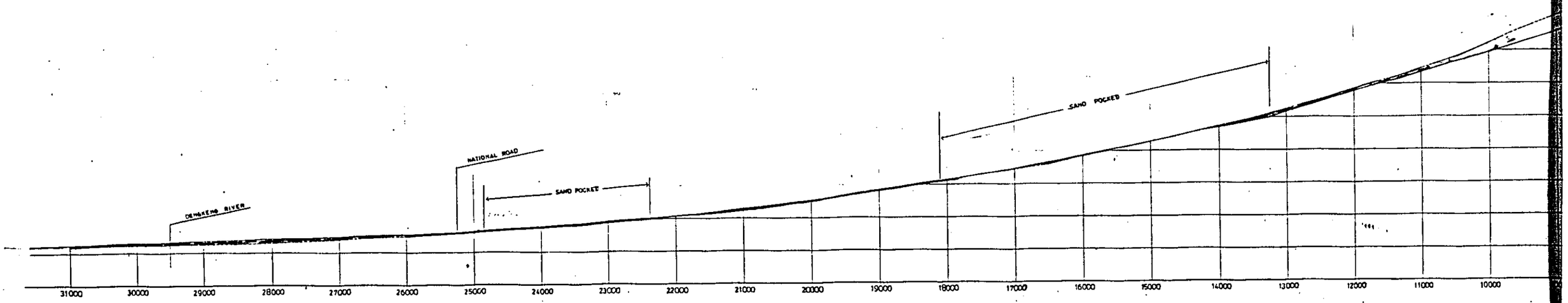


FIG.45 **LONGITUDINAL PROFILE of K. WORO**

SCALA : ↑ 1 : 4000
→ 1 : 20000

——— river bed
------- estimated pre-existed volcano surface

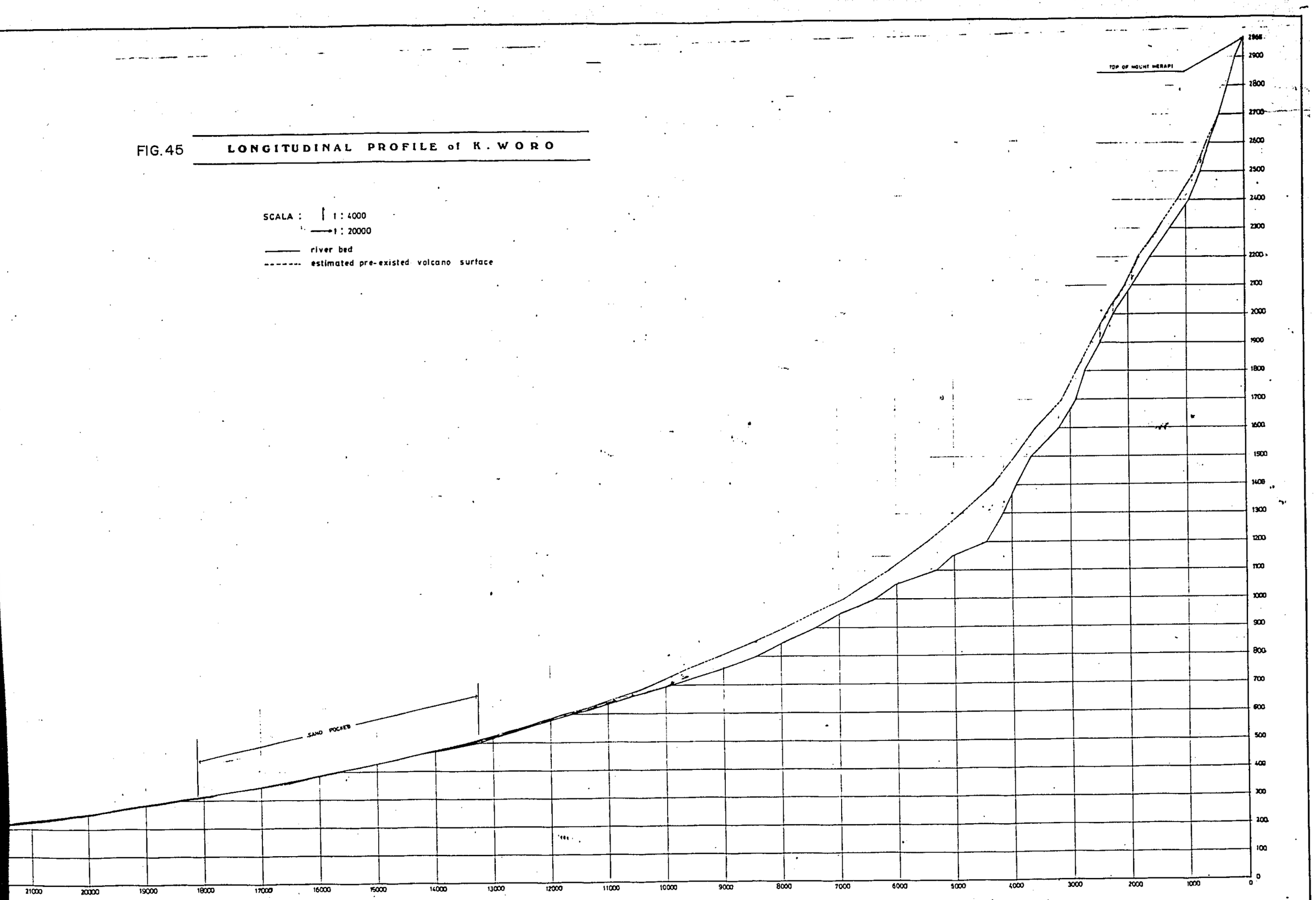


FIG.46 LONGITUDINAL PROFILE of K. KUNING

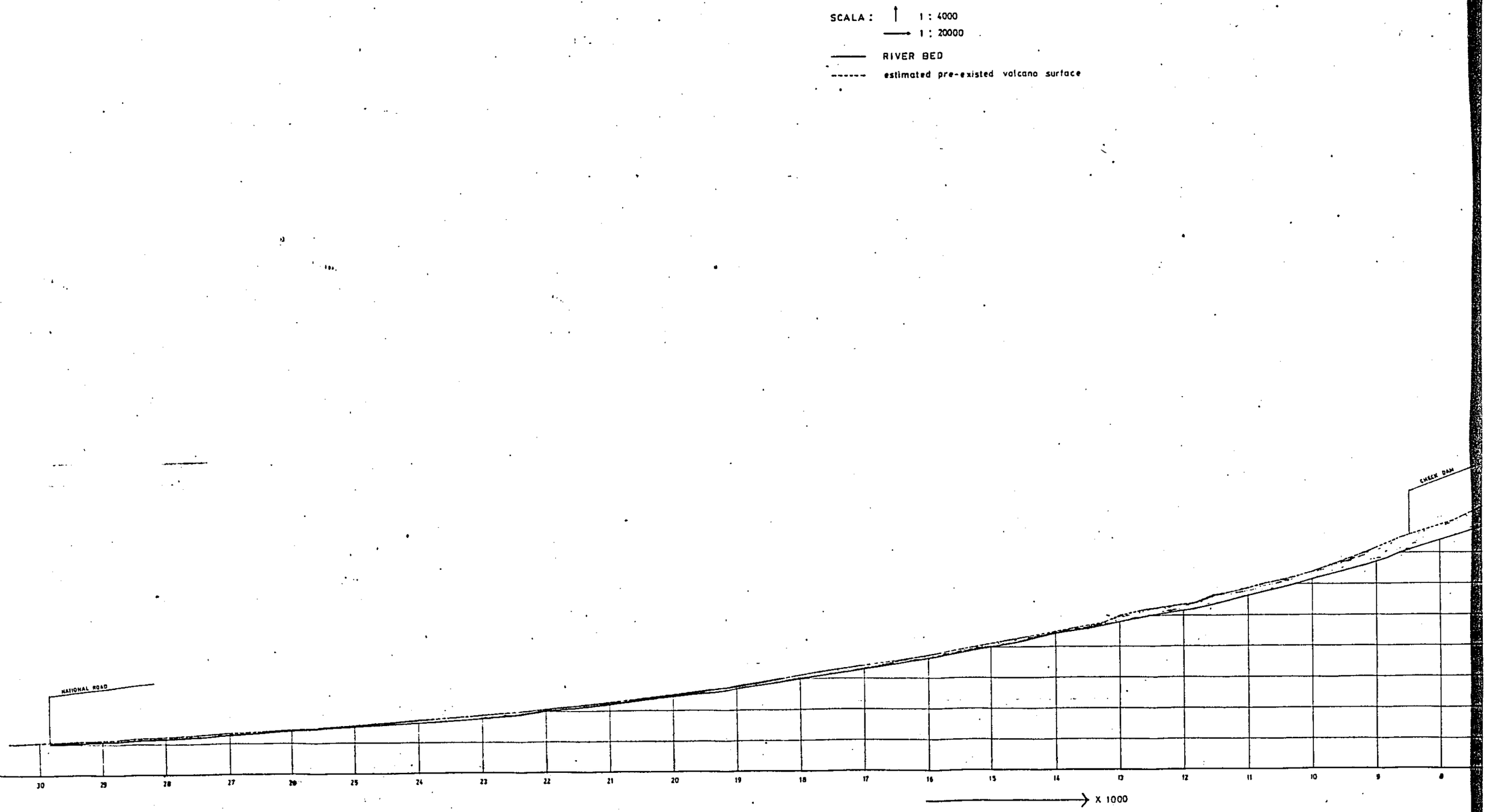


FIG.46 **LONGITUDINAL PROFILE of K. KUNING**

SCALA : ↑ 1 : 4000
→ 1 : 20000

——— RIVER BED
------ estimated pre-existed volcano surface

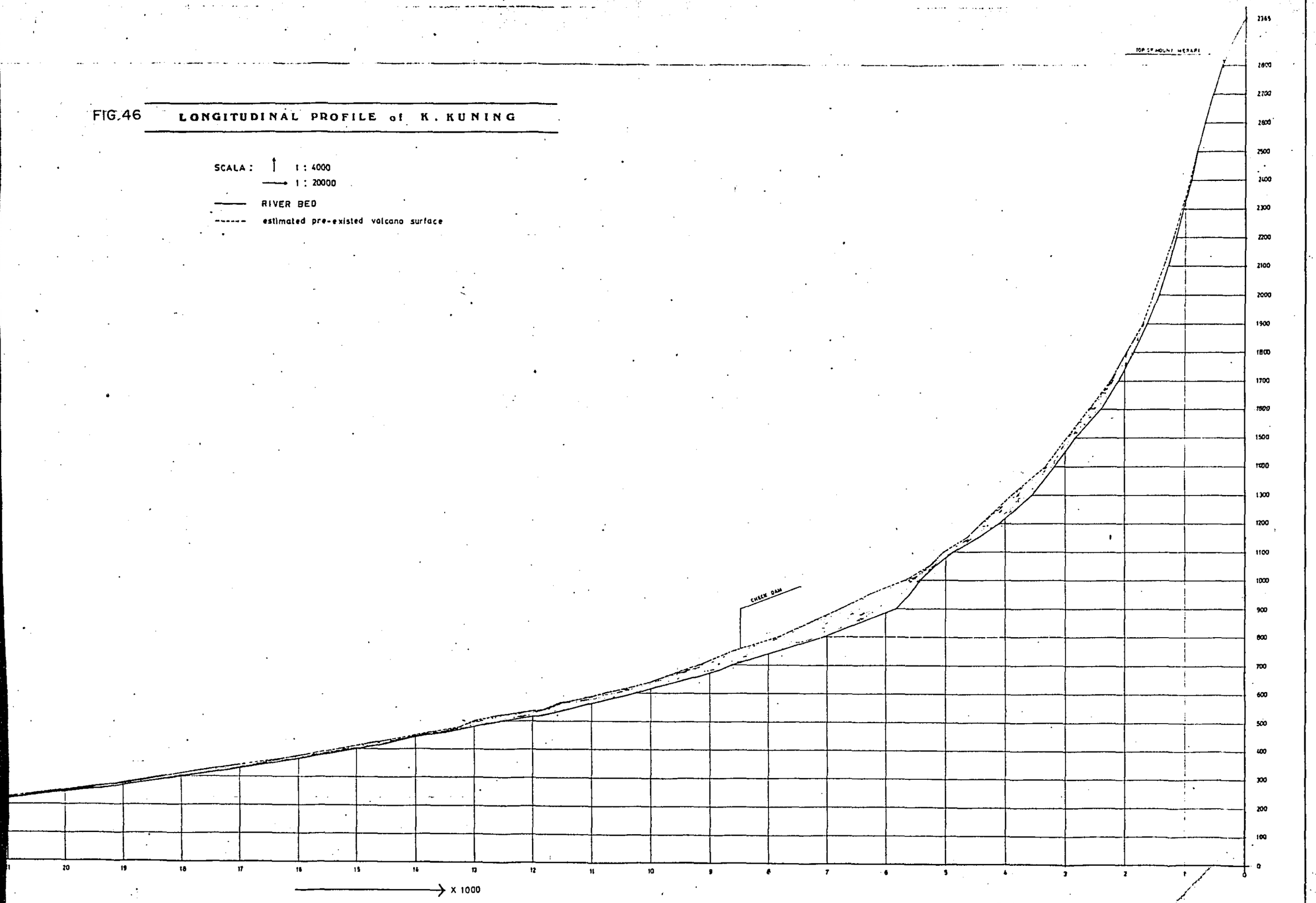


FIG.47 K.PABELAN

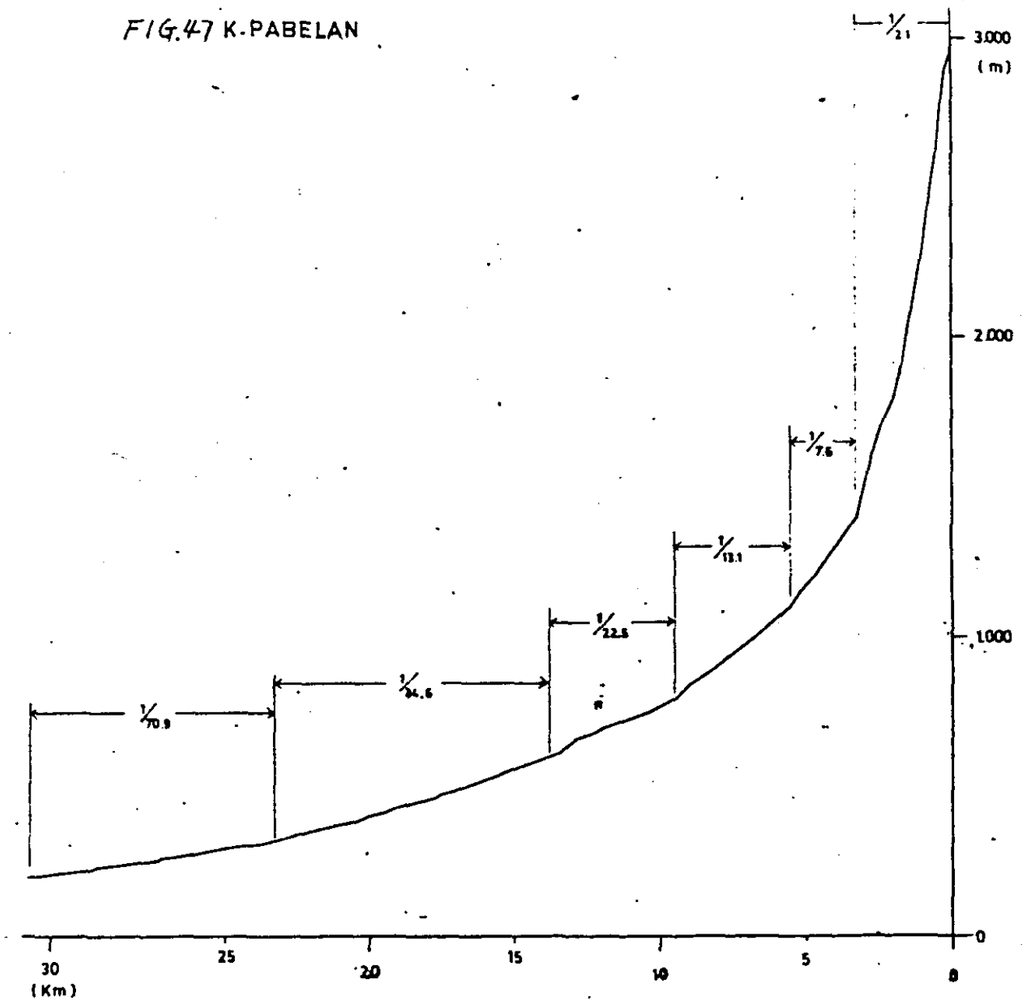
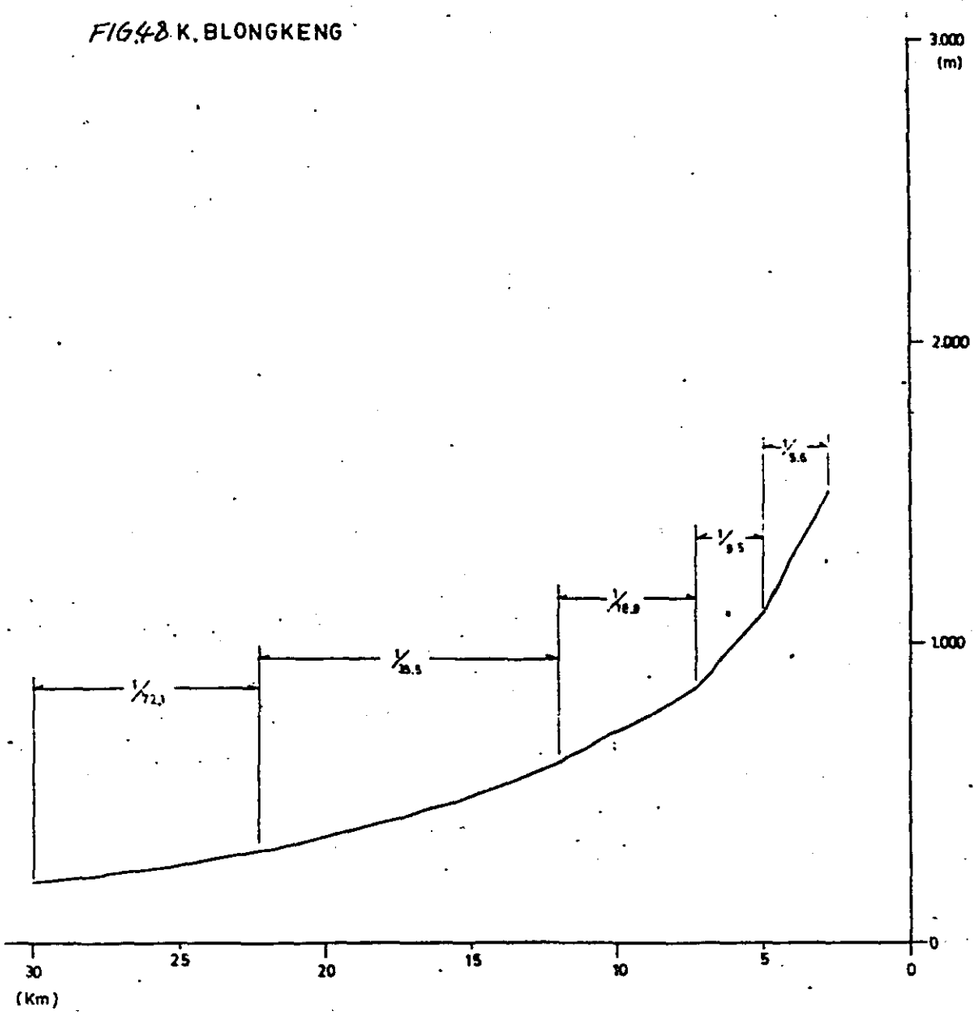


FIG.48 K.BLONGKENG



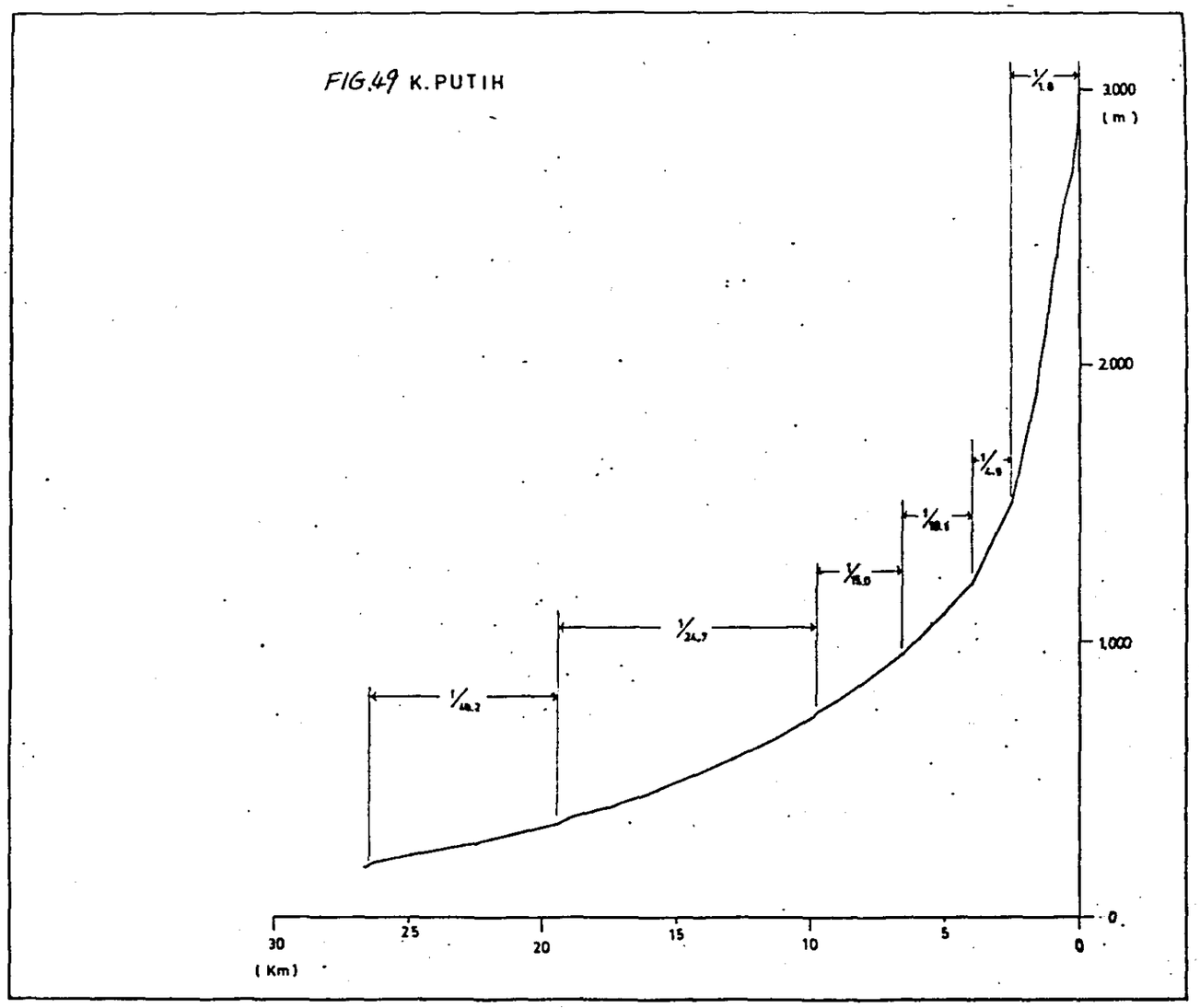


FIG.49 K.PUTIH
3.000
(m)
2.000
1.000
0
30
25
20
15
10
5
0
(Km)

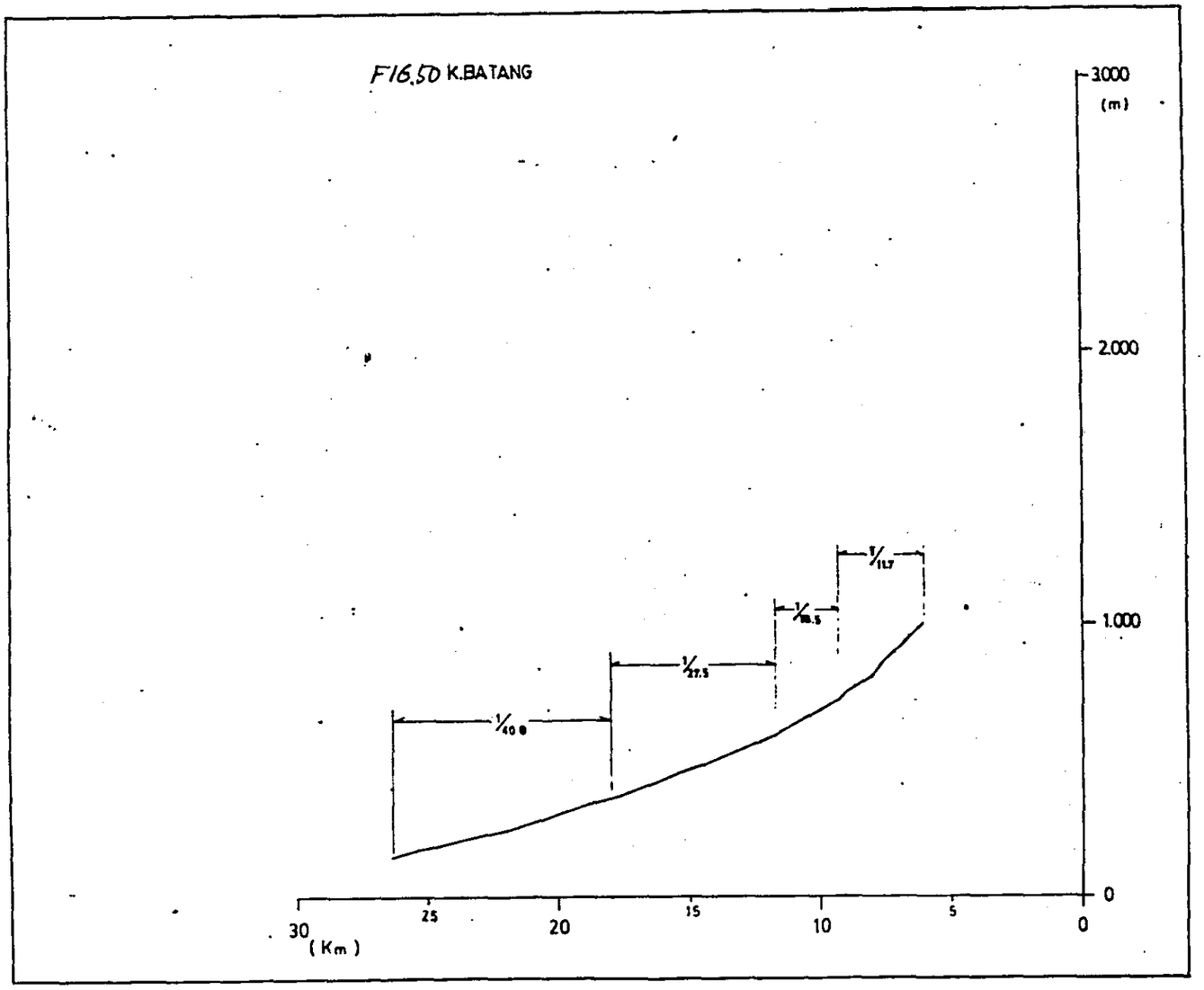
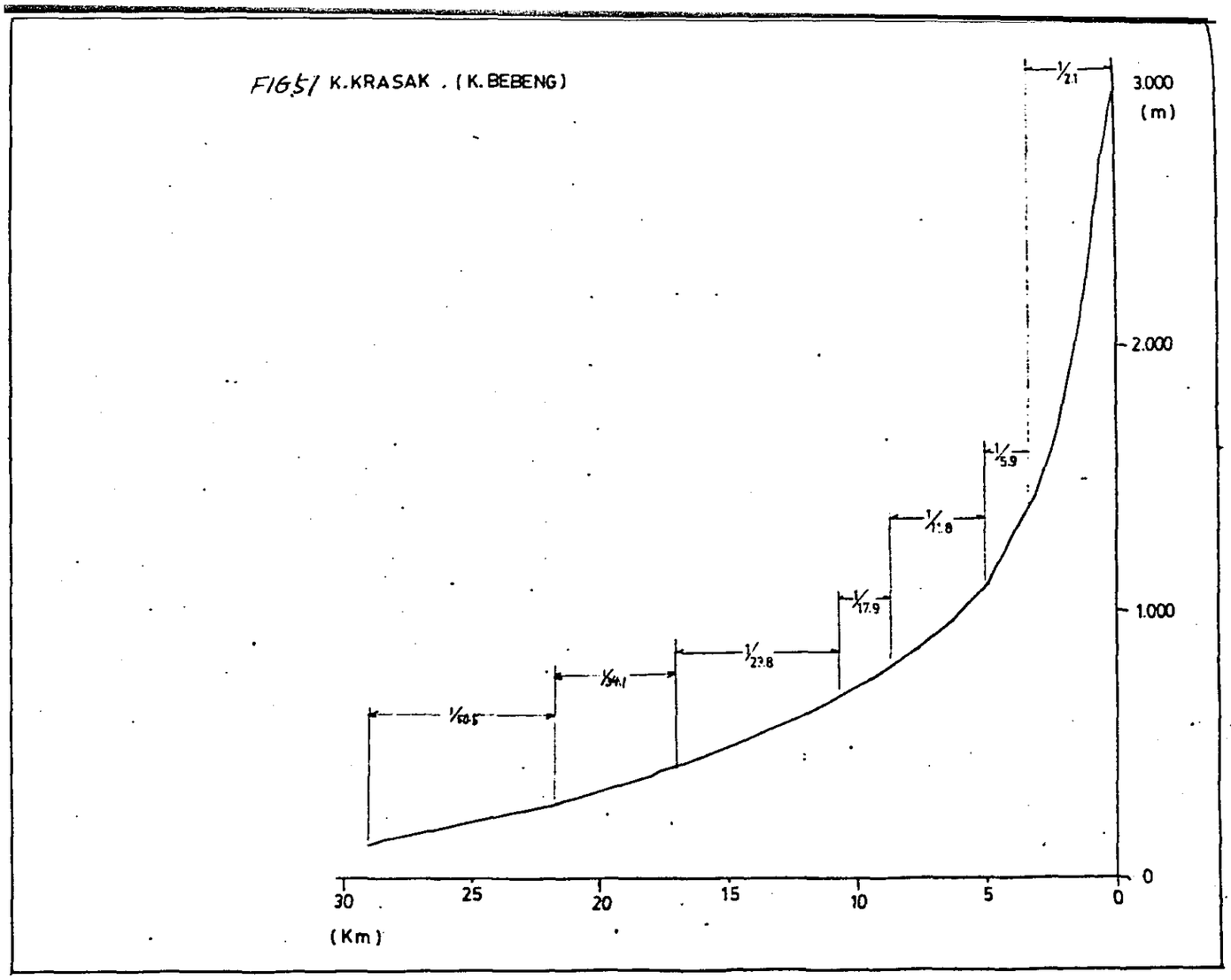
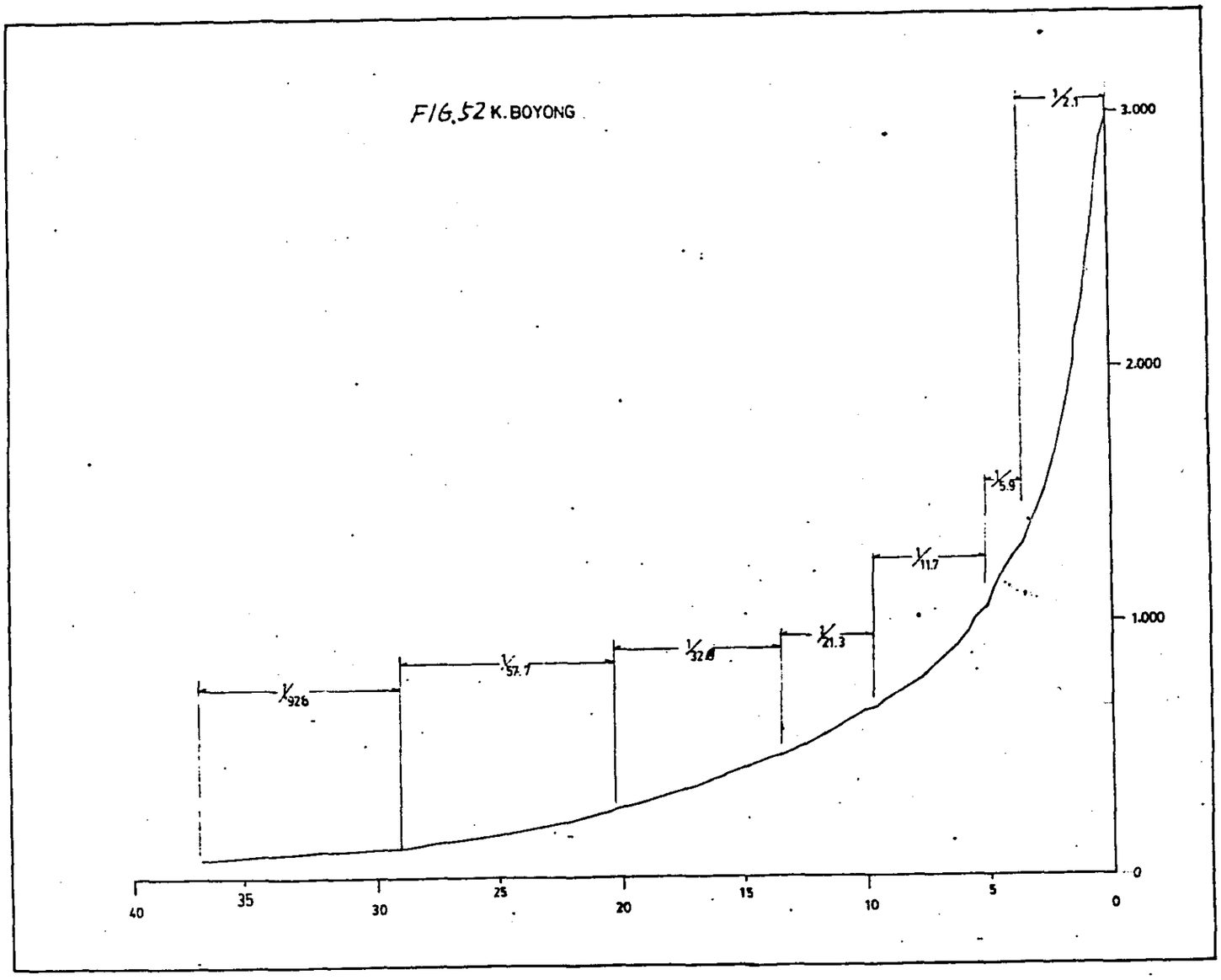


FIG.50 K.BATANG
3000
(m)
2.000
1.000
0
30
25
20
15
10
5
0
(Km)


F16.51 K.KRASAK . (K.BEBENG)
1/2.1
3.000
(m)
2.000
1/5.9
1/11.8
1/17.9
1.000
1/23.8
1/34.1
1/60.5
0
30
25
20
15
10
5
0
(Km)


F16.52 K.BOYONG
1/2.1
3.000
2.000
1/5.9
1/11.7
1.000
1/21.3
1/32.8
1/57.1
1/92.6
0
40
35
30
25
20
15
10
5
0

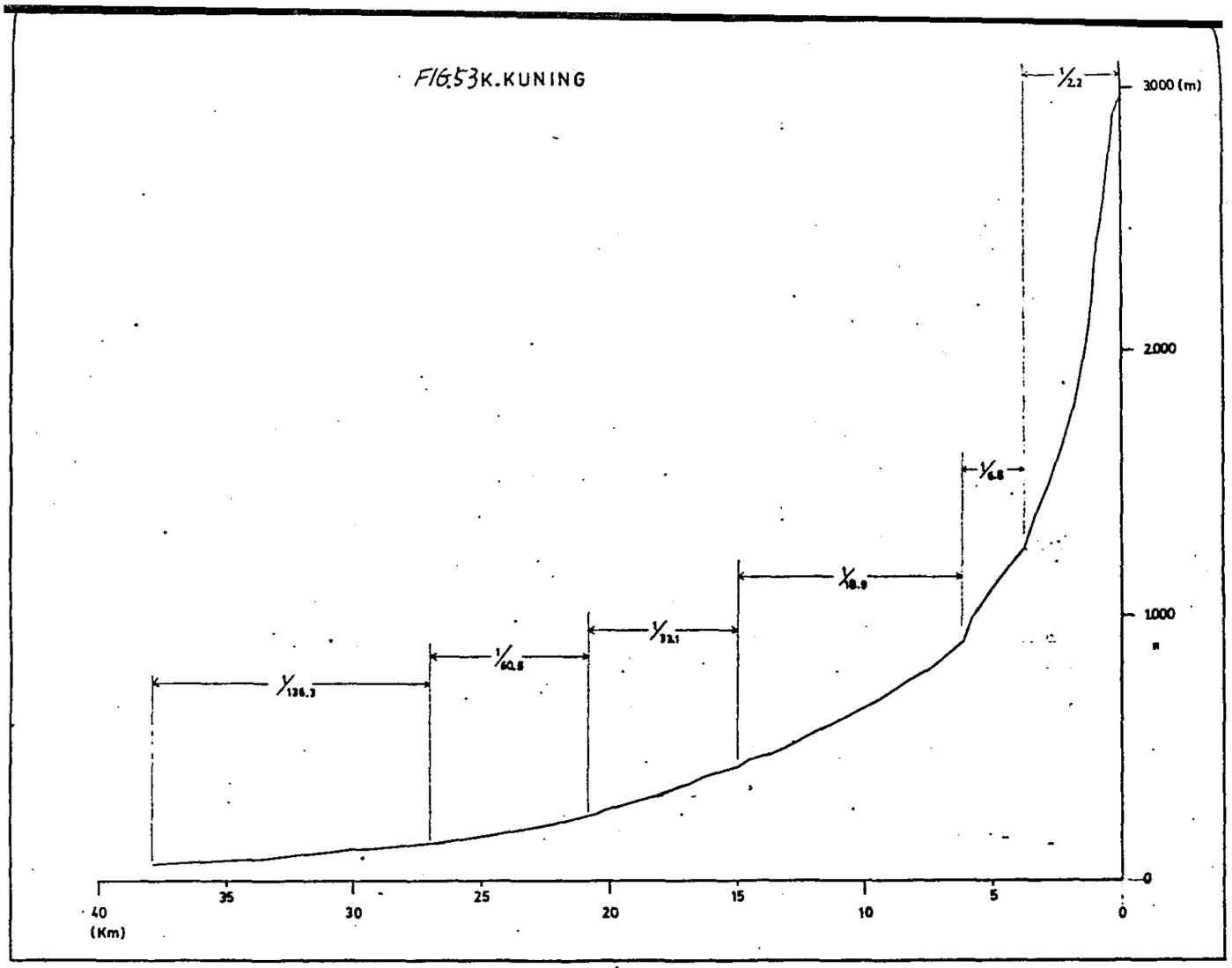


FIG.53 K.KUNING
1/2.2
3000 (m)
2000
1/6.8
1/18.9
1000
1/32.1
1/60.8
1/136.3
0
40
35
30
25
20
15
10
5
0
(Km)

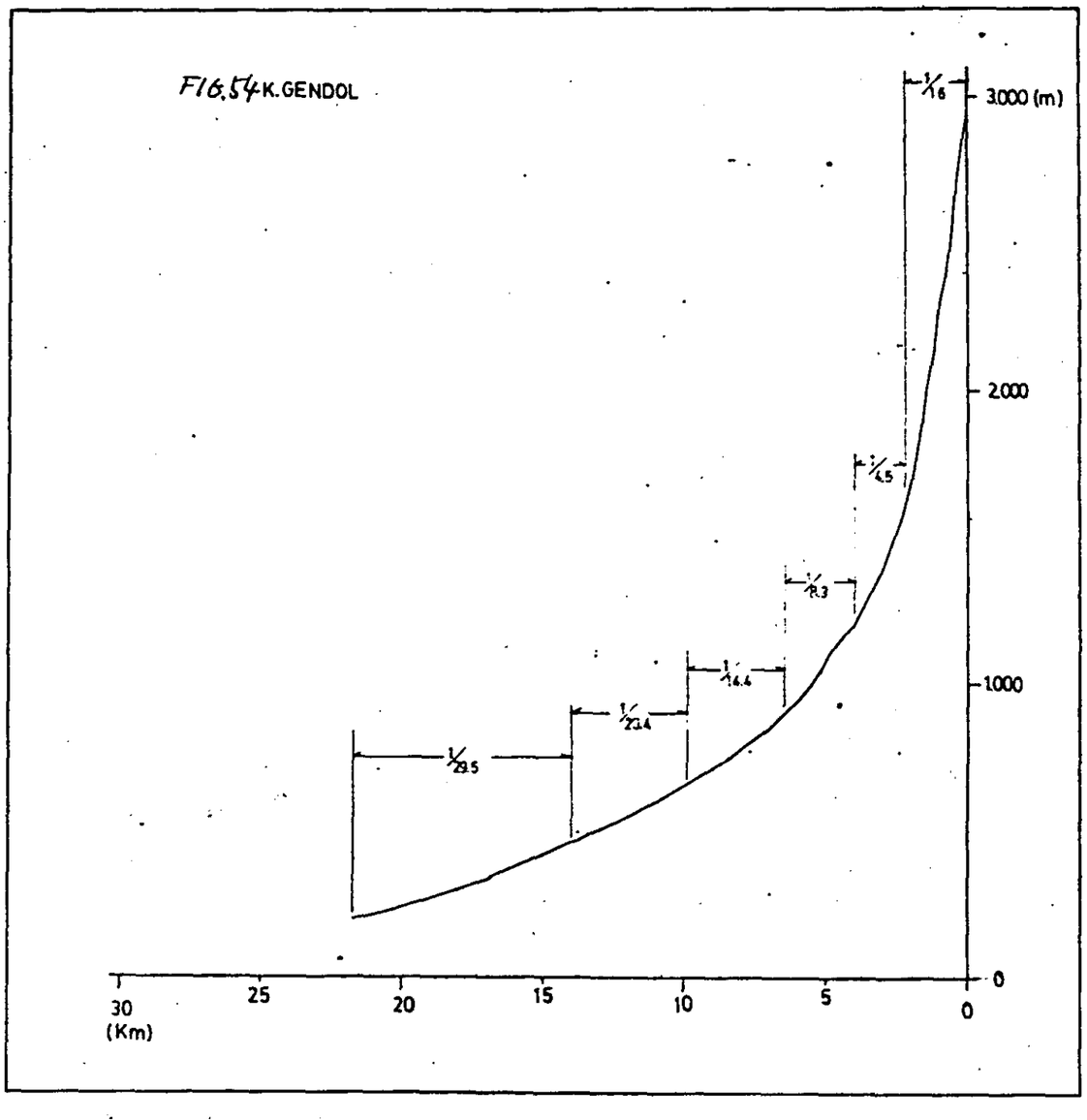


FIG.54 K.GENDOL
1/16
3000 (m)
2000
1/4.5
1/8.3
1/14.4
1000
1/23.4
1/29.5
0
30
25
20
15
10
5
0
(Km)

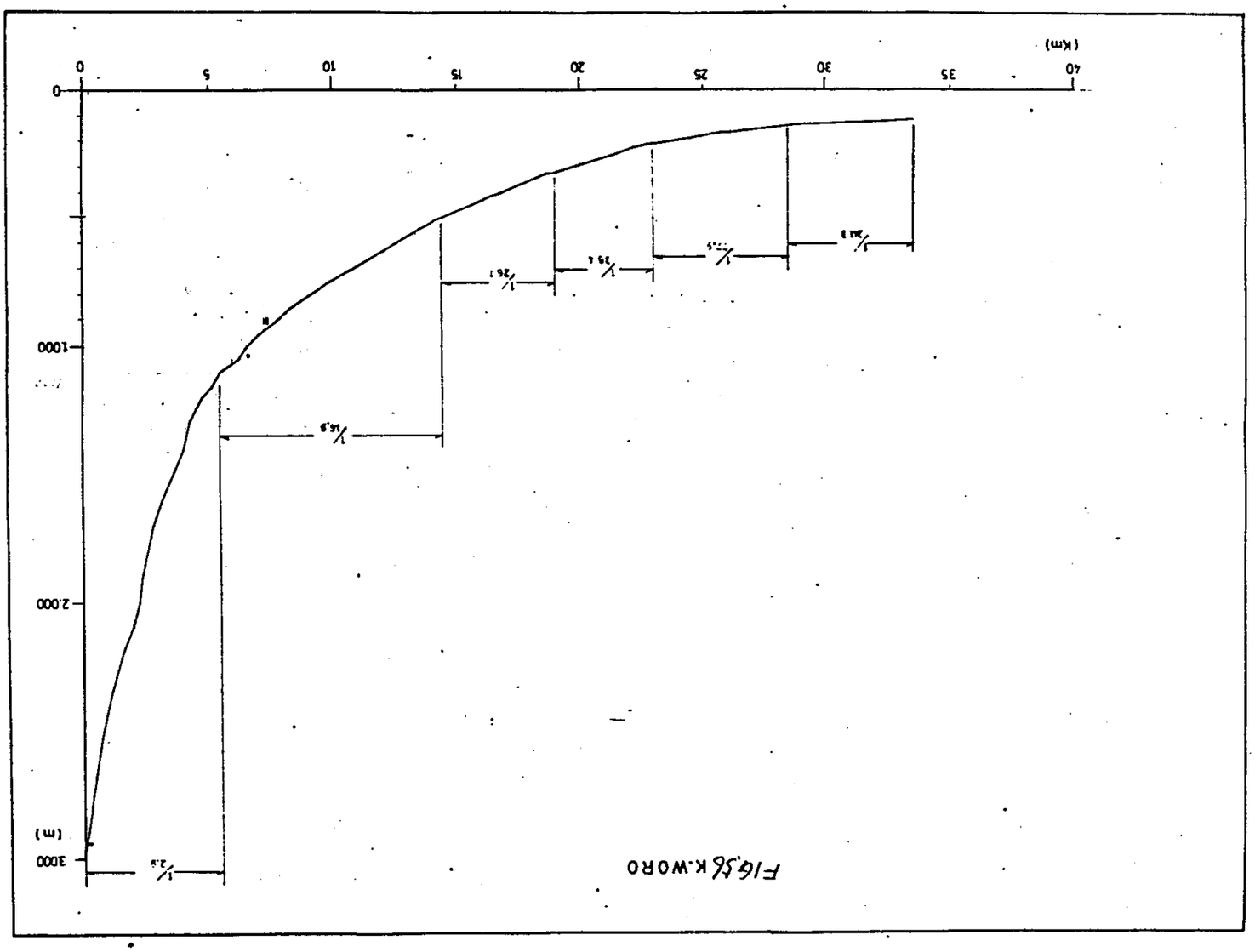


Fig.56 K.WORO

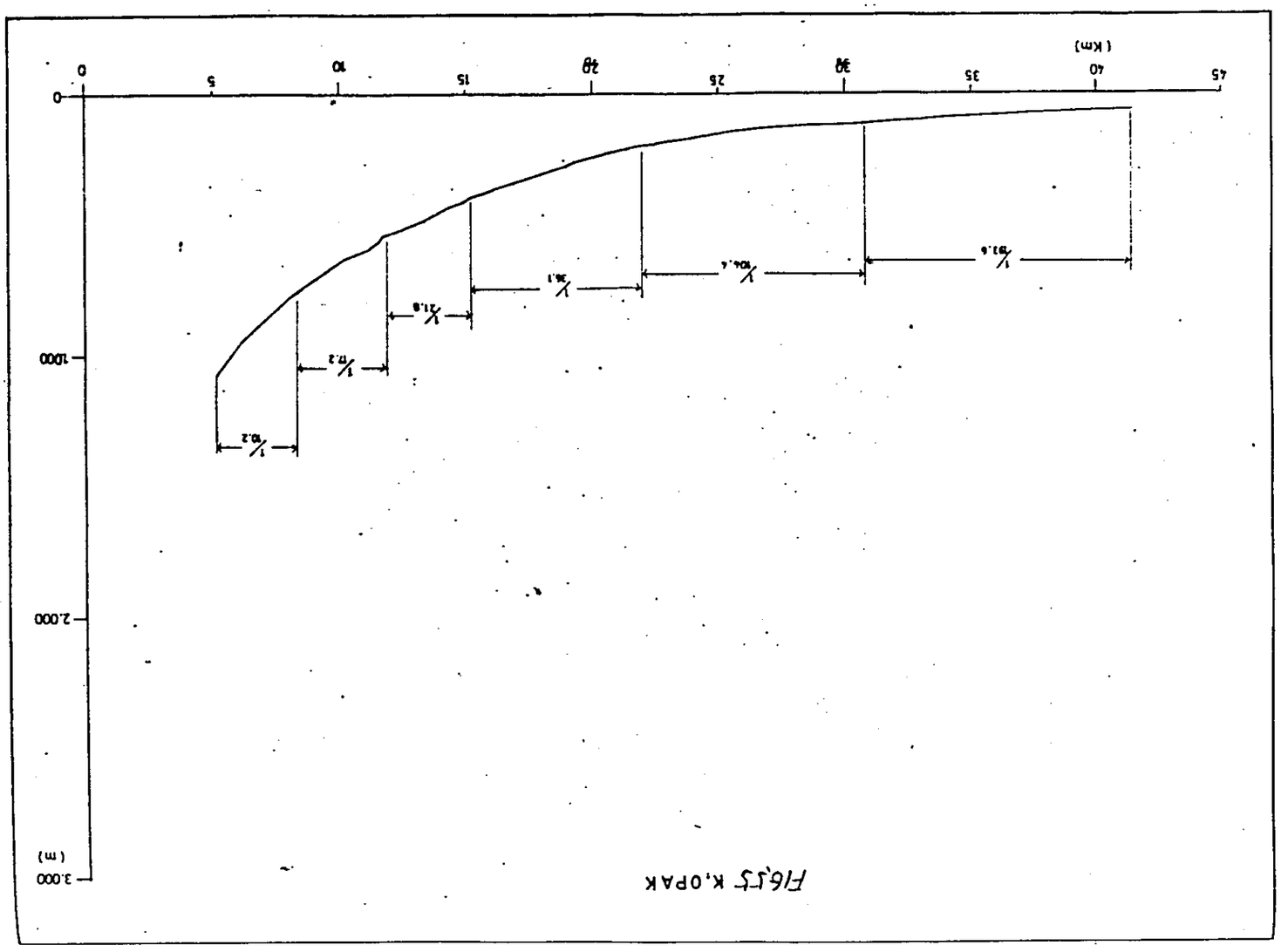


Fig.57 K.OPAK