SECTION 2 : RAINSTORM RUNOFF ON SLOPES 1984 - 1988

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FOREWORD

The Runoff Study was initiated in 1983 with the aim of evaluating the effect of different types of ground surface cover on runoff and infiltration on slopes. The impetus for the study was a recommendation given in the Soil Suction Study report by M.G. Anderson (GCO Publication No. 1/84). Monitoring of rainfall and runoff on seven man-made slopes commenced in 1984 and was continued until late 1988. The slope surface covers investigated were chunam, grass (both hydroseeded and turfed) and grass with shrubs and trees.

The measurements made in 1984 and 1985 were analysed previously and the results were presented in Special Project Report No. 5/86 by J. Premchitt, H.F. Lam and J.M. Shen.

In this report, the data collected from 1986 to 1988 are presented and analysed. They are also combined with the previous two years' records and re-analysed in order to derive conclusions from the full five years of monitoring.

Professor Anderson's initial input was invaluable in establishing the field sites and the framework of the study. Several GCO staff also made significant contributions to the work reported here, in particular Messrs J.M. Shen, A.J. Cooper and H.F. Lam. Most of the fieldwork was carried out very capably by the technical staff of the Special Projects Division, notably TO(G)s A.C.F. Chow, Y.W. Ng, C.K. Tai and H.T. Yu. The Highways Department, Architectural Services Department and Agriculture and Fisheries Department co-operated readily over the use of the sites. All these contributions are gratefully acknowledged.

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CONTENTS

1. INTRODUCTION

The Soil Suction Study by Anderson (1983) and the Mid-levels Study (GCO, 1982a) indicated that one of the most important aspects of slope hydrology with respect to slope stability and drainage is the effect of ground surface cover on runoff and infiltration for rainstorms of different intensity. Although some local studies of hillslope hydrology have been carried out (Government of Hong Kong, 1968; Hsu et al, 1983), their findings are not directly applicable to the majority of man-made slopes. In order to gather data and to establish the runoff and infiltration characteristics of typical formed slopes in Hong Kong, a runoff study was commissioned in 1983. Field monitoring was implemented in 1984 on seven man-made (cut and fill) slopes. These slopes are located at Clear Water Bay Road, Chuk Yuen, on the periphery of the site for the new University of Science and Technology (formerly the Kohima Barracks) in Sai Kung, and at Tsuen Wan. The surface covers examined are representative of all the main local types, viz chunam, grass (both hydroseeded and turfed) and grass with varying densities of shrubs and trees.

Rainfall and runoff were measured at each of these sites by installing weirs and raingauges. The potential infiltration was obtained by substracting the runoff from the rainfall. Instrumentation of five of the slopes was completed early in 1984 and data collection was initiated in the wet season of that year. Two additional sites were instrumented in 1985. The rainfall and runoff measurements made in 1984 and 1985 have already been analysed and reported by Premchitt et al (1986). The report included a statistical analysis of the field data and presented broad conclusions about the influence of rainfall intensity and different surface covers on infiltration and runoff.

In order to confirm the findings from the first report and to assess the effectiveness of the various slope protection covers over a longer period, the monitoring was continued from 1986 up to the end of 1988. The additional data collected covers a wider range of weather conditions and provides a larger data population for statistical analysis. In this report, the rainfall and runoff data measured from 1986 to 1988 are presented and analysed using methods similar to those used in Premchitt et al (1986) in order to provide a direct comparison of the results. The complete data set from all five years of monitoring are then grouped together and re-analysed. Relationships are developed which are useful for estimating the runoff and infiltration characteristics of slopes with different types of surface cover. The information provided should be of value for the estimation of erosion loss, suction and groundwater changes during rainstorms, and for the design of drainage systems.

2. BACKGROUND

2.1 General

A literature review of previous studies of runoff, infiltration and groundwater flow on slopes can be found in Premchitt et al (1986) and is not repeated here. Only definitions of terms and runoff models directly relevant to this report are described here.

2.2 Initial Abstraction, Infiltration and Runoff

The disposal of rainfall on a catchment during a storm is shown schematically in Figure 1. When rain falls on a natural slope surface, a portion of it is intercepted by the vegetation and is returned to the atmosphere by evapotranspiration. The water so retained is termed interception and, together with the depression storage and soil moisture, this constitutes the initial abstraction. All the slopes studied in this report are fairly steep and have reasonably uniform gradients, which means that the depression storage is likely to be low. The density of the surface vegetation cover on the grassed slopes is also relatively low. The initial abstraction on these slopes therefore can be considered to be small.

Infiltration is defined as the movement of water through the ground surface into soil or rock via the pores or interstices of the ground mass. Infiltration can be further divided into that part which is retained locally and that which is transported as interflow and as groundwater flow. The latter two parts eventually join the total runoff in streams and rivers. In this study, since runoff was measured immediately adjacent to the catchment, the contribution from interflow or groundwater flow to the measured runoff is considered to have been very small. The infiltration process can be studied by field infiltration tests. The infiltration capacity of a soil depends on many factors. Tests have indicated that the infiltration capacity for a bare soil under average summer conditions and after 1 hour of rain can vary from 0.25 mm/hr for heavy clayey soils to 25 mm/hr for loose sandy soils. A permanent forest or grass cover in good condition can increase these rates three to seven times (Linsley & Franzini, 1972).

Runoff is that portion of the rainfall that flows from a catchment into streams, lakes or seas. It consists of surface flow and groundwater flow, but the contribution of the latter component in this study as mentioned above is not significant. The amount of runoff in any catchment depends on a number of factors such as the condition and nature of soil and bedrock, the intensity and duration of rainfall, slope angle, surface cover and the antecedent conditions within the catchment. The amount or depth of runoff can be measured directly in the field in contrast to the crude determination of the other components. The proportion of rainfall that flows from a catchment to the total depth of rainfall over the catchment area is defined as the runoff coefficient.

2.3 Runoff Models

2.3.1 General

Runoff can be modelled in various ways. Three main types of runoff models are in common use and are briefly described in the following sections.

2.3.2 Φ-index

The Φ-index is defined as the rainfall intensity above which further rainfall would appear as runoff and below which the rain will be totally absorbed by initial abstraction and infiltration. This is shown schematically in Figure 2a. In other words, the Φ-index is the rate of rainfall above which the rainfall volume equals the runoff volume. For short-duration storms, the value of the Φ-index is affected by the catchment retention, the filling of natural depressions, infiltration and antecedent rainfall. As the duration of the storm increases, the effects of infiltration predominate until the soils become fully saturated. This model has been used by the Water Supplies Department (Government of Hong Kong, 1968) for forty-three storms in eight natural catchments. Various curve-fitting techniques were applied to the data, and from these the runoff corresponding to the limiting Φ-index was found to be between 50 % and 70 %. Therefore, assuming that infiltration takes place at the limiting rate and that 50 % of rainfall runs off, a rainfall intensity equal to twice the saturated permeability is necessary to create these conditions. A limiting Φ-index value of about 3 mm/hr for long-duration storms as shown in Figure 2b has been established. For short-duration rainfalls, the index can be as high as 80 mm/hr. Rainfalls of this intensity are not uncommon in Hong Kong (GCO, 1982a).

2.3.3 Multi-Variable Relationships

Runoff is obviously not only a function of the rainfall amount but is also dependent on other factors like antecedent rainfall, rainfall duration and intensity. The relationships between these parameters and their relative effects on runoff can be analysed statistically (Osborne & Lane, 1961; Hsu et al, 1983; Linsley et al, 1982). This approach, however, is purely mathematical and no explanation of the physical significance of the equation is given.

2.3.4 Rainfall-Runoff Relationships

The simplest rainfall-runoff model is a two-variable plotting of the rainfall amount versus resulting runoff. This simple approach has been developed and established for a great variety of catchments by the Soil Conservation Service (SCS) of the US Department of Agriculture (Soil Conservation Service, 1972). This semi-empirical method is based on the assumption that the ratio of runoff to the rainfall in excess of initial abstraction is equal to the ratio of rainwater retained in the soil to the potential maximum retention. The SCS expression derived for runoff in terms of rainfall and the potential maximum retention is given in Appendix A. On the basis of this assumption, a set of typical curves is obtained as a function of the curve number (CN), as shown in Figure 3. CN is a dimensionless number related to the potential maximum retention (Appendix A). For a wholly impervious surface CN equals 100, but it is generally much less for natural surfaces.

This technique has been used fairly extensively in hydrological studies and in infiltration estimation (Overton & Meadows, 1976; Hawkins, 1978; Aron et al 1977). Examples of CN values for different surface cover types, soil types, land use and antecedent rainfall conditions are given in Premchitt et al (1986).

3. FIELDWORK

3.1 Description of Sites

A detailed description of the seven sites selected for the study is given by Premchitt et al (1986). Only a brief outline is given here.

A location map of the seven slope sites is given in Figure 4 and the information pertinent to the slope conditions is summarised in Table 1. Of the seven sites, six are weathered granite cut slopes and one is a compacted volcanic soil fill slope. The six granite cut slopes are grouped in three pairs at sites on Clear Water Bay Road, at Chuk Yuen and at Tsuen Wan. The volcanic fill slope is on the periphery of the Kohima Barracks in Sai Kung. A detailed plan of each of the slopes is provided in Figures 5 to 10.

The runoff catchment areas under study at the slope sites are all broadly rectilinear in plan and vary in size from 260 to 710 m^2. Slope angles vary widely from 28 to 60°. Well-defined drainage systems consisting of stepped channels and U-channels were installed on these slopes prior to the runoff measurements. These slopes have no horizontal drains or any subsurface drainage measures which could alter the normal groundwater conditions. On the basis of piezometer measurements and absence of surface seepage, the permanent groundwater table is inferred to be low at all the sites.

The two sites at Clear Water Bay Road are about 200 m apart. One of them is chunamed (CWA) and the other is covered with grass and some trees (CWB). The two grassed slopes at Chuk Yuen are contiguous. One of them is hydroseeded (CYA) and the other is turfed (CYB). Scattered shrubs are present as well as the grass cover on these slopes. The compacted fill slope at Kohima Barracks (KOH) has a number of trees on the slope as well as the grass cover. Both slopes at Tsuen Wan (TWA and TWB) are covered with grass and trees and they are less than 200 m apart.

It is known that the planting methods used at the Chuk Yuen sites (CYA and CYB) were hydroseeding and turfing respectively. The details for the other vegetated slopes are not certain, but it is likely that the initial grass covers on the three cut slopes (TWA, TWB and CWB) and the fill slope (KOH) were all established by turfing. The trees on the Tsuen Wan slopes (TWA and TWB) appear to have been planted, whereas the trees at Kohima Barracks (KOH) and Clear Water Bay Road (CWB) have probably grown naturally.

The results of a survey of the number and intensity of trees and shrubs, density of grass and condition of chunam on the seven slopes carried out in 1986 are summarised in Table 2. The chunam condition on slope CWA was classified as poor on the scale of bad-poor-average used in the CHASE study (GCO, 1982b). Some cracks were noted on the chunam surface but most of them were very narrow with openings limited to less than 0.5 mm. The trees found on slopes CYA, CYB and KOH were all less than 2 m tall, and only 25 % of the trees on slope CWB were taller than 2 m. About 29 % of the trees on the two slopes TWA and TWB were less than 2 m in height. The highest grass density was found on slope KOH whereas the lowest was on slope CYB. The species of vegetation for each slope are listed in Table 3.

The condition of the surface covers was reviewed again in October, 1989. Recent photographs are shown in Plates 1 to 7. No distinctive difference was noted for the condition of the chunam on slope CWA. Almost all of the trees on slopes CWB, KOH, TWA and TWB now had heights in excess of 2 m whereas little change was noted on slopes CYA and CYB. Trees on slope CWB were particularly dense with their canopies overlapping each other. The grass density on all the slopes was found to be high except for slope TWB (see Plate 7).

A limited number of field infiltration and permeability tests were carried out at these sites in 1986. Infiltration tests were carried out at each site but variable-head permeability tests (GCO, 1987) were limited to only the slopes at Clear Water Bay Road (CWA and CWB). In the infiltration tests, an infiltrometer consisting of a metal tube 200 to 300 mm in diameter was forced into the soil to a depth of about 0.5 m with a few centimetres projecting above the soil surface. Water was poured into the tube, and the rate of disappearance was measured. For the weathered granite slopes, the permeability values were established to be in the range of 20 to 55 mm/hr (6 to 15×10^{-6} m/s). The permeability of the volcanic fill slope KOH was lower, in the region of 6.4 mm/hr (1.8×10^{-6} m/s).

3.2 Instrumentation

To measure runoff, a stilling basin including a V-notch weir as shown in Figure 11 was installed at each site. A Clarke automatic water level recorder with a one revolution per day clock was used. The V-notch weirs were constructed locally and the weir angles varied from 17° for the Clear Water Bay slopes (CWA and CWB) to 60° for the Kohima Barracks slope (KOH). These weirs were calibrated after installation and the constants derived were used to compute the runoff. The calibration constants are given in Premchitt et al (1986). Rainfall data were taken from nearby GCO raingauges, the locations of which are shown in Figures 5 to 10. At Chuk Yuen, where the existing raingauges were relatively far away, autographic gauges were installed near the site in June, 1985. In all cases, the distance to the closest raingauge was less than 250 m.

3.3 Data Collection

The 15-minute rainfall was taken as the basic unit for the analyses. For each rainfall event, a series of 15-minute rainfall data for the relevant time period was extracted and entered into a computer.

Field visits were made once a week during the wet seasons to collect runoff data at all sites and to collect rainfall data from the autographic raingauges. Runoff and rainfall were estimated from the graph sheets collected from the site recorders.

4. MONITORING RESULTS AND ANALYSIS

4.1 Runoff Determination

In the report by Premchitt et al (1986), the data were analysed using the Government Data Processing Agency's (GDPA) mainframe ICL 2988 computer via the terminal in the GCO. With the advent of micro-computers, it has become much more convenient and efficient to use them for analysis. All the analyses contained in this report were carried out using micro-computers.

The technique of evaluating runoff from the hydrographs collected from sites has been described in detail in Premchitt et al (1986). As a general rule, the site hydrographs were first digitised using a digitizer and a micro-computer into time and water height co-ordinates, and runoff was then computed from these co-ordinates making use of the appropriate formula and the weir constants derived from field calibration. Runoff hydrographs for two adjacent rainstorms were separated by adopting a cut-off at the low stage level of 5 mm as used in the previous analysis.

Selected rainfall events were used in the analysis. Those events which lacked adequate records were excluded. These were mostly cases in which the recorders had failed to operate or the recording paper was found to be tilted. For the TWA slope at Tsuen Wan, little reliable data was collected because the stilling basin was found to be leaking soon after installation. Although several attempts were made to salvage the basin, there was little success. For this reason, the data collected from this site have not been included in the following analyses.

4.2 Rainfall Frequency Distribution

All the basic rainfall and the calculated runoff data collected from 1986 to 1988 are summarised in the tables in Appendix B. The statistics of the 1986 to 1988 rainfall events for the six slope sites are given in Figures 12 to 17. These figures show the distributions of the number of events with respect to rainfall amount, maximum rainfall intensity, rainfall duration and 5-day antecedent rainfall. The distributions of rainfall amount and rainfall duration are skewed to the left, indicating that there were only a few heavy rainstorms but a large number of light rain events in these few years.

The 1986 to 1988 data have been combined with the previous two years' data. The distributions of the number of events with respect to rainfall amount, maximum rainfall intensity, rainfall duration and 5-day antecedent rainfall from 1984 to 1988 are shown in Figures 18 to 23. These are similar to the 1986 to 1988 data.

4.3 Φ-index Analysis

The Φ-index analysis was carried out in accordance with the method outlined in Section 2.3.2. For each rainstorm event, the total rainfall in excess of a chosen intensity (Φ-index) was calculated iteratively with different Φ-index values until it was within 1.0 % of the actual measured runoff. The series of 15-minute rainfall data was used in the calculation.

The average Φ-index value is a good indicator of the relative imperviousness of the slope cover. A large Φ-index indicates that conditions of heavy infiltration and relatively low runoff prevail on the slope, and vice-versa. The average Φ-index values established previously for the 1984 to 1985 data and the values computed for the 1986 to 1988 data are plotted and compared for the different slopes in Figure 24. The overall average values based on the complete five-year data are also included in Figure 24 to give an indication of the longer-term infiltration and runoff characteristics of the slopes.

Based on the 1984 to 1985 data, it can be seen that among the six slopes investigated, the largest runoffs occurred on the chunamed slope CWA which had the smallest average Φ-index value of 1.8 mm/hr. The least runoff was on the grassed slope CWB and the turfed slope CYB, both of which had average Φ-index values of around 17.0 mm/hr. In between are the average Φ-index values for the slopes CYA, KOH and TWB. The values for these slopes were close, in the range of 9.9 to 14.1 mm/hr.

In comparing the 1984 to 1985 data with the data collected from 1986 to 1988, some changes in the runoff patterns on the six slopes are observed. While the largest runoff from 1986 to 1988 was still on the chunamed slope CWA (average Φ-index value of 3.2 mm/hr), the least runoff occurred on the hydroseeded slope CYA and the turfed slope CYB. The average Φ-index values for these slopes were 19.4 mm/hr and 22.1 mm/hr. The average Φ-index values for the other grassed slopes CWB and KOH, and the tree-covered slope TWB, were in the range of 14.3 to 14.8 mm/hr. Over the years, the average Φ-index value for the chunamed slope CWA has increased by 7.8 %. An increase in the average Φ-index values is also observed for slopes CYA, CYB, KOH and TWB, with a percentage increase of 96 %, 32 %, 26 % and 4 % respectively, signifying that on these slopes runoff has been reducing with time. The largest percentage Φ-index increase is on the hydroseeded slope CYA, whereas the smallest is on the tree-covered slope TWB. The average Φ-index value decreased only on the grassed slope CWB, with a percentage change of 15 %.

For the combined data set from 1984 to 1988, the average Φ-index is 2.7 mm/hr for the chunamed slope CWA. For the grassed slopes CWB, CYA, CYB and KOH, the average values become 15.2 mm/hr, 16.2 mm/hr, 20.3 mm/hr and 13.8 mm/hr respectively. The average value for the tree-covered slope TWB is 14.5 mm/hr.

For comparison purposes, all the Φ-index values derived from the 1986 to 1988 data are plotted against rainfall duration in Figure 25 in the same way as is given in the Geotechnical Manual for Slopes (GCO, 1984, Figure 2b). The upper limit for natural catchments given in the Geotechnical Manual is also included. The general conclusion that there is a limiting Φ-index value of 3 mm/hr for long-duration storms in natural catchments does not appear to be relevant to these man-made slopes. While Figure 25 might be interpreted as showing a slight overall decrease in Φ-index with duration, the main conclusion from this analysis is that the Φ-index values remain essentially constant, at least for durations up to 30 to 40 hours. An upper limit of 50 mm/hr is appropriate to contain most of the 1986 to 1988 data, in comparison with the upper limit of 40 mm/hr used for the 1984 to 1985 data points (Premchitt et al, 1986). The same observation is noted when the complete five-year data are used to produce the Φ-index versus rainfall duration plot shown in Figure 26.

4.4 Multiple Regression Analysis

Multiple regression analysis was carried out to identify the degrees of correlation between runoff and rainfall parameters, namely rainfall amount, rainfall duration, maximum rainfall intensity and antecedent rainfall. The standard SPSS statistical package (Norusis, 1988) for micro-computers was used for the analysis.

Results of the regression analysis of the 1986 to 1988 data and the five-year data from 1984 to 1988 for the six slopes are summarised in the tables given in Appendix C. Regression coefficients relevant to each equation are also included in the tables.

A one-to-one regression analysis between runoff and each of the rainfall parameters was first performed. For all slopes, it was established that the best correlation is with the rainfall amount and the poorest is with the antecedent rainfall. The correlation coefficient relating runoff and rainfall amount for the six slopes is shown in Figure 27. Based on the 1986 to 1988 data, the correlation coefficient varies from 0.889 for the grassed slope KOH to 0.991 for the chunamed slope CWA. The percentage change in the correlation coefficient between the 1984 to 1985 data and the 1986 and 1988 data is also included in Figure 27. On the whole, the change has not been substantial, with the maximum percentage change lying in the range of ± 5.0 %. The correlation coefficients for the five-year data from 1984 to 1988 are also given in the same figure for comparison.

Regression analyses for two, three and four variables were also carried out. All combinations of the parameters were investigated (Appendix C). The sets that give the highest correlation are extracted and given in Table 4. In the table, the correlation coefficients derived previously from the 1984 to 1986 data, the 1986 to 1988 data and the five-year data from 1984 to 1988 are included for comparison. As a general rule, the rainfall amount is still the best parameter that correlates with runoff. With more variables added to the equations, there is some improvement to the overall correlation coefficients but the changes are not great.

The equations provided in Appendix C can be used to estimate runoff but it should be emphasised that these are only mathematical relationships. No physical explanation of the significance of each individual parameter is provided in these equations.

4.5 Rainfall-Runoff Relationships

As confirmed in the regression analysis above, the parameter that gives the best correlation with runoff is the rainfall amount. The addition of other parameters yields only a marginal improvement to the prediction of runoff.

Rainfall can be simply related to runoff by the runoff coefficient, which is defined as a ratio of runoff to rainfall amount. Generally, when rainfall is less than 40 mm, irrespective of duration, initial losses are high : the runoff coefficients for this range of rainfall are relatively small but highly scattered. The coefficients tend towards a more uniform value at higher rainfall. The average runoff coefficients for rainfall greater than 50 mm are a good indicator of the relative imperviousness of the slopes.

Figure 28 shows the average runoff coefficients for rainstorms greater than 50 mm based on the 1986 to 1988 data and the five-year data from 1984 to 1988. The values established previously for the 1984 to 1985 data are also given for comparison.

Based on the 1984 to 1985 data, the chunamed slope CWA had the highest average runoff coefficient of 0.93, in comparison with the least runoff coefficient of 0.27 for the grassed slope CWB. The average runoff coefficients for the other slopes were between 0.66 and 0.40.

The results of the analysis of the 1986 to 1988 data also indicate that the average runoff coefficient is highest for the chunamed slope CWA and lowest for the grassed slope CWB. There is, however, a slight reduction in the runoff coefficient value for the chunamed slope CWA, the grassed slopes CYA, CYB and KOH, and the tree-covered slope TWB when compared with the 1984 to 1985 values. The percentage decrease is 9 %, 5 %, 15 %, 30 % and 4 % respectively. Only runoff on the grassed slope CWB has increased and the change is 19 %. On the basis of the five-year (1984 to 1988) data, the runoff coefficients are 0.86 for the chunamed slope CWA, 0.30, 0.55 and 0.36 respectively for the grassed slopes CWB, CYA and CYB, 0.54 for the grassed compacted volcanic fill slope KOH and 0.53 for the tree-covered slope TWB.

The rainfall-runoff relationship discussed in Section 2.3.4 can also be used to provide a simple and sufficiently accurate method for the estimation of runoff.

The rainfall-runoff relationships for the 1986 to 1988 data obtained in the study are shown in Figures 29 to 32 for the six slopes. In these figures, SCS curves are used to contain the data. Two SCS curves are drawn for each slope to define the envelopes which contain 90 % of all the data. For the chunamed slope CWA, the data are within the CN values 100 and 90, in comparison with the CN values 85 and 55 for the adjacent grassed slope CWB. For the other grassed slopes CYA and CYB, CN values of 100 and 75, and 85 and 60 are used. The data for the compacted volcanic fill slope KOH are within CN values 100 and 70 and those for the tree-covered slope TWB are contained by CN values 100 and 75.

The rainfall-runoff relationships for the five-year data from 1984 to 1988 are given in Figures 33 to 36. CN values similar to those used for the 1986 to 1988 data are applicable.

The ranges of CN values used for the six slopes for the 1984 to 1985 and 1986 to 1988 data are compared in Figure 37. For the chunamed slope CWA, the CN values 100 and 95 are modified to 100 and 90 in order to contain the 1986 to 1988 data. Similarly, for the grassed slopes CYA and KOH, and the tree-covered slope TWB, slightly lower limits of the CN values of 75, 70 and 75 are found to be applicable. No change in the CN values is noted for the grassed slopes CWB and CYB.

The envelopes established from all the slopes for the five-year data 1984 to 1988 are plotted in Figure 38a. They reflect the long term rainfall-runoff characteristics of the slopes. The curves cover the range of CN values from 100 to 55. The data from the chunamed slope CWA are within the CN values 100 and 90. The two grassed slopes CWB and CYB are grouped together with their data defined by CN values 85 and 55. The data from the hydroseeded slope CYA, on the other hand, are contained by the same curves as those of the other two slopes KOH and TWB, defined by CN values 100 and 70. From these relationships, potential infiltration on these slopes can be evaluated by simply substracting runoff from the rainfall. The results are plotted in Figure 38b. They represent the maximum infiltration that may occur on the slope in a rainstorm of up to 250 mm.

5. DISCUSSION

5.1 Runoff Analysis

Three different approaches have been used in the analysis of runoff, namely the ø-index, multiple regression and direct rainfall-runoff relationship. Each approach gives a similar prediction of runoff and they could all be used in practice. The choice depends on the application and the available rainfall data. For the multiple regression approach, it should be noted that the regression equations and the parameters derived from them are obtained from mathematical analysis, and do not represent actual physical processes and quantities. They provide useful indications of rainfall-runoff relationships but must be used with caution.

5.2 Effects of Different Surface Covers on Runoff and Infiltration

Analysis of the data has confirmed the common belief that a chunam cover is much more effective in promoting runoff and reducing infiltration on slopes compared with the vegetated covers. While the upper bounds of the SCS curves for the two vegetated slopes (CYA and KOH) are also drawn at a CN value of 100 (Figures 34 and 35), it can be seen that there are only few data points close to the upper limit and generally there is a much greater spread of data points towards the lower CN values when compared with the chunamed slope. The average ϕ-index values in Figure 24 confirm this conclusion.

Among the vegetated slopes, runoff and infiltration characteristics depend on both the species of vegetation and the process of planting. When all the slopes are considered, it appears that there is no obvious general relationship between the initial grass density and the amount of runoff produced (Table 2 and Figure 38) : this is probably masked by the influence of other factors such as the variable tree cover, grass species type and slope geometry. The most instructive comparison is between the adjacent slopes with a hydroseeded cover (CYA) and turfed cover (CYB), where an appreciable difference in the long-term rainfall-runoff characteristics is noted. More runoff has consistently been recorded on the former slope. This difference is mainly attributable to the types of grass planted on the slopes as well as the process of planting. As listed in Table 3, imported Bermuda and Bahia grasses were used on the hydroseeded slope CYA, whereas local grasses Panic and Hilo were planted on the turfed slope CYB. Bermuda and Bahia grasses have an extensive root system. The roots can spread and extend to a much greater depth than the local grasses. A higher stem count per square metre had already been recorded on slope CYA by Premchitt et al (1986) (see Table 2). In hydroseeding, the seeds are injected onto the slope surface, and as a result, a larger number are planted as compared with the normal density of turfing. The process of hydroseeding under a pressurised jet is also thought to have the overall effect of densifying the surface soil, thus reducing the infiltration.

Runoff characteristics are also dependent on the density and species of the trees. As discussed by Greenway (1987), trees with a high water consumption and a deep root system can extract more moisture from the soil and can affect the runoff and infiltration characteristics of large catchments where runoff responses are slow. On the other hand, for a given tree type and for the small catchments considered in this study where runoff responses are relatively short-term, increasing tree density will not necessarily lead to reduced runoff because the effects of a greater tree canopy in promoting runoff at canopy level may outweigh the effects of soil moisture extraction. This is discussed further in the following section.

5.3 Changes in Runoff with Time

The availability of the five-year data allows temporal changes in the rainfall-runoff characteristics of the six slopes to be investigated. Over the years, runoff on the chunamed slope CWA has decreased, possibly due to minor deterioration of the chunam. Cracking of chunam as a result of shrinkage could reduce the effectiveness of chunam cover in preventing infiltration. A crack model has also been proposed by Anderson (1983) for determining the effective permeability of chunam as a function of the intact permeability of chunam and the crack spacing. This parameter can be used for evaluating the rate of deterioration of chunam, but the data obtained in this study do not permit a quantitative assessment of this aspect.

A reduced amount of runoff is noted on the vegetated slopes CYA, CYB, KOH and TWB. This reduction is attributable mainly to the increase of the density of vegetation and the maturity of trees on these slopes but could also be due to the changing surface soil conditions (e.g. an increased soil surface permeability). Only runoff on the grassed slope CWB has been found to increase with time. This difference is possibly due to the recent rapid growth of the tree canopy on slope CWB. In the period between 1984 and 1985, trees on the slope were small with little canopy cover. However, there was a great change in the later period from 1986 to 1988 when the trees became more mature with their canopies fully overlapping. With a full canopy, more runoff was generated by raindrop aggregation at the canopy level, resulting in less fine rain being intercepted by the surface vegetation. In comparison, the tree cover on slope TWB was dense from the beginning of the study in 1984. For this slope, there was no great change in canopy cover since 1984 and hence only a small change in the runoff characteristics during the past five years.

5.4 Implications for Slope and Surface Drainage Design

The relationships developed in Section 4.5 can be used directly in slope and surface drainage design. Either the runoff coefficients given in Figure 28 or the rainfall-runoff relationships in Figure 38 can be used for the estimation of runoff. The rainfall-runoff curves include important characteristics of runoff processes and have been established on the basis of extensive overseas experience (SCS, 1972; Overton & Meadows, 1976; Hjelmfelt, 1980) as well as the field data measured in this study. In using these relationships, it is prudent to adopt a high limit of runoff for surface drainage design and a high limit of infiltration (corresponding to a low limit of runoff) for stability analysis and design of slopes.

On the basis of the findings given in the report, it becomes clear that the recommendations in the Geotechnical Manual for Slopes (GCO, 1984) with respect to slope and surface drainage design are too generalised. In slope stability design, Section 4.4.3 of the Manual recommends that the rainfall intensity for the design storm should be equal to the saturated permeability of the soil forming the slope surface multiplied by a factor of 2 to take account of runoff. As mentioned in Section 2.3.2, this factor of 2 (or a runoff coefficient of 0.5) is established primarily on the basis of the measurements made by the Water Supplies Department for forty-three storms in eight natural catchments. As seen in Figure 28, while the factor of 2 is relevant to the hydroseeded and some of the grass/tree-covered slopes (slopes CYA, KOH and TWB), a lower factor of around 1.5 would be more appropriate for the turfed slope CYB and the slope covered with grass and a few trees (CWB). This implies that a lower rainstorm intensity should be used in design for certain types of vegetated slopes. Until more data are available to confirm these findings (in respect of density, species type, and planting processes), it would be prudent to use a general multiplier of 1.5 times the soil permeability for the design rainfall intensity on vegetated slopes.

For surface drainage design, Section 8.2.1 of the Geotechnical Manual for Slopes recommends that the "Rational Method" (Linsley & Franzini, 1972) should be adopted because of its simplicity and its applicability to relatively small catchments in Hong Kong (Tin, 1969). In the method, the maximum runoff is computed as follows :

$$Q = \frac{k\ i\ A}{3600}$$

where Q is the maximum runoff in litres per second, i is the design mean intensity of rainfall in mm per hour, A is the catchment area in square metres and k is the runoff coefficient. The Manual recommends a value of 1.0 for the runoff coefficent. As discussed in the Manual, use of this value will generally result in an overestimation of runoff, especially on vegetated slopes, and lead to overdesign of drainage systems. For small drainage channels, this additional capacity is not usually of major economic concern and is considered to be beneficial in that it makes allowance for siltation. Nevertheless, if slope drainage systems could be designed such that siltation and the possibility of debris causing blockage can be minimised, then lower values of runoff coefficients could be used. From the results of this study, runoff coefficients ranging from 0.3 to 0.5 for slopes covered with vegetation and approximately 0.9 for chunamed slopes given in Figure 28 would be applicable.

5.5 Limitations

This report has covered the runoff and infiltration characteristics of six slopes. They represent all the commonly-encountered surface covers in Hong Kong and the results should be applicable to other slopes with similar characteristics. However, it should be noted that the soil types on these slopes are limited to decomposed granite (grades III to V) and one volcanic fill slope. Other common soil types (e.g. insitu decomposed volcanics) are not represented. Also the slopes examined do not cover those with large upslope catchment areas or high base groundwater tables. Caution should be used when applying these results to other slope types and settings.

6. CONCLUSIONS

Rainfall and runoff have been measured on six man-made slopes with different surface covers over a five-year period from 1984 to 1988. The data for the last three years of recording have been analysed in this report and the results compared with those previously reported by Premchitt et al (1986) on the basis of the data from the first two years. An overall analysis of the complete five-year data has also been made.

The main conclusions of this study are :

(a) Among the slope surface covers investigated, chunam is the most effective in preventing infiltration on slopes, followed by the groups of hydroseeded grass and grass with abundant tree cover, and then the turfed grass.

(b) The runoff from all slopes has been found to be largely dependent on the rainfall amount, while other parameters such as antecedent rainfall and duration contribute small secondary effects.

(c) On all the vegetated slopes, there are high initial losses at low rainfall of about 10 to 40 mm, when almost no runoff is produced, and a gradual increase in runoff at higher rainfall. The initial loss is interpreted to be a small surface abstraction plus a large initial infiltration. The relatively small losses at high rainfall could be infiltration at the limiting rate.

(d) The broad recommendations in the Geotechnical Manual for Slopes (GCO, 1984) with regard to groundwater levels for slope design and design of surface drainage systems could be refined as a result of this study. For assessment of groundwater levels using the wetting-band approach, a design storm intensity of 1.5 times the saturated soil permeability is considered to be an appropriate conservative value for vegetated slopes. For surface drainage design, appropriate runoff coefficients for granitic soil cut slopes with a surface cover of chunam, hydroseeded grass or grass with trees, and turfed grass are 0.9, 0.5, and 0.3 respectively. For a compacted volcanic fill slope with turfed grass cover, the runoff coefficient is 0.5. However, these values do not make any allowance for siltation or drain blockage.

(e) The runoff characteristics of grass-covered slopes depend largely on the method of planting, and to a lesser extent, the species. A hydroseeded slope cover is found to be more effective in generating runoff than a turfed cover.

(f) With one exception, runoff on all the slopes has been found to decrease with time. This general decline is due largely to the deterioration of the chunam cover or changing surface conditions on the vegetated slopes since the time of slope formation (e.g. increase in vegetation density, increased surface soil permeability). Over a period of five years, the average runoff coefficient on the chunamed slope CWA decreased by 9 %. On the vegetated slopes, the reduction varied from 4 % for the tree-covered slope TWB (which showed the least increase in vegetation density) up to 30 % for the turfed grass slope KOH (compacted fill). For the anomalous case (grassed slope CWB), the 19 % increase in the runoff coefficient was probably due to rapid growth of the tree canopy towards the end of the monitoring period.

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LIST OF TABLES

Table 1 - Characteristics of the Slopes and the Instrumentation

Code	Slope	Plan Area (m^2)	Slope Angle (deg)	Soil Type	Surface Covering / Vegetation ▲	Raingauge Used	Distance from Raingauge (km)	Weir Angle (deg)
CWA	Clear Water Bay Rd A	280	60	Highly / completely decomposed granite	Chunam	N08	0	17
CWB	Clear Water Bay Rd B	260	45	Highly / completely decomposed granite	Grass with some trees	N08	0.20	17
CYA	Chuk Yuen A	410	35	Highly decomposed granite	Grass (hydroseeded)	K02 ✱	0.95 (0.21)	24
CYB	Chuk Yuen B	410	35	Highly decomposed granite	Grass (turfed)	K02 ✱	0.99 (0.24)	24
KOH	Kohima Barracks	710	30	Volcanic fill	Grass with some trees	N16	0	65
TWA★	Tsuen Wan A	530	30	Highly / completely decomposed granite	Grass with dense trees	N03 ✱	1.21 (0.19)	22
TWB	Tsuen Wan B	330	28	Moderately / highly decomposed granite	Trees with some grass	N03 ✱	0.97 (0.03)	22

Legend :
✱ Autographic raingauges were used to supplement the GCO automatic raingauges
★ Data from this slope were not used in the analysis (see Section 4.1)
▲ Condition as of 1989

Table 2 - Conditions of Surface Covers at the Seven Slopes Observed in 1986

Slope	Well-developed Trees More Than 2m High		Shrubs & Immature Trees Less Than 2m High		Estimated Density of Grass (Root stems/m²)
	No.	Average Spacing (m)	No.	Average Spacing (m)	
CWB	7	6.1	21	3.5	600 - 800
TWA	70	2.8	20	5.0	300 - 1100
TWB	72	2.1	21	4.0	500 - 650
CYA	-	-	15	- *	500 - 700
CYB	-	-	25	- *	400 - 500
KOH	-	-	68	6.0	1000 - 1900
CWA (Chunam)	There are cracks generally less than 0.5mm wide with a few cracks up to 4mm wide. The total crack length is about 6000mm/m², this is classed as 'poor' condition on the scale of bad - poor - average used by Anderson (1983)				

Legend :

* Shrubs are concentrated in a few groups, not evenly distributed

Notes:
(1) Data based on field observation and measurements on 9.7.1986.
(2) Photographs of the slope covers are shown in Plates 1 to 7.
(3) Other details of the slopes are given in Table 1.

Table 3 - Species of Vegetation on the Slopes

Slope	Vegetation	
	Common Name	Scientific Name
CWB	Golden Fern Weeping Love Oriental Blechnum Slash Pine Horsetail Tree	Pityrogramma tartarea Eragrostis curvula Blechnum orientale Pinus elliottii Casuarina sp.
CYA	Bermuda Grass Bahia Grass Weeping Love	Cynodon dactylon Paspalum notatum Eragrostis curvula
CYB	Panic Grass India Duck - beak Hilo Grass	Panicum sp. Ischaemum indicum Paspalum conjugatum
KOH	Panic Grass India Duck - beak Slash Pine	Panicum sp. Ischaemum indicum Pinus elliottii
TWA	Bur Grass Yellow Oleander (60 %)* Elephant's Ear (30 %) Lebbek Tree (10 %)	Achyranthes sp. Cenchrus echinatus L. Thevetia peruviana Macaranga tanarius Albizia lebbek
TWB	Hilo Grass Beggar Weed Hairy Bur-Marigold Acacia (90 %) Horsetail Tree (10 %)	Paspalum sp. Desmodium tortuosum Bidens pilosa Acacia confusa Casuarina equisetifolia

Legend :

* Percentages relate to relative numbers of trees only

Table 4 - Summary of the Results from Multiple Regression Analysis

Slope	No. of Variables	Multiple Correlation Coefficients		
		1984-85	1986-88	1984-88
CWA	1	0.985	0.991	0.990
	2	0.986	0.992	0.991
	3	0.987	0.993	0.991
	4	0.987	0.993	0.991
CWB	1	0.851	0.893	0.873
	2	0.926	0.898	0.893
	3	0.930	0.900	0.899
	4	0.933	0.900	0.900
CYA	1	0.952	0.938	0.947
	2	0.961	0.942	0.947
	3	0.963	0.942	0.947
	4	0.964	0.932	0.944
CYB	1	0.946	0.932	0.937
	2	0.954	0.947	0.947
	3	0.955	0.956	0.948
	4	0.956	0.954	0.948
KOH	1	0.927	0.889	0.898
	2	0.933	0.917	0.900
	3	0.941	0.924	0.900
	4	0.942	0.924	0.902
TWB	1	0.962	0.959	0.956
	2	0.979	0.967	0.963
	3	0.979	0.968	0.964
	4	0.976	0.968	0.965

Note : The coefficients given in the table are extracted from Appendix C. They represent the highest correlations of each set. Coefficients for the regression equations are included in the appendix.

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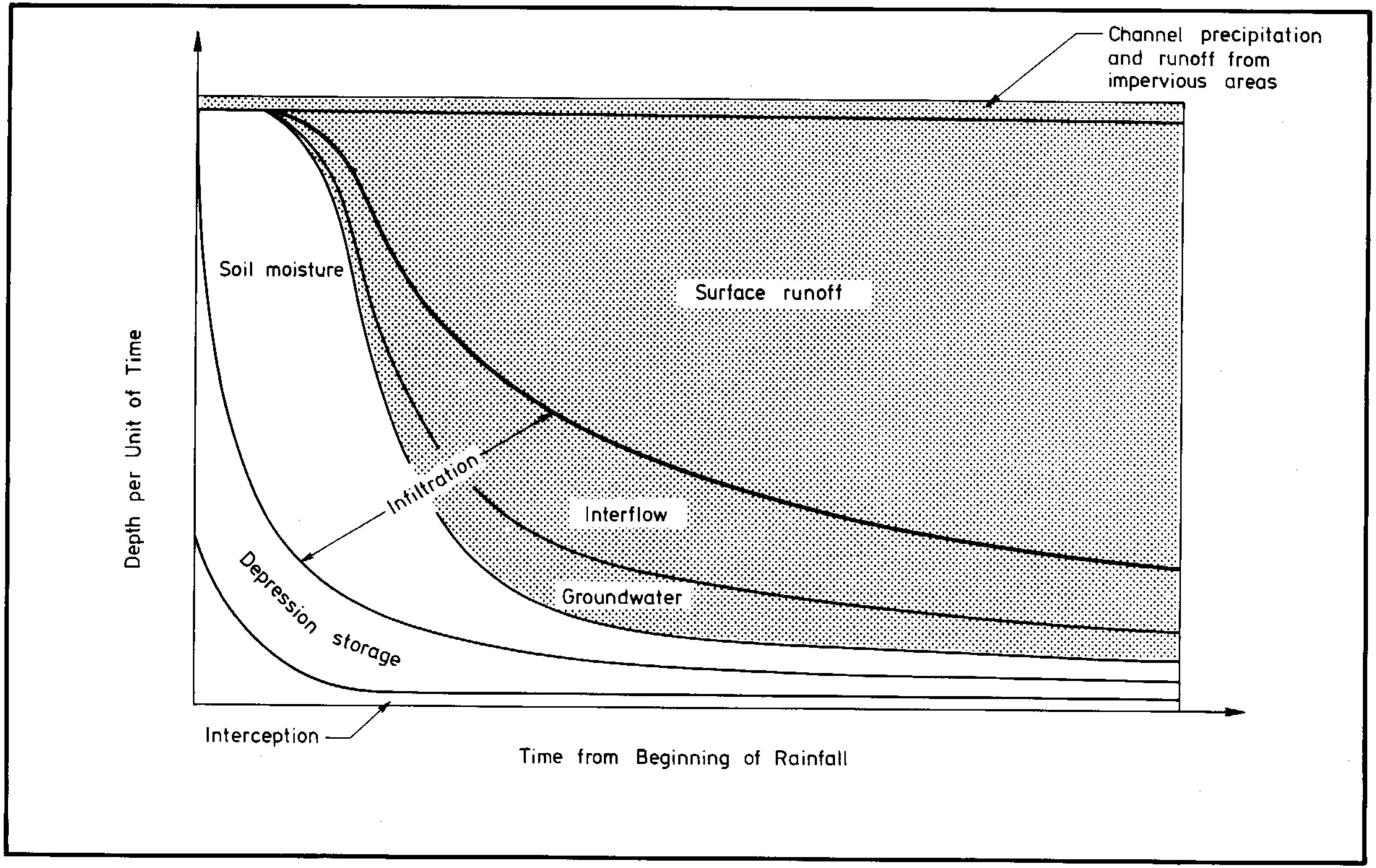
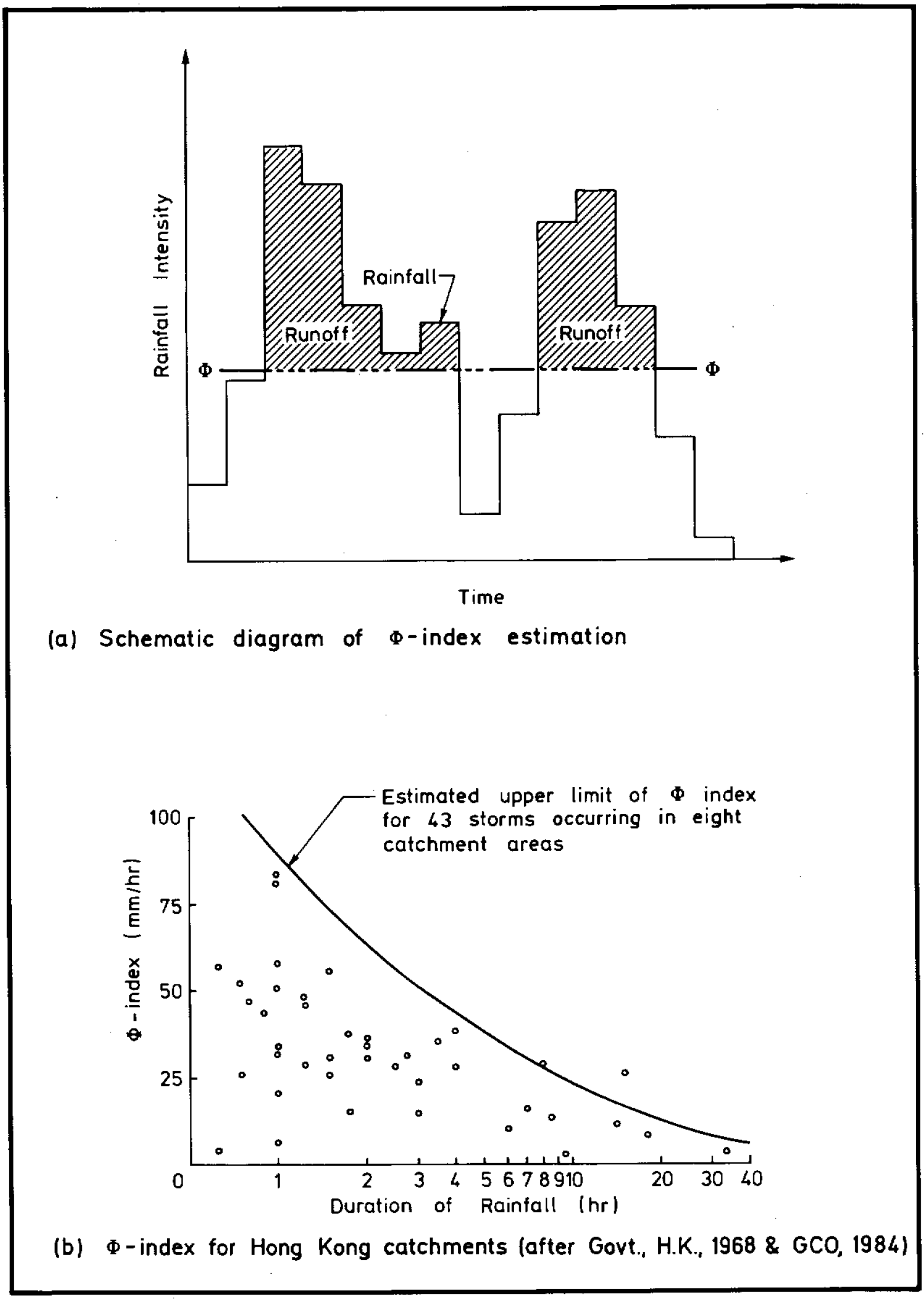


Figure 1 - Schematic Diagram of the Components of Storm Rainfall (after Linsley et al, 1982)



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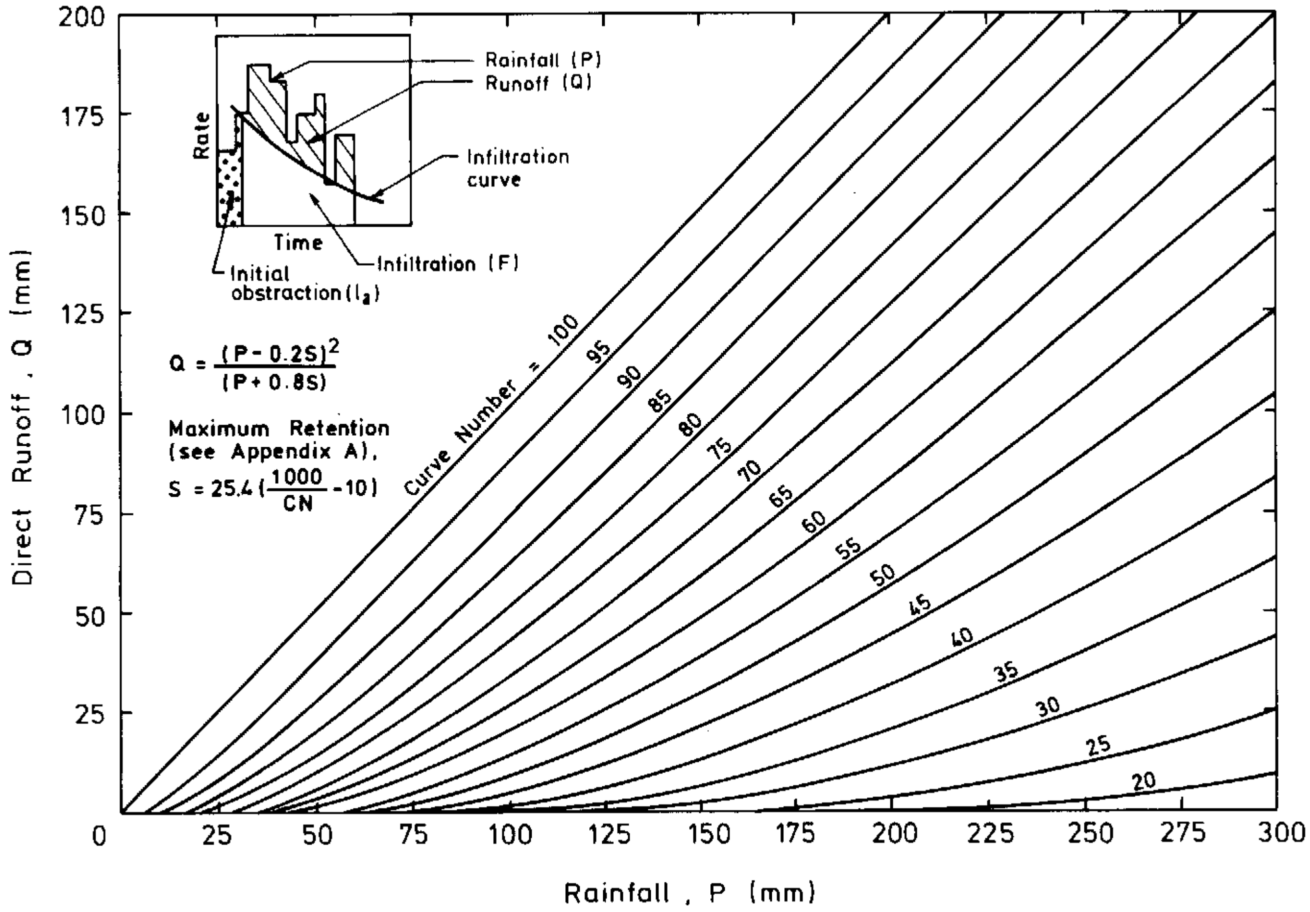

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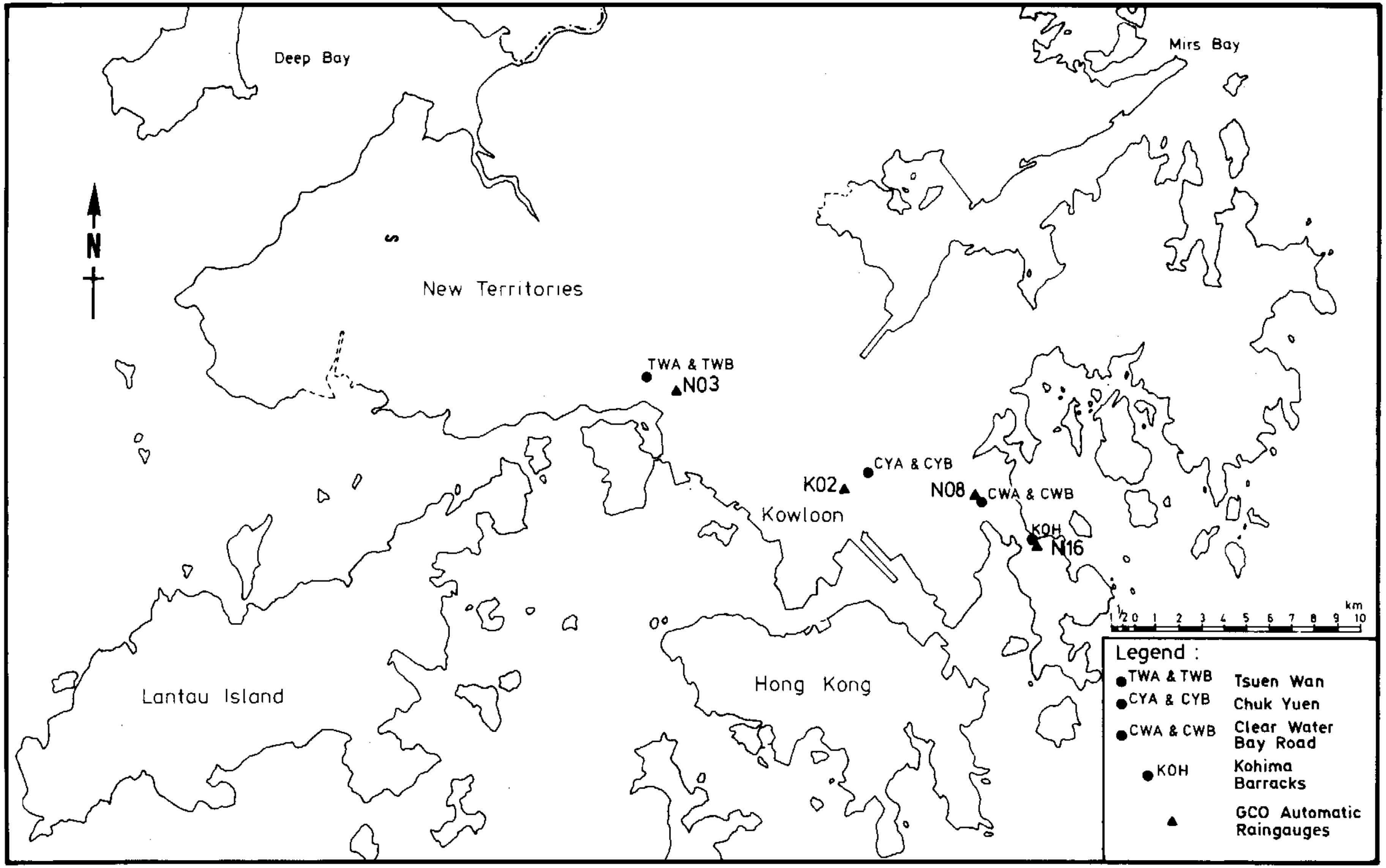

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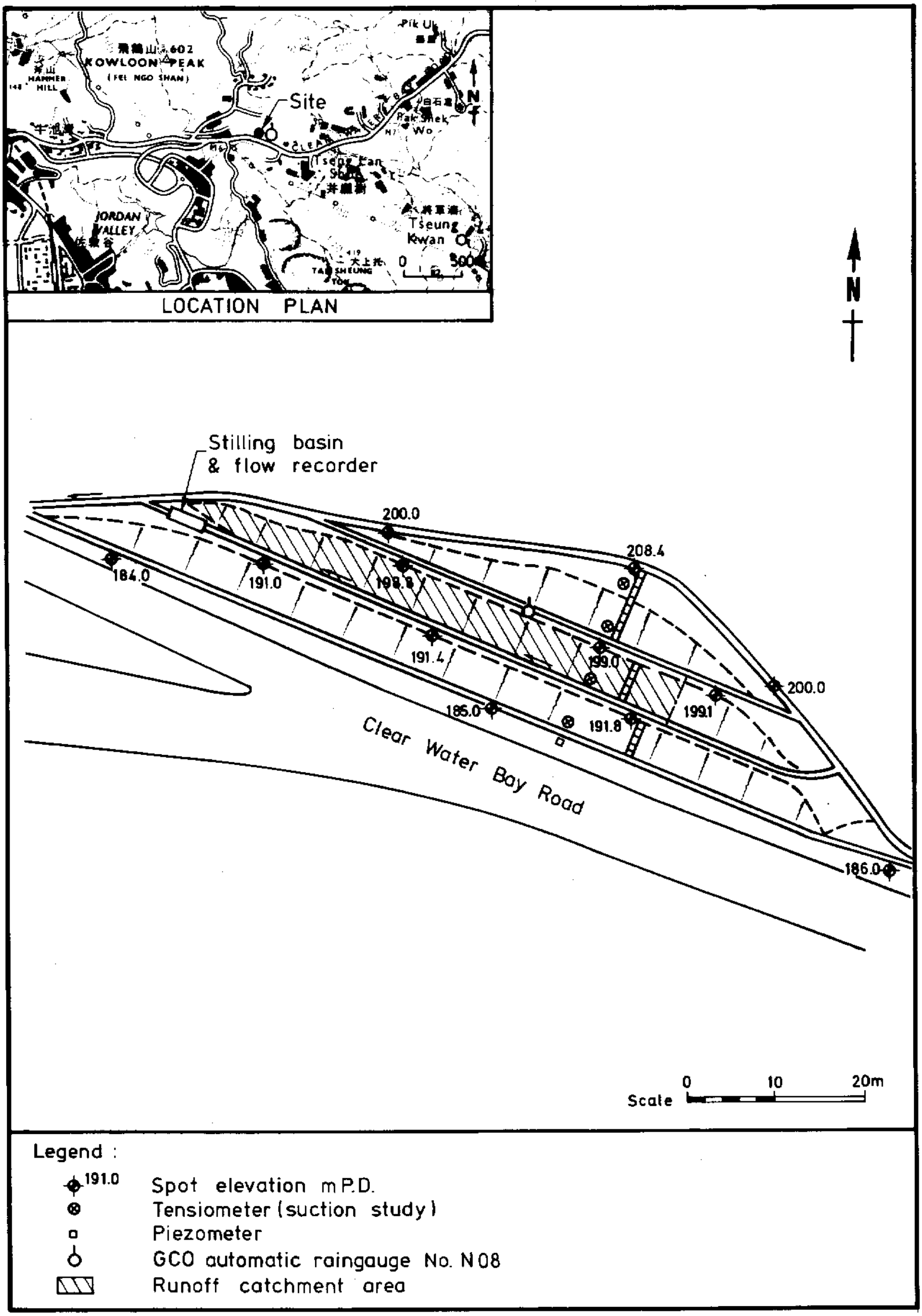
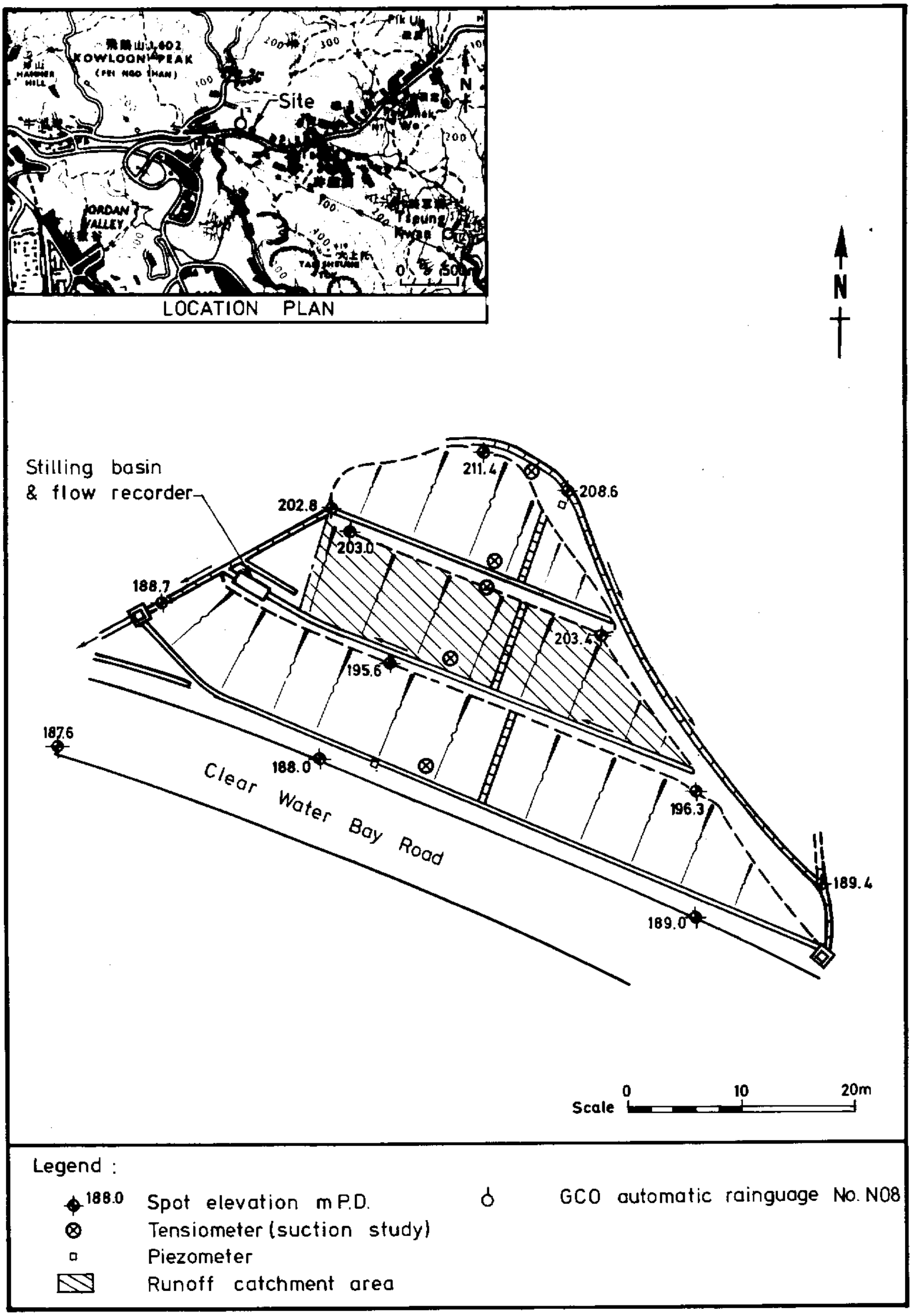


Figure 5 - Site Plan for the Runoff Plot at Clear Water Bay Road (CWA)



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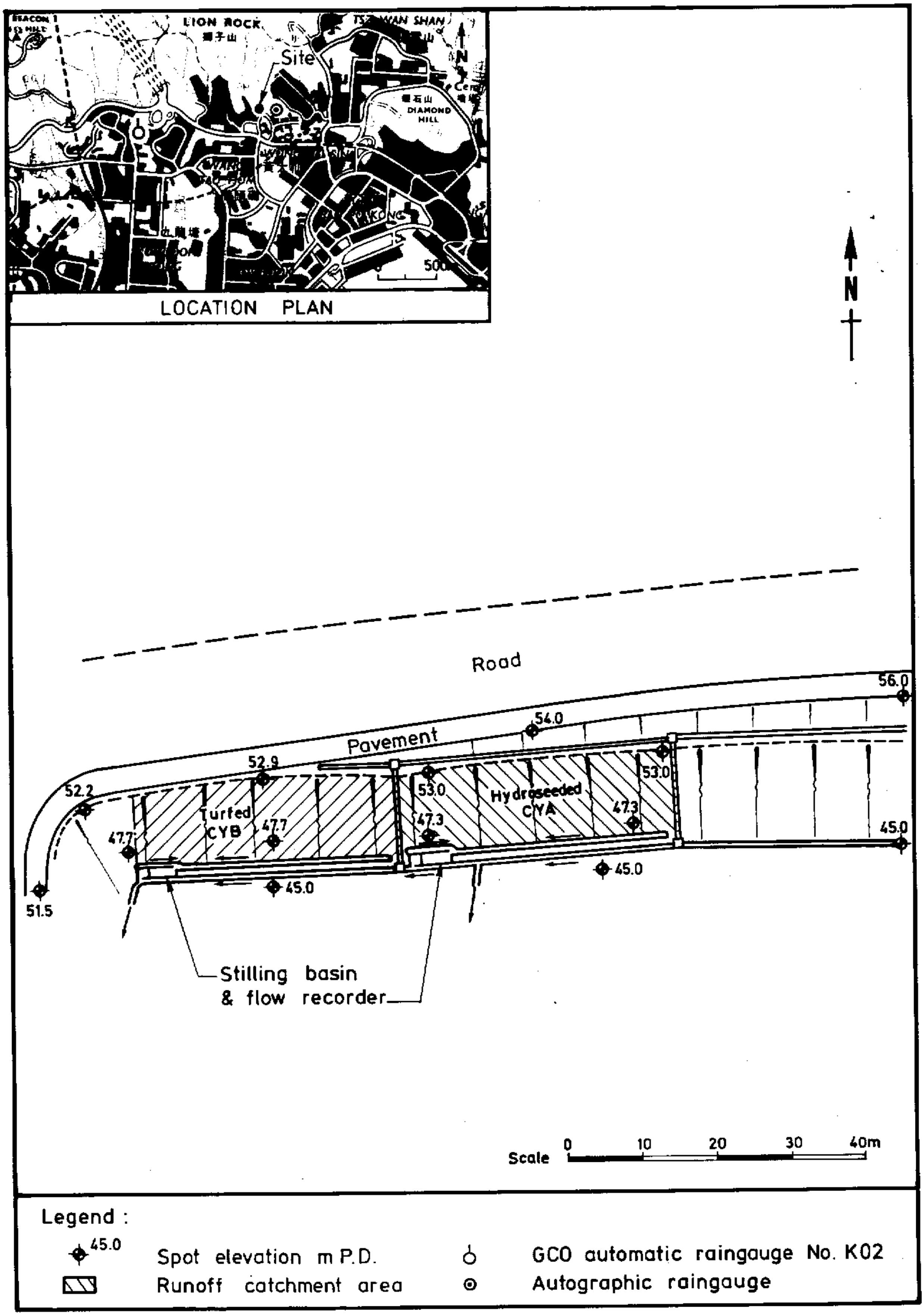

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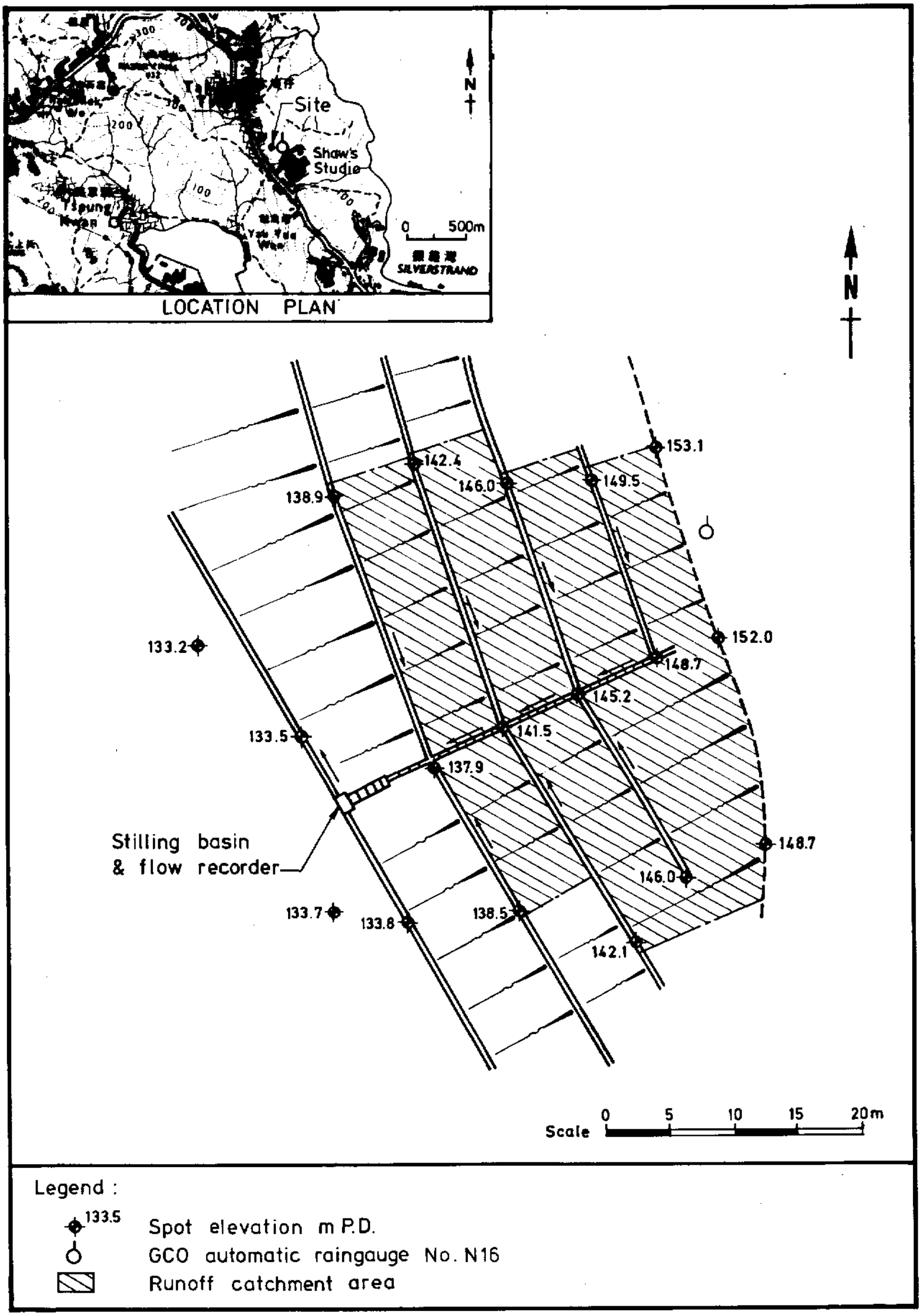

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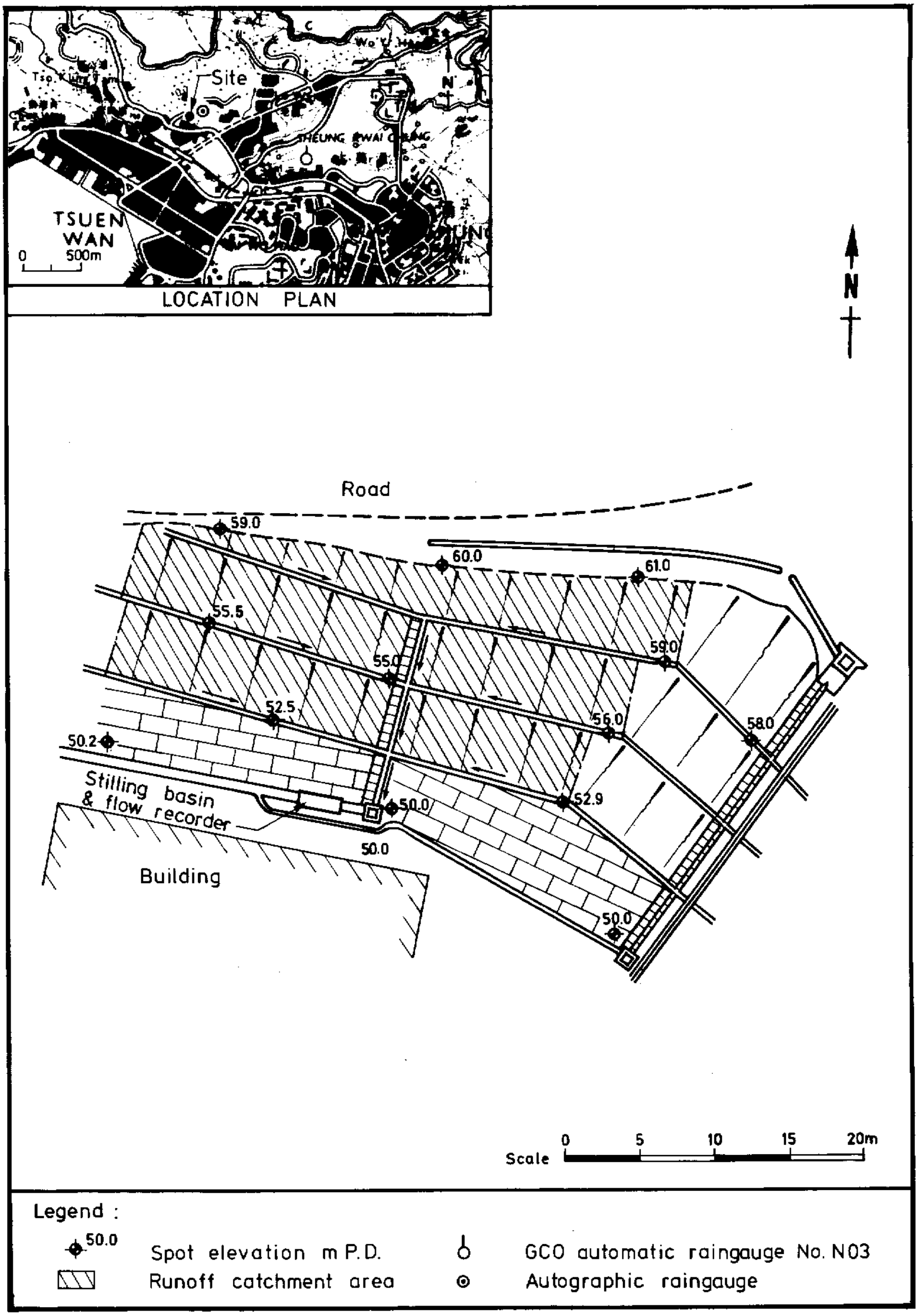

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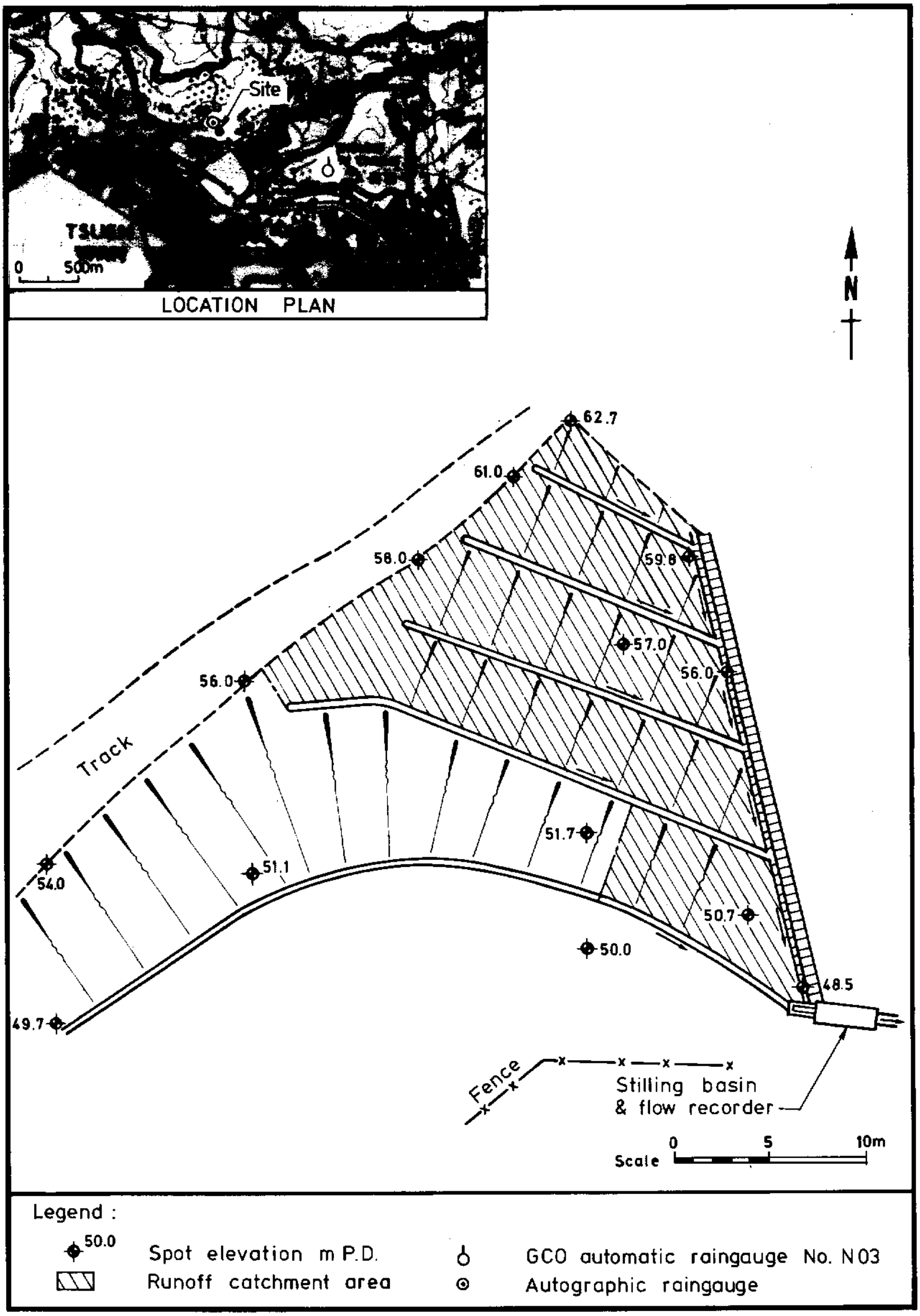

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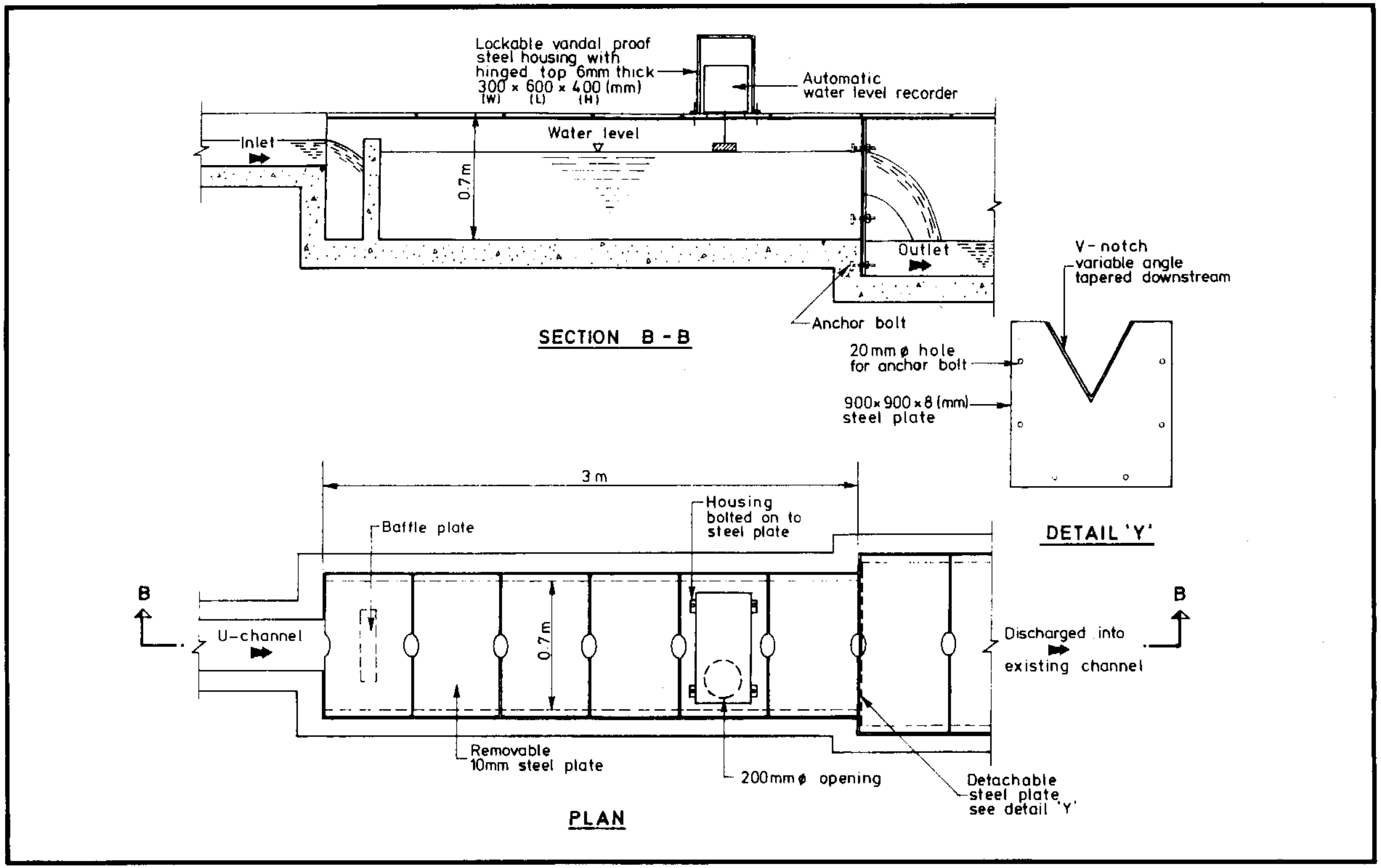

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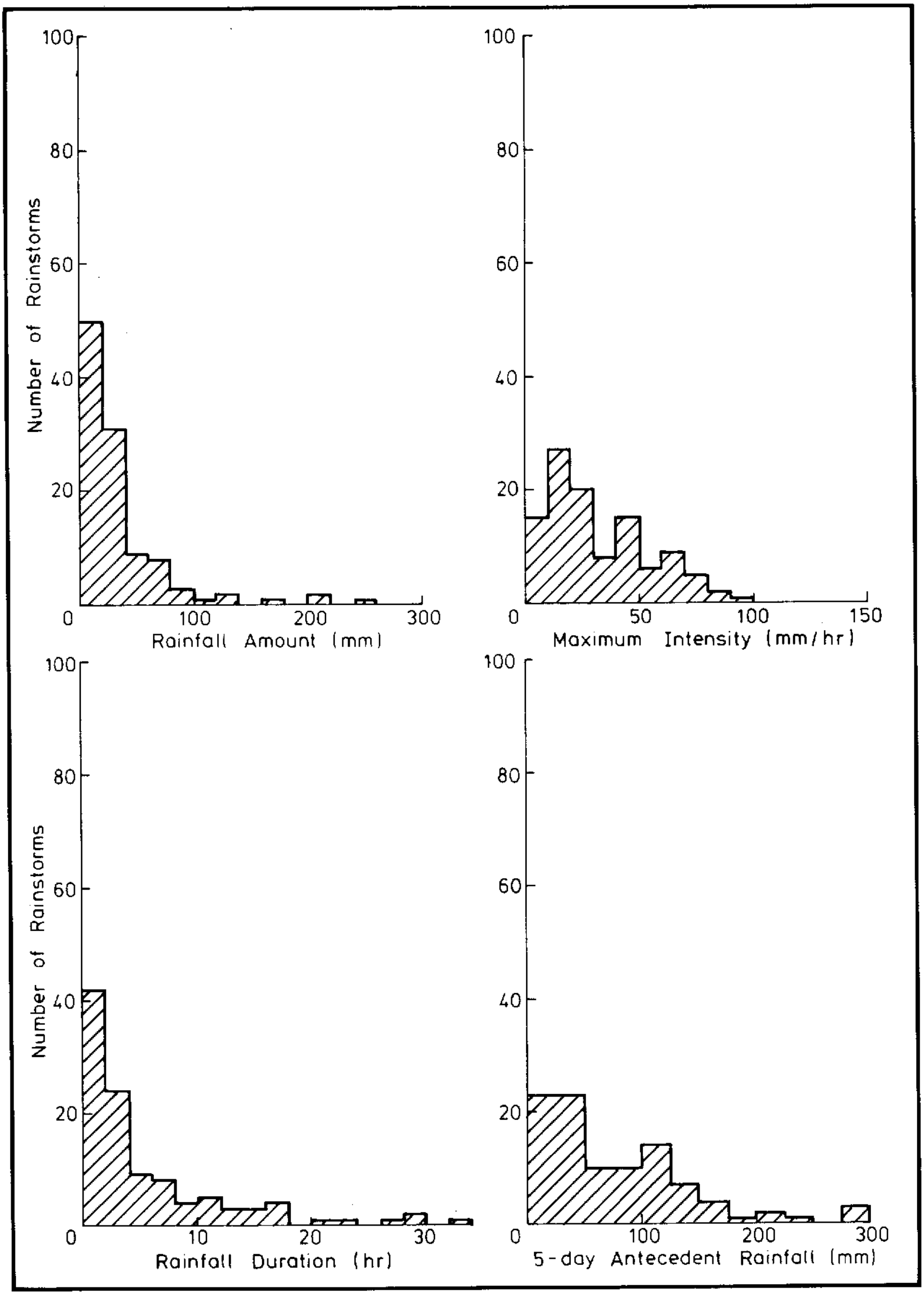

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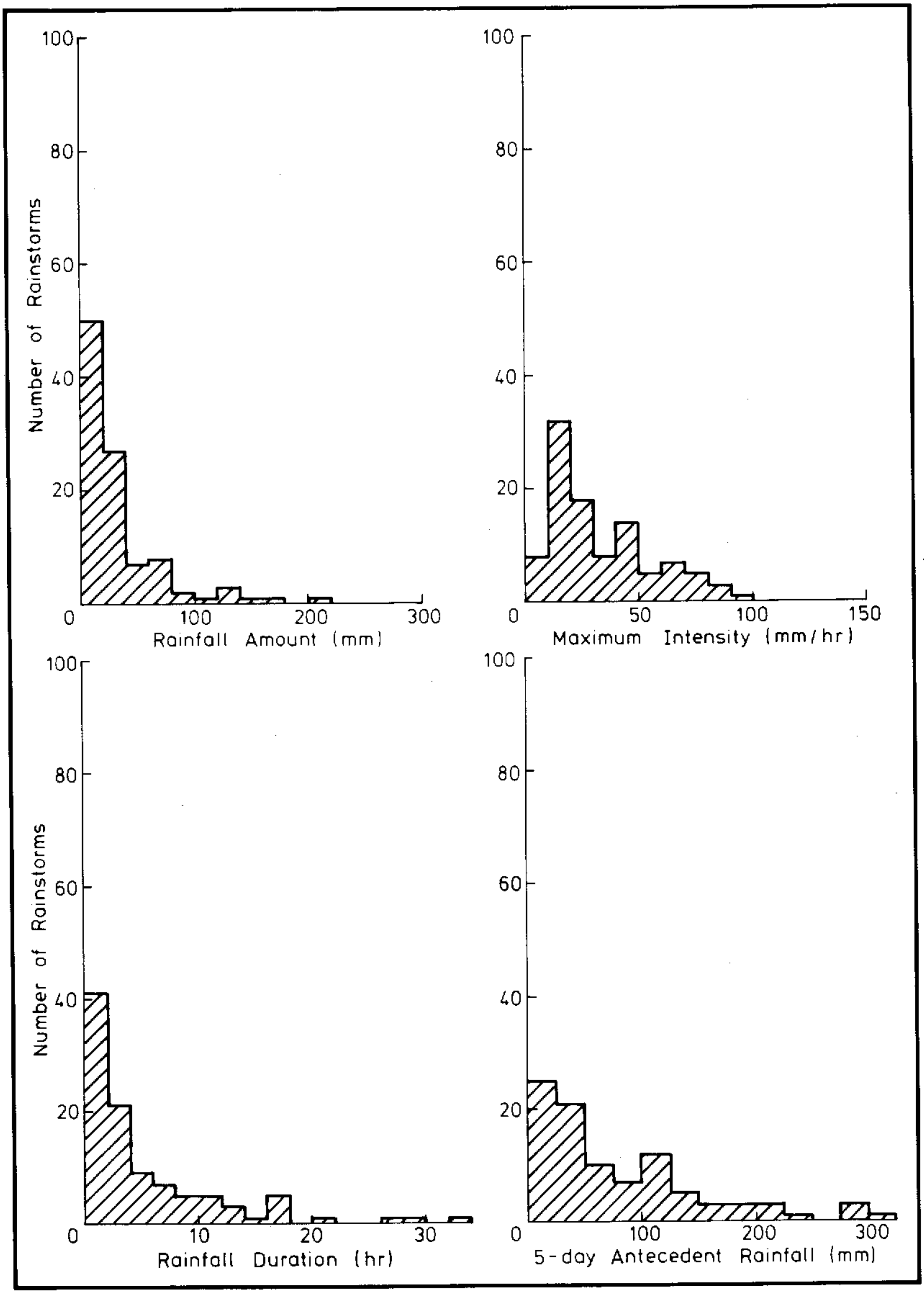

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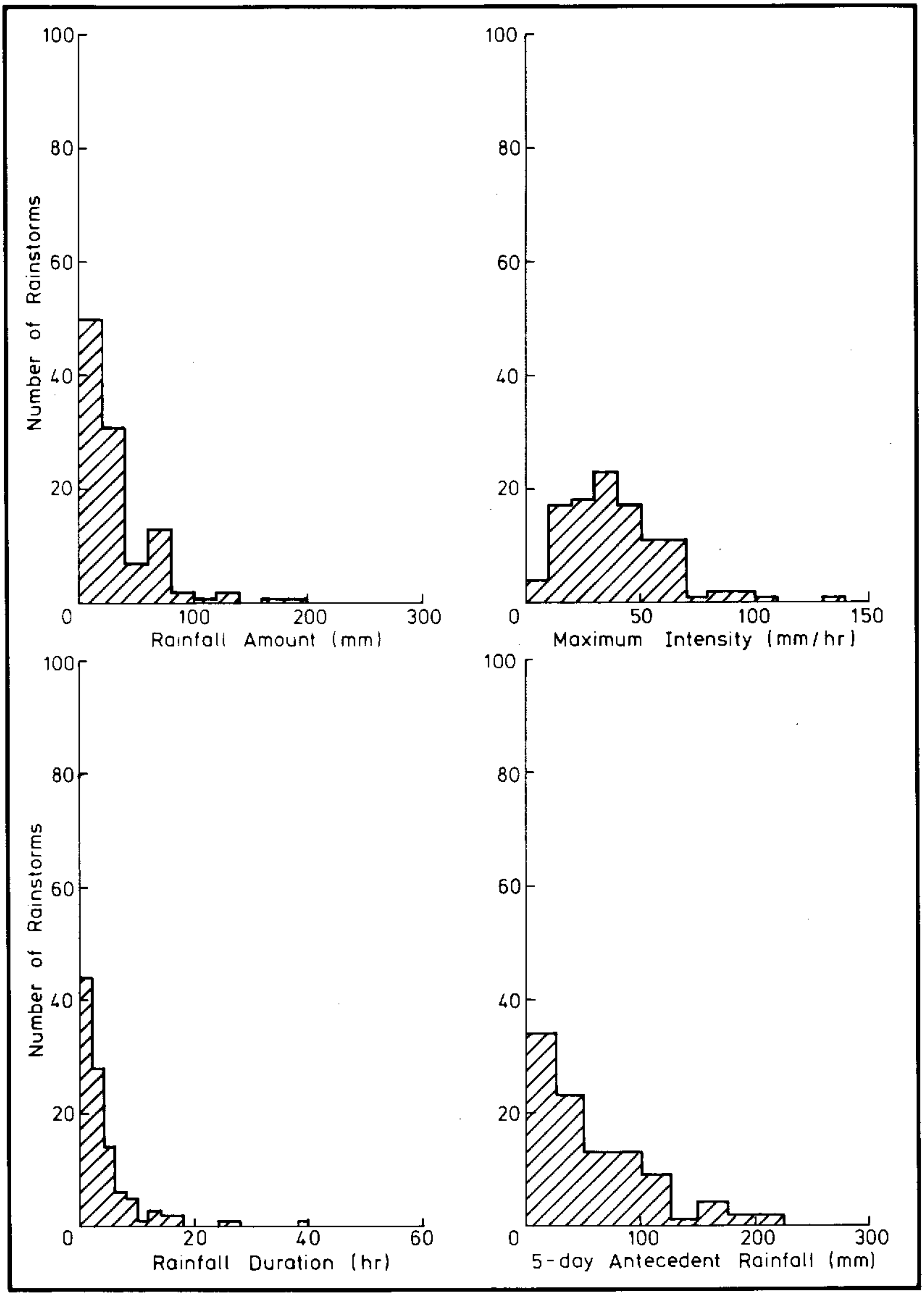

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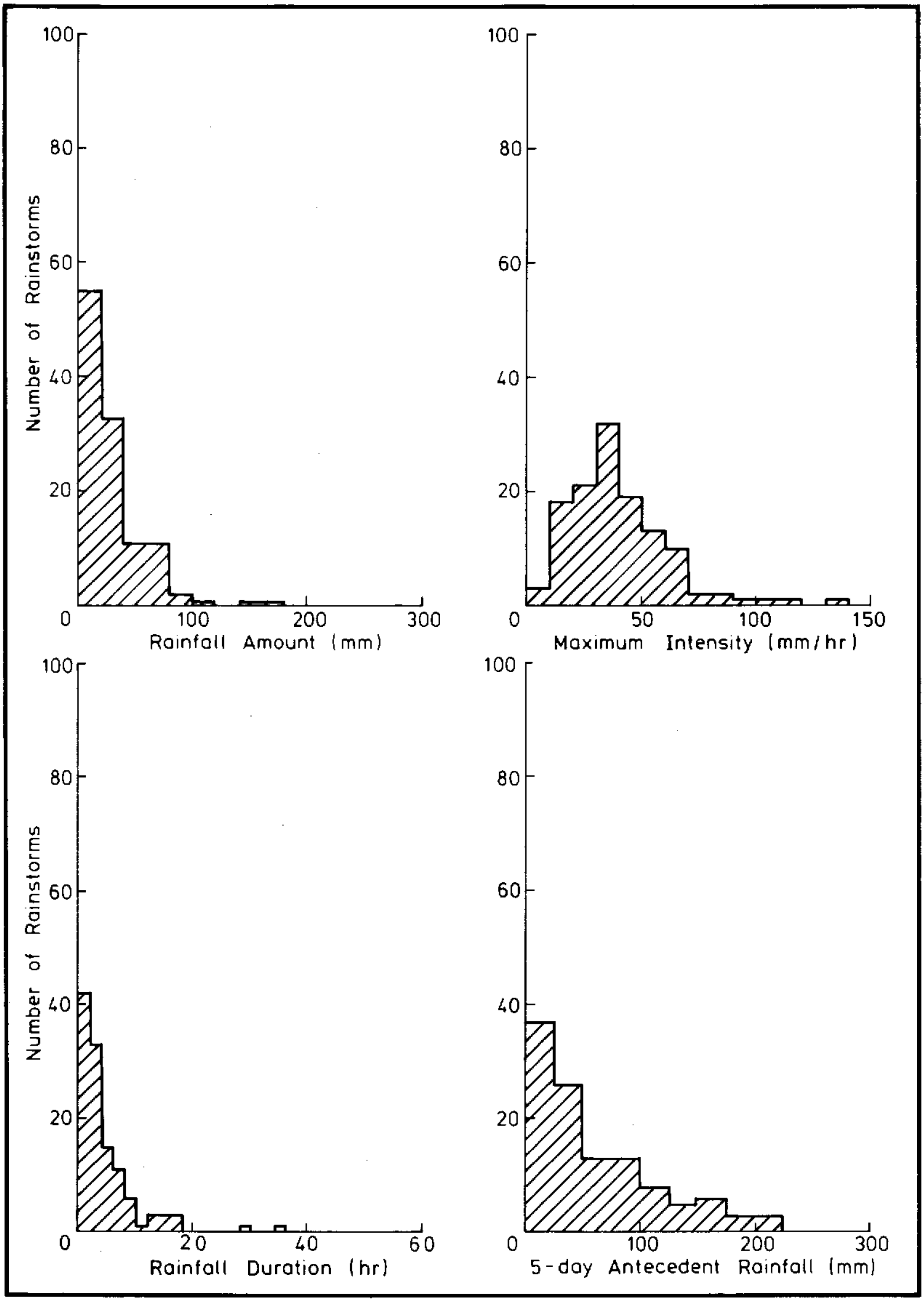

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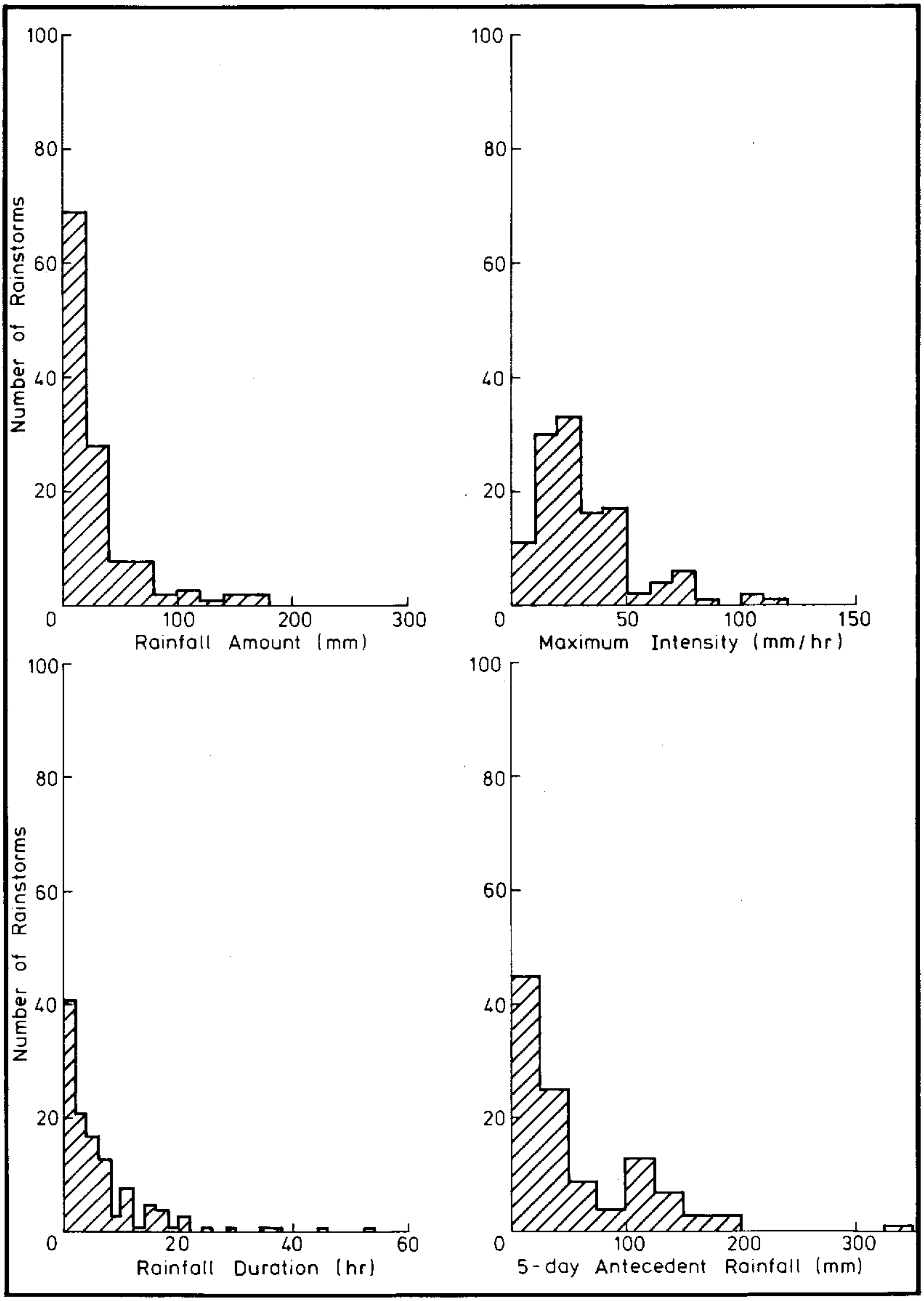

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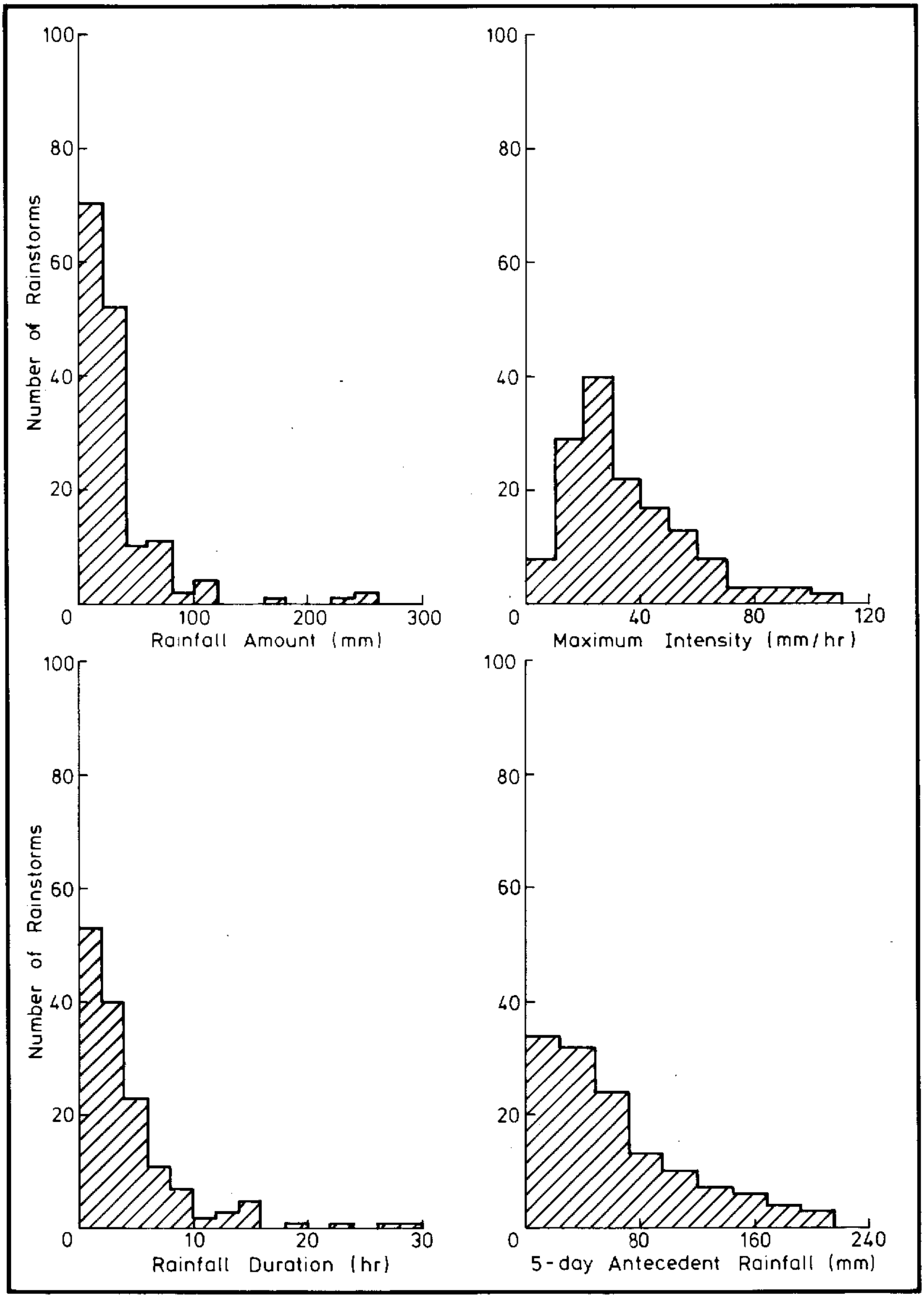

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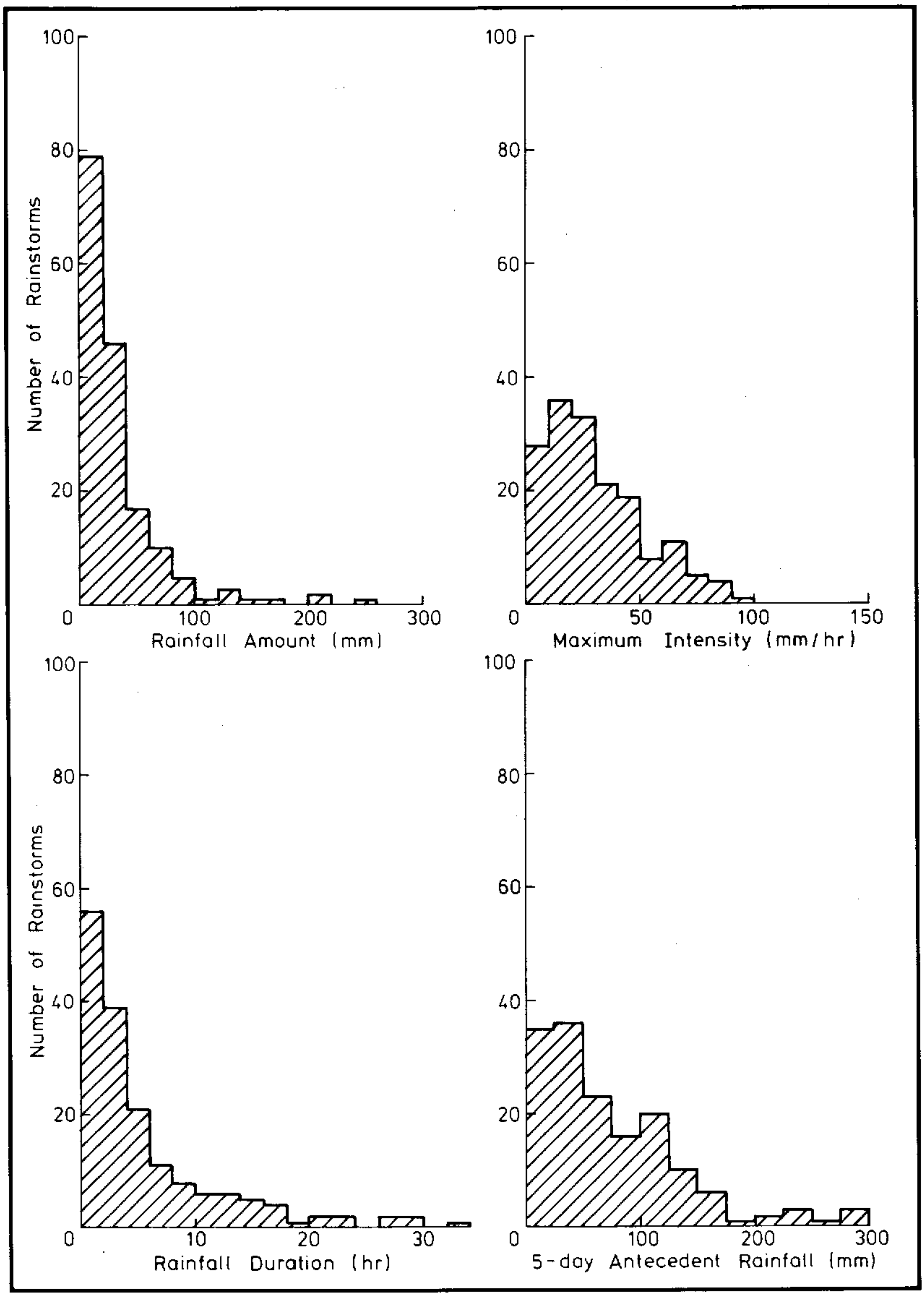

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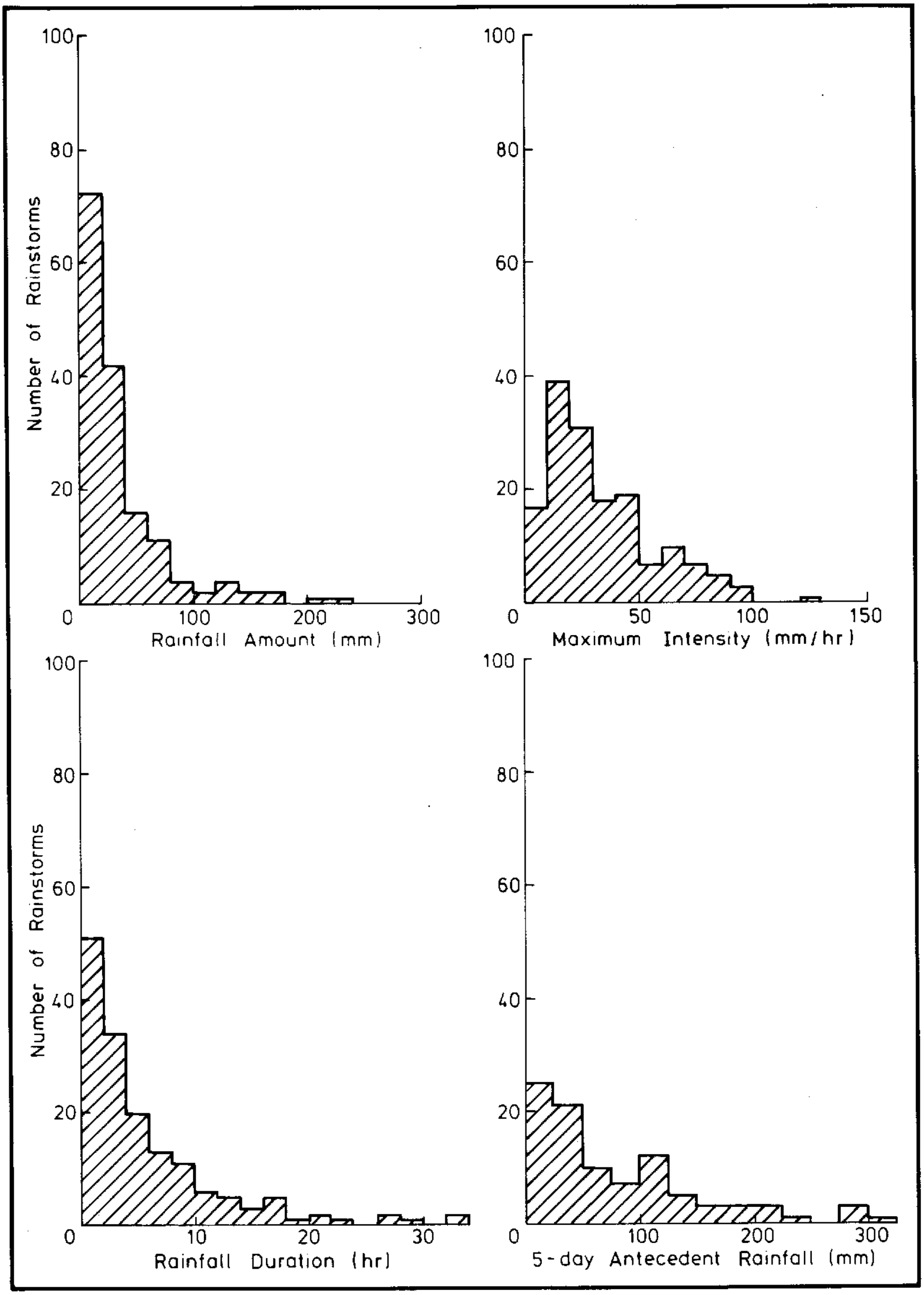

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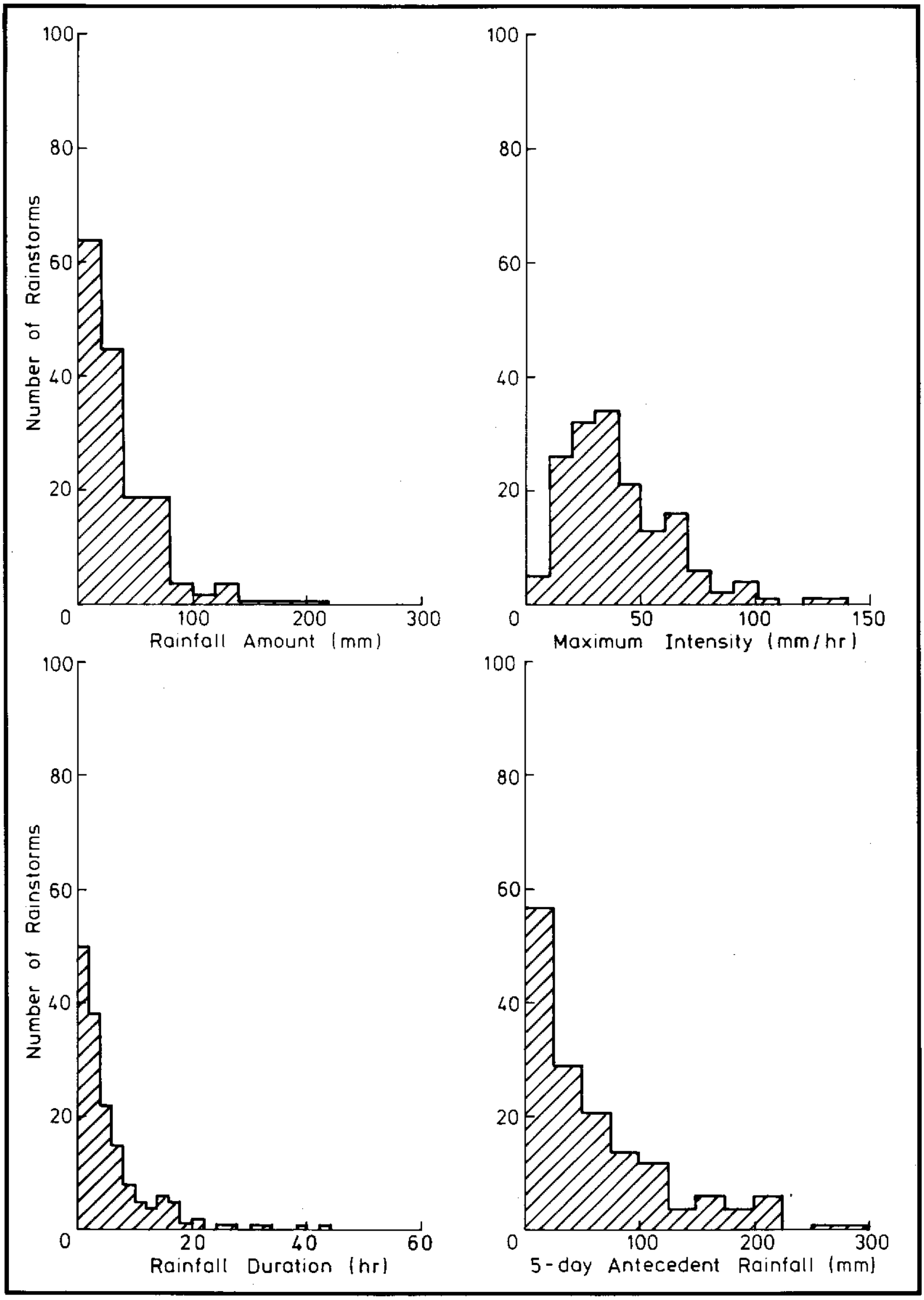

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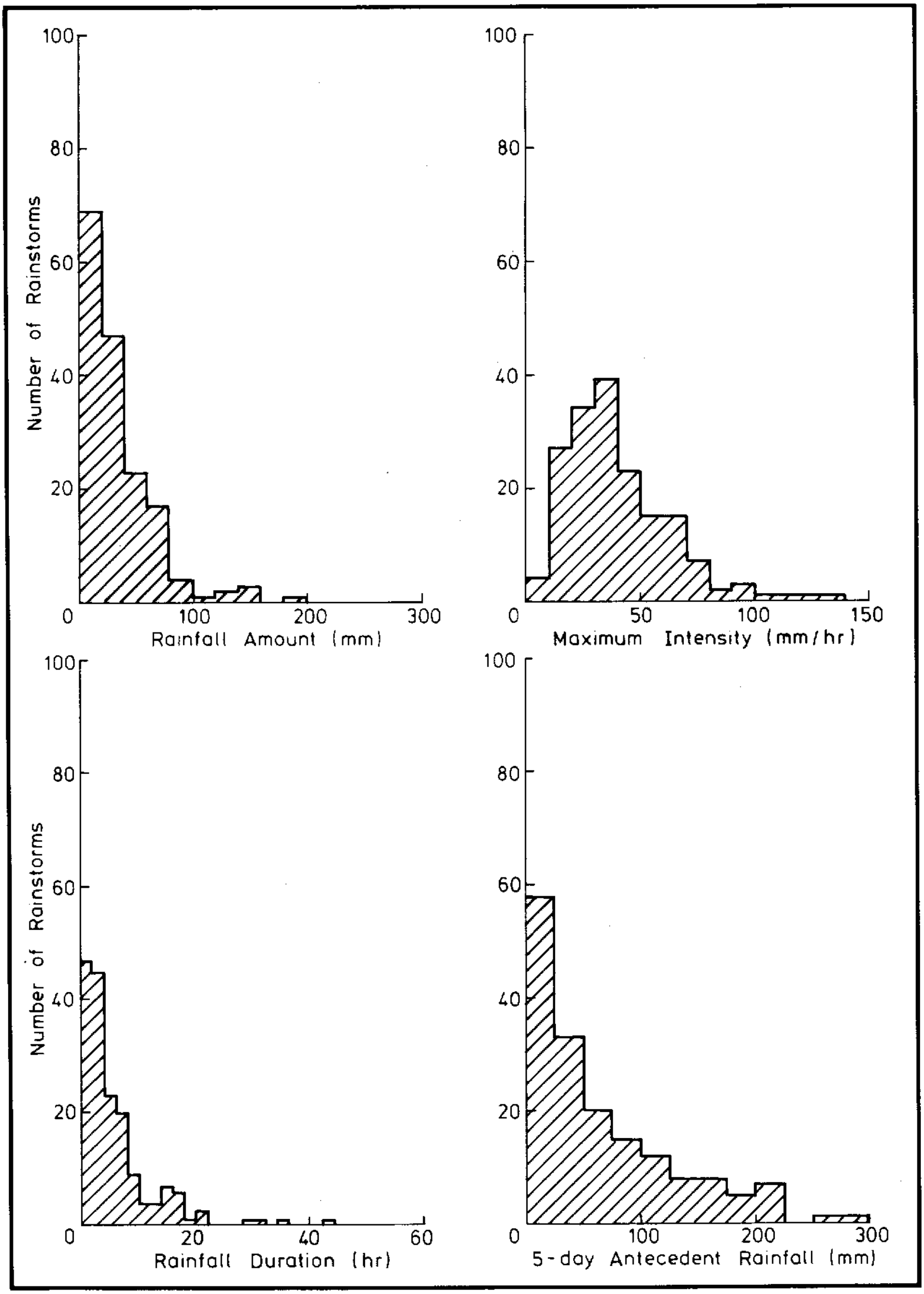

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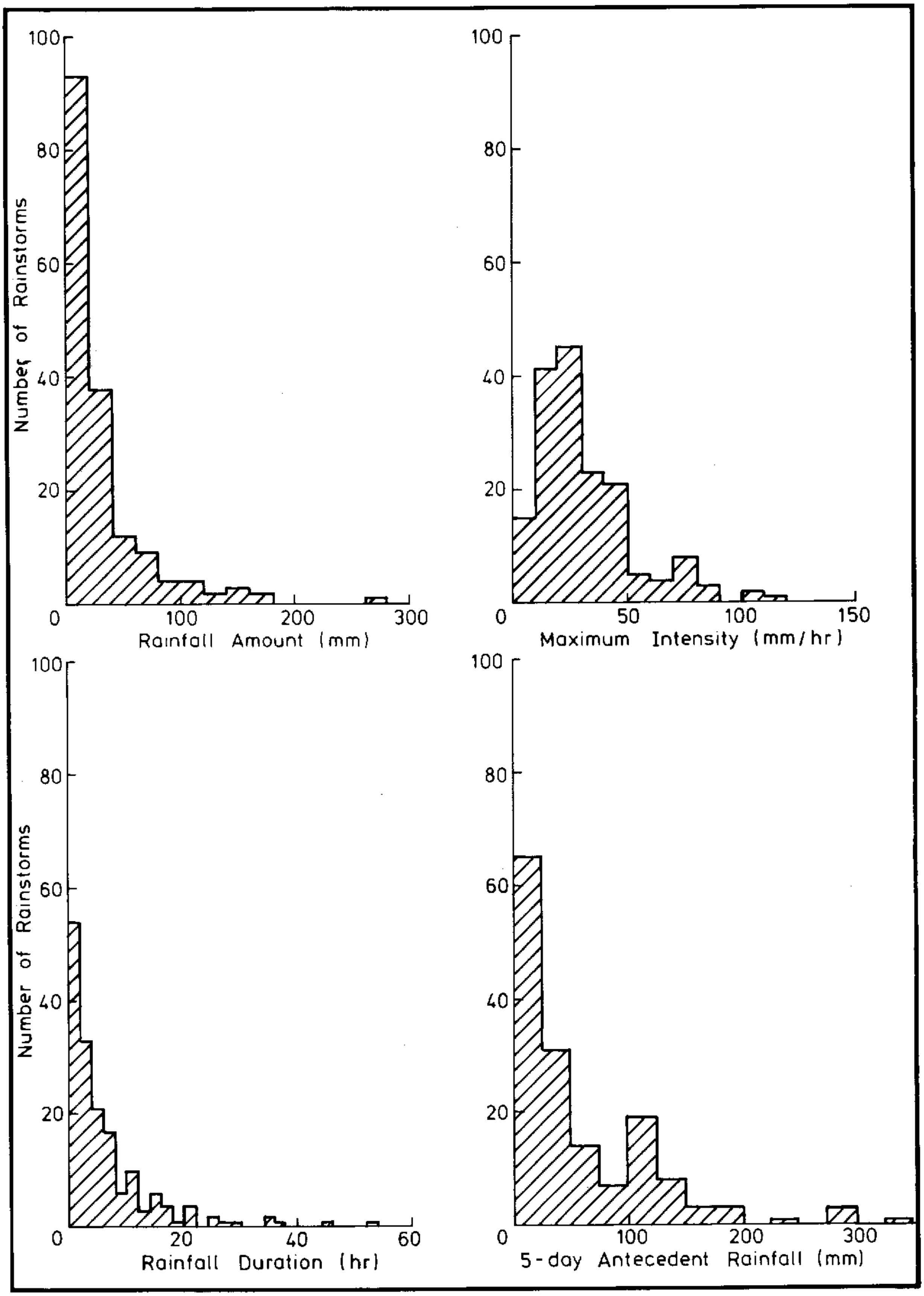

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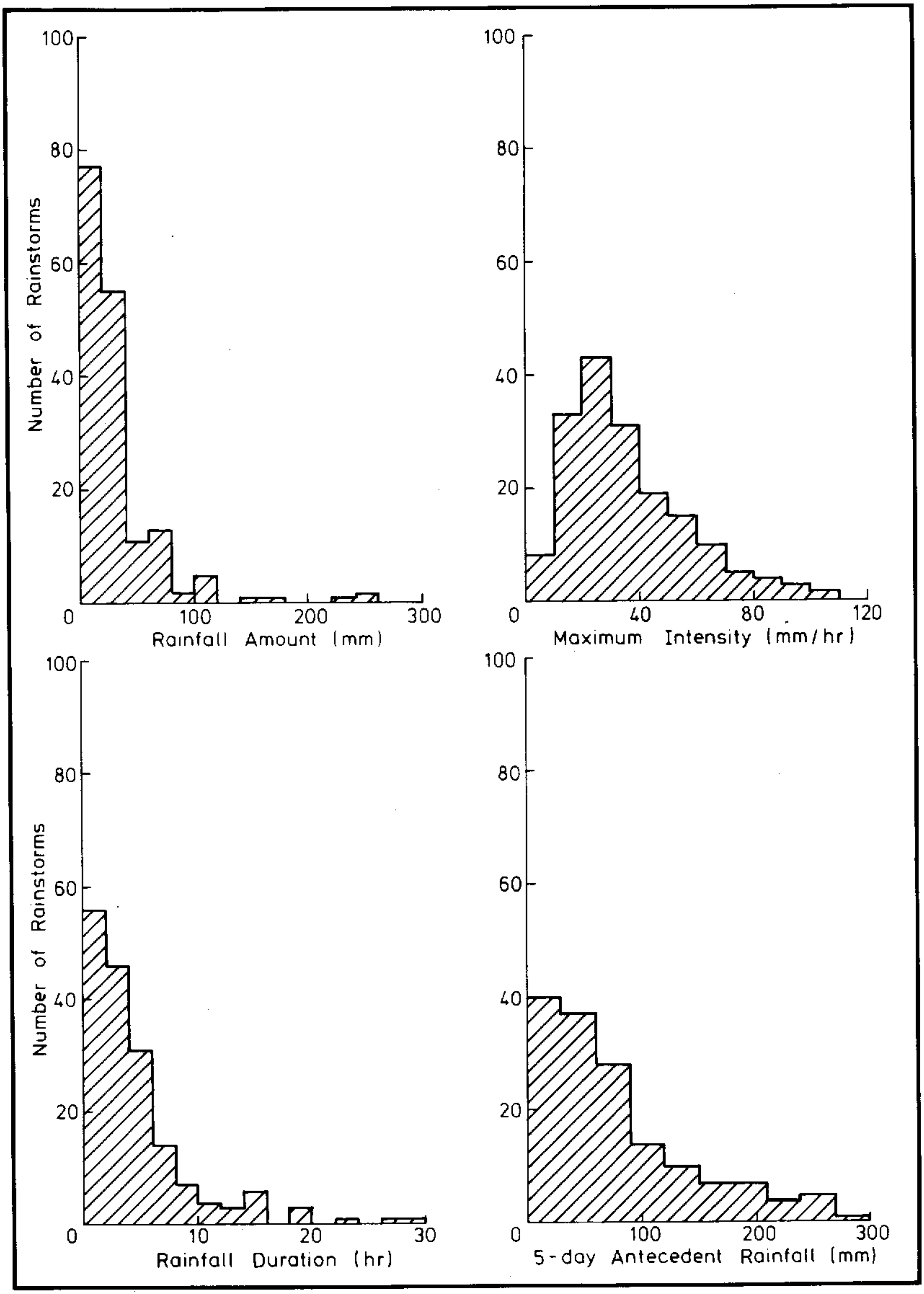

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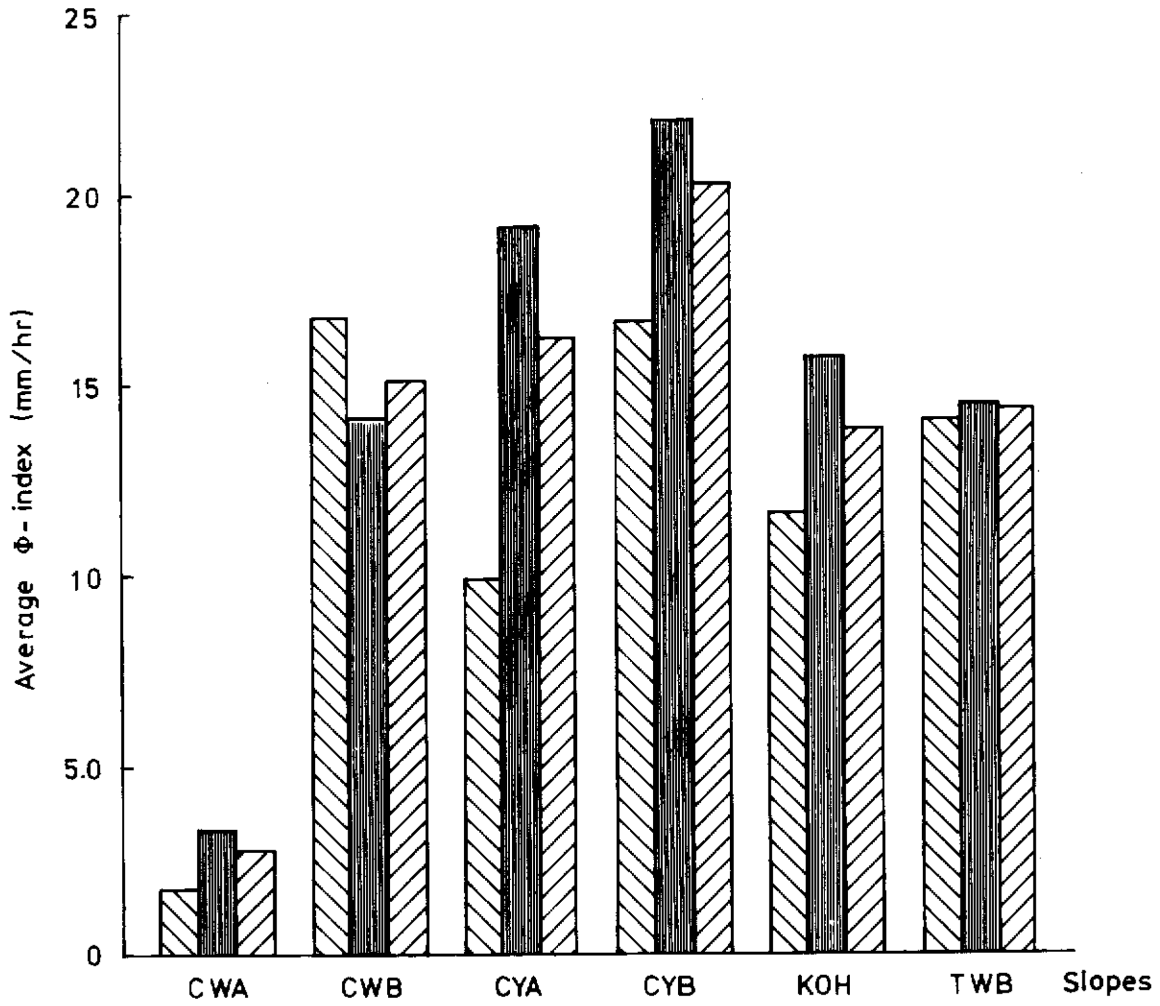
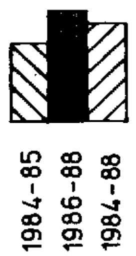


Slope	Surface Cover	Average Φ - index		
		1984-85	1986-88	1984-88
CWA	Chunam	1.8	3.2	2.7
CWB	Grass with some trees	16.9	14.3	15.2
CYA	Grass (hydroseeded)	9.9	19.4	16.2
CYB	Grass (turfed)	16.7	22.1	20.3
KOH	Grass with some trees	11.7	14.8	13.8
TWB	Trees with some grass	14.1	14.6	14.5

Legend:



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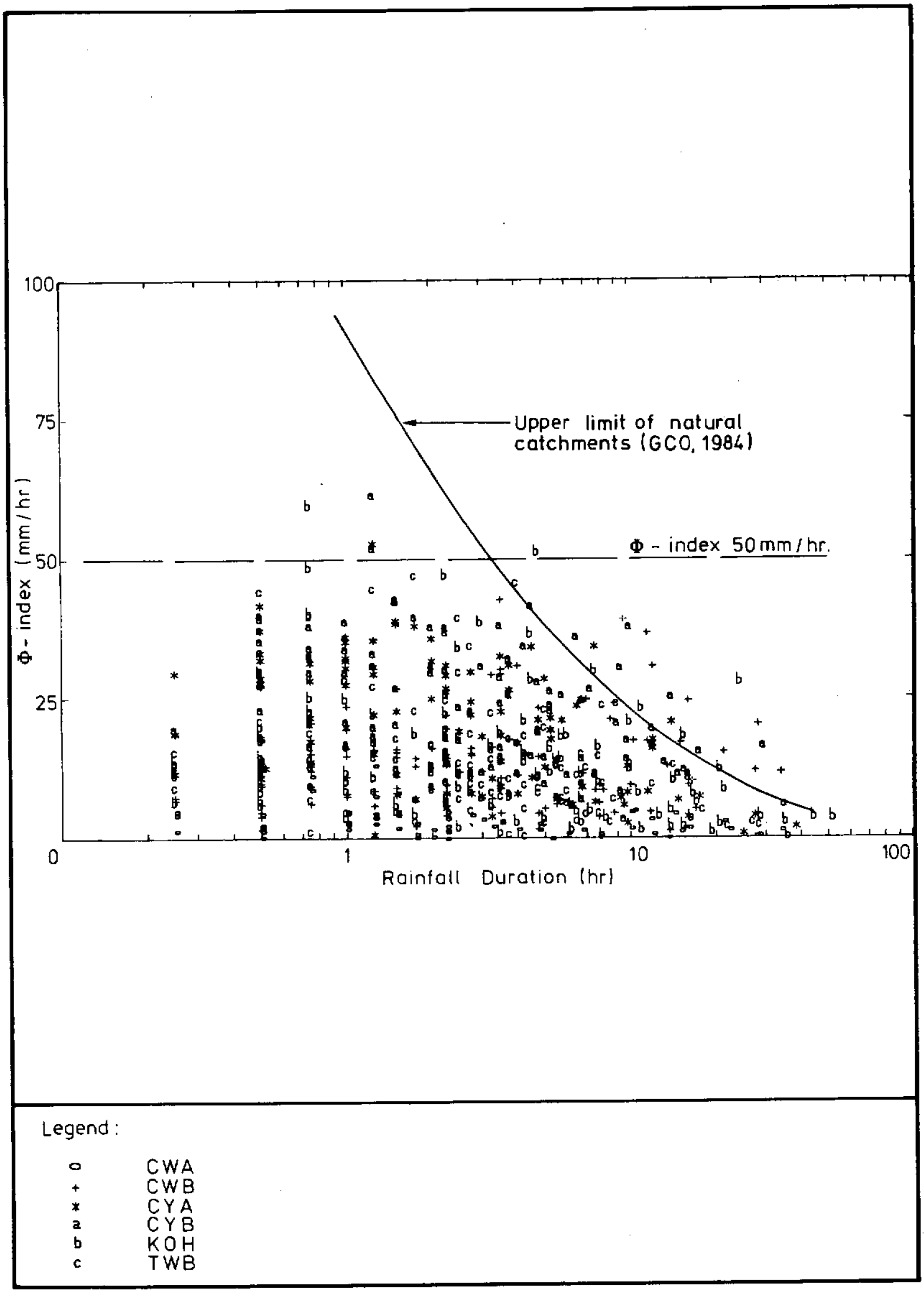

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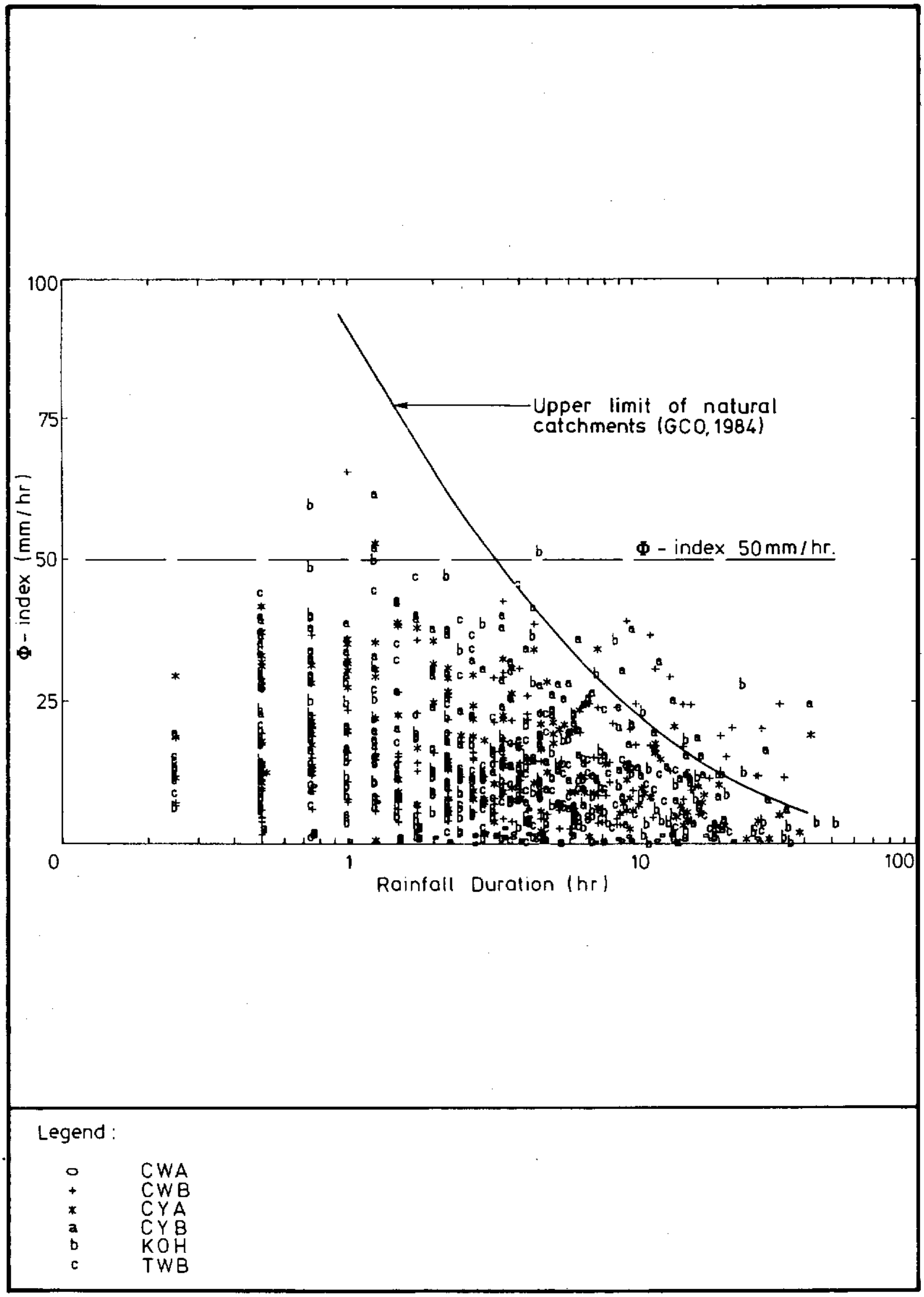

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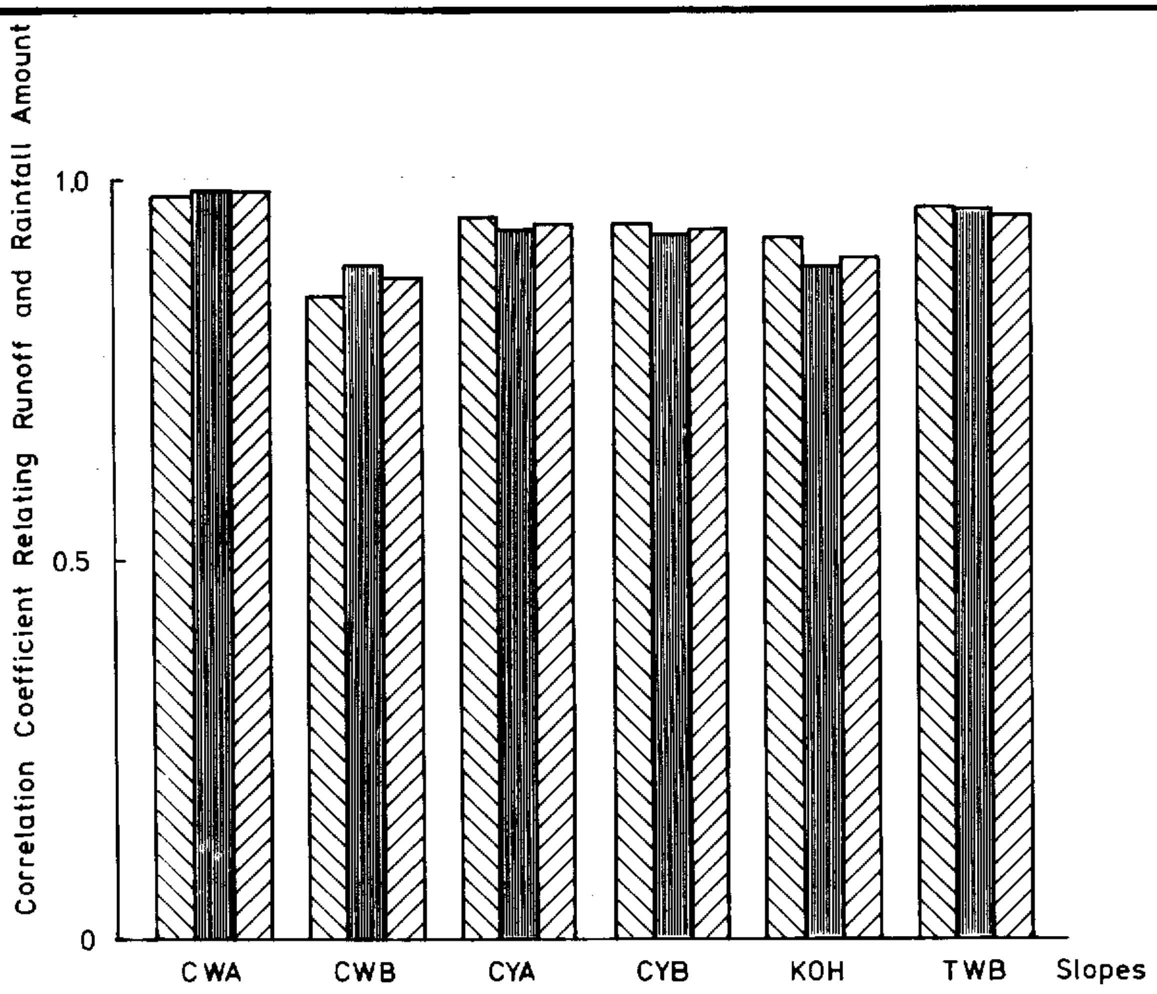
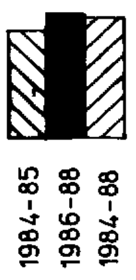


Slope	Surface Cover	Correlation Coefficient		
		1984-85	1986-88	1984-88
CWA	Chunam	0.985	0.991	0.990
CWB	Grass with some trees	0.851	0.893	0.873
CYA	Grass (hydroseeded)	0.952	0.938	0.947
CYB	Grass (turfed)	0.946	0.932	0.937
KOH	Grass with some trees	0.927	0.889	0.898
TWB	Trees with some grass	0.962	0.959	0.956

Legend:



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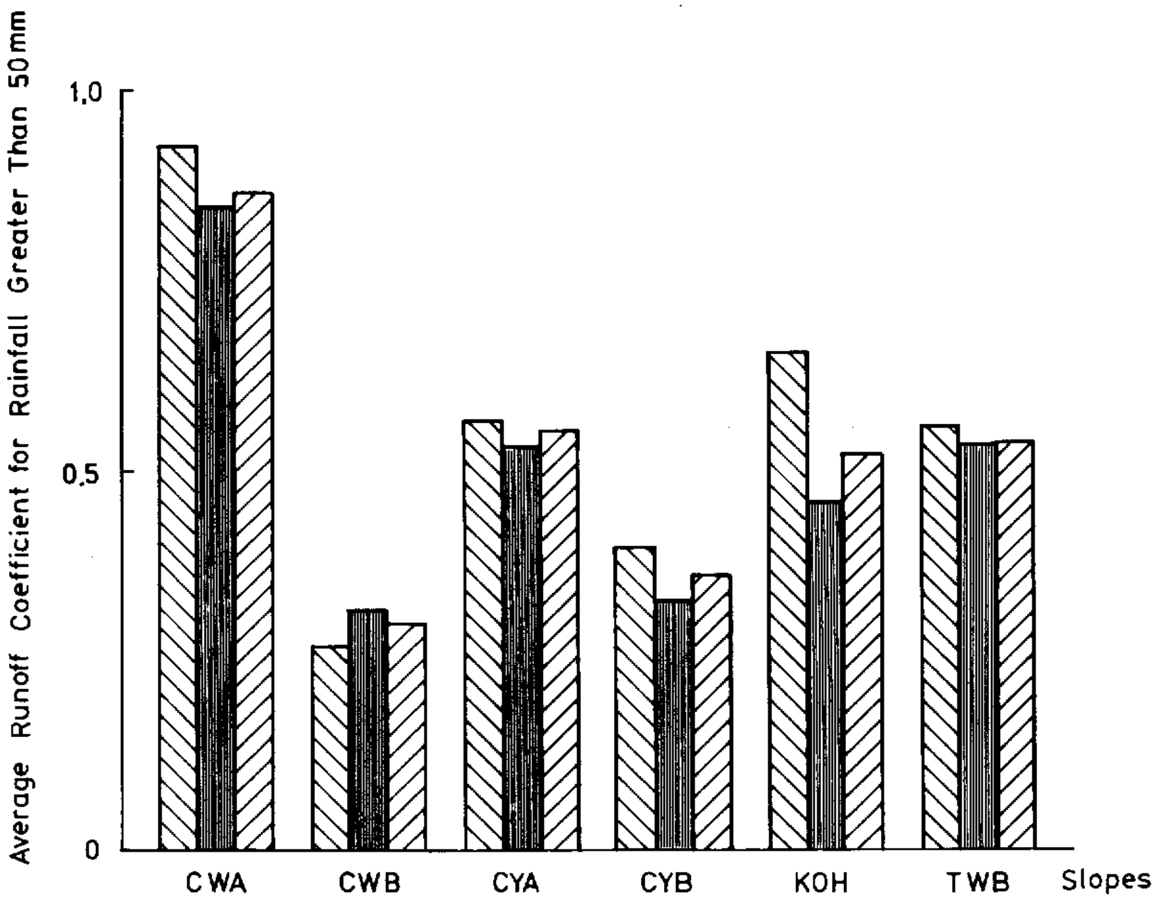


Slope	Surface Cover	Average Runoff Coefficient		
		1984-85	**1986-88**	**1984-88**
CWA	Chunam	0.93	0.85	0.86
CWB	Grass with some trees	0.27	0.32	0.30
CYA	Grass (hydroseeded)	0.57	0.54	0.55
CYB	Grass (turfed)	0.40	0.34	0.36
KOH	Grass with some trees	0.66	0.46	0.53
TWB	Trees with some grass	0.56	0.54	0.54

Legend:

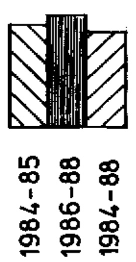


Figure 28 - Comparison of the Average Runoff Coefficient for Rainfall Greater than 50 mm for the Six Slopes

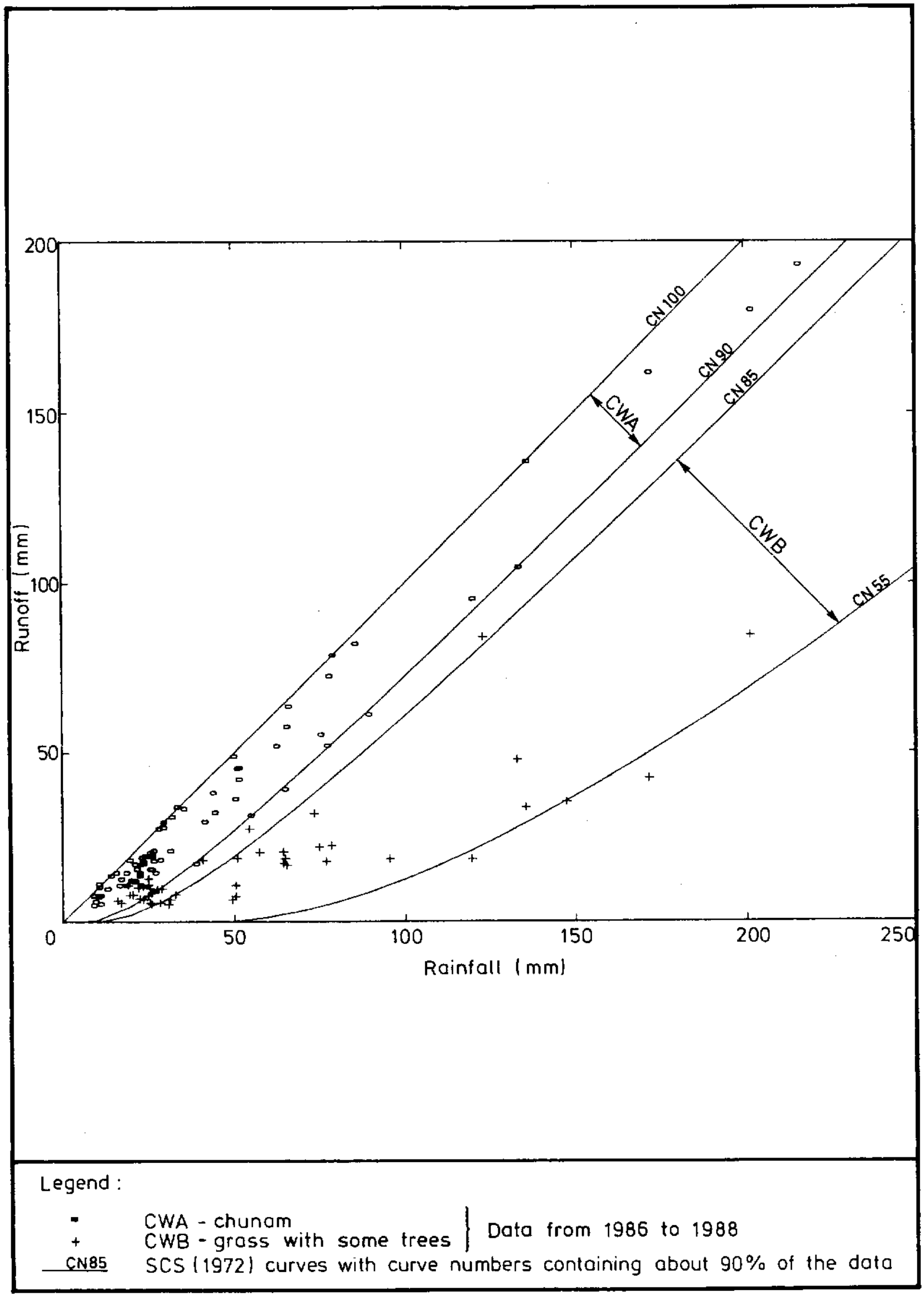


Figure 29 - Relationship Between the 1986 to 1988 Rainfall and Runoff for the Two Plots at Clear Water Bay Road (CWA and CWB)

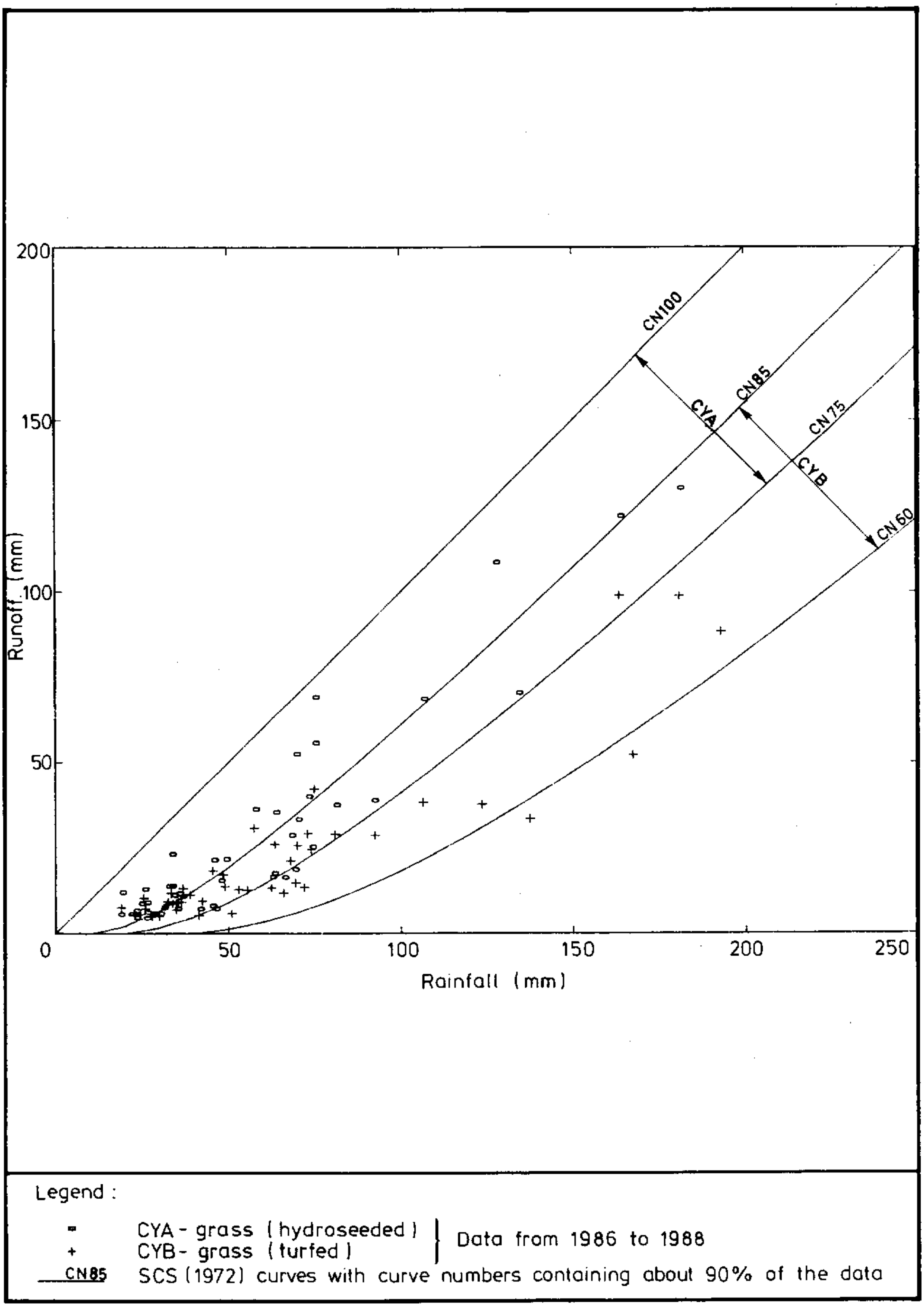


Figure 30 - Relationship Between the 1986 to 1988 Rainfall and Runoff for the Two Plots at Chuk Yuen (CYA and CYB)

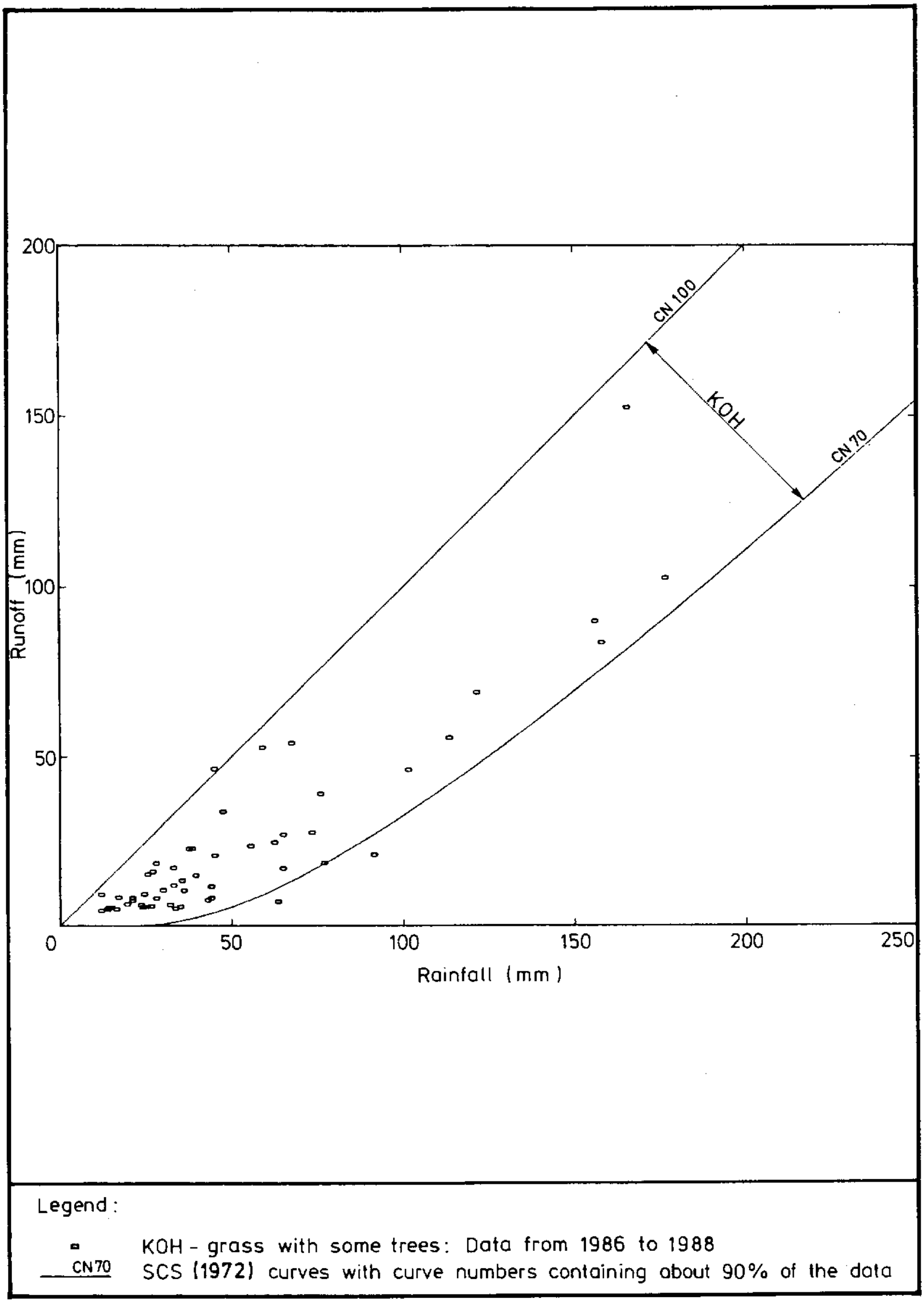


Figure 31 - Relationship Between the 1986 to 1988 Rainfall and Runoff for the Plot at Kohima Barracks (KOH)

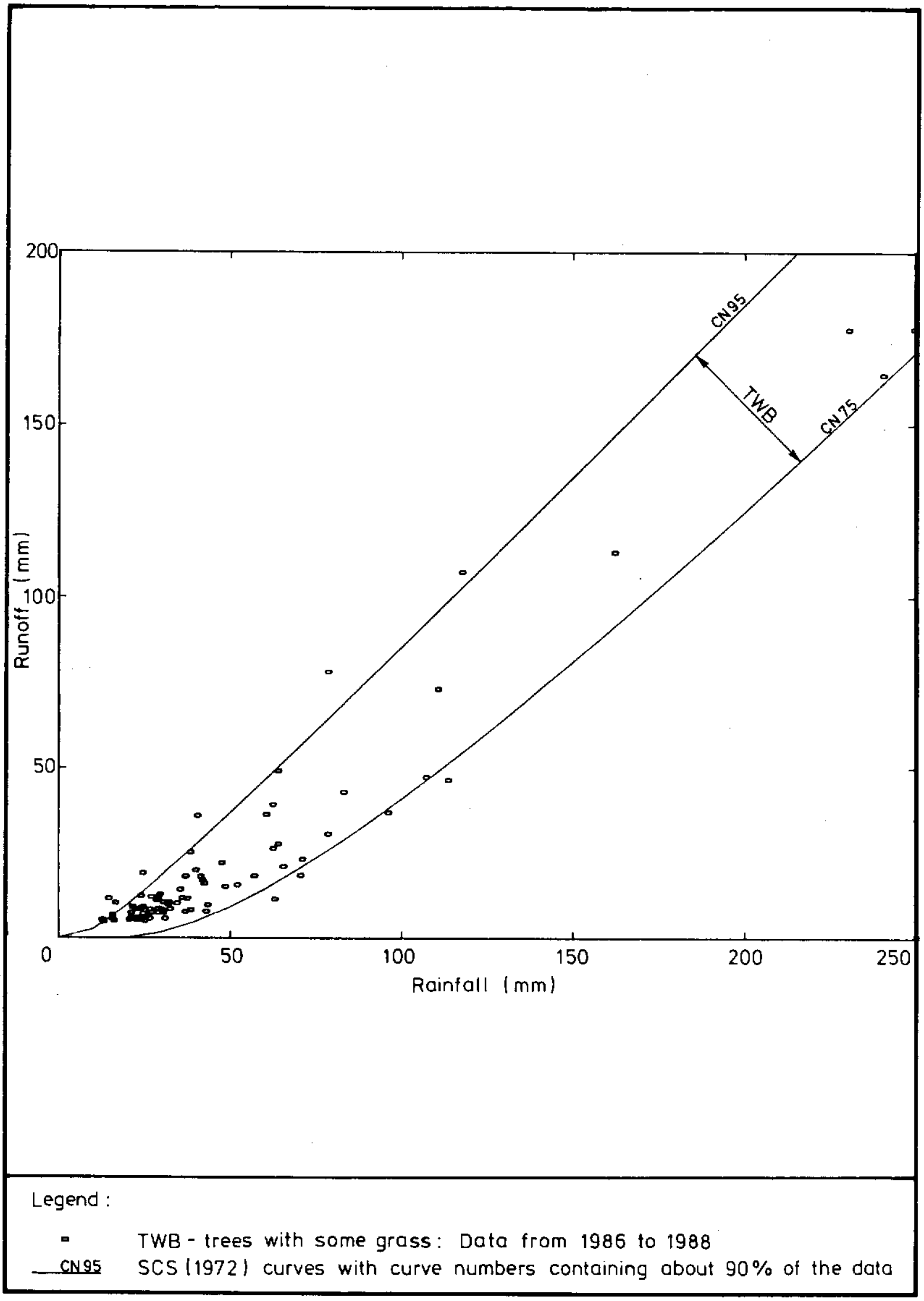


Figure 32 - Relationship Between the 1986 to 1988 Rainfall and Runoff for the Plot at Tsuen Wan (TWB)

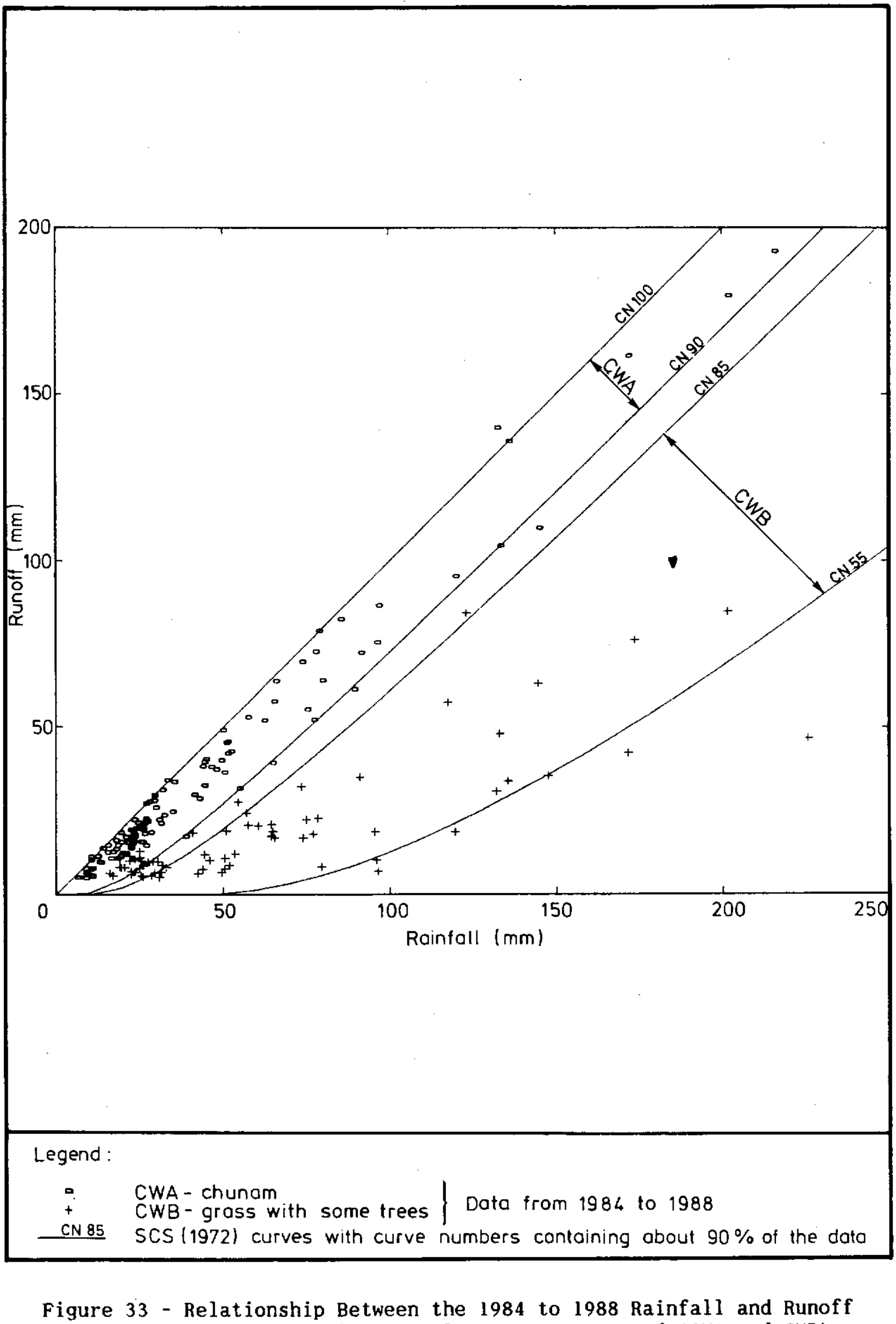
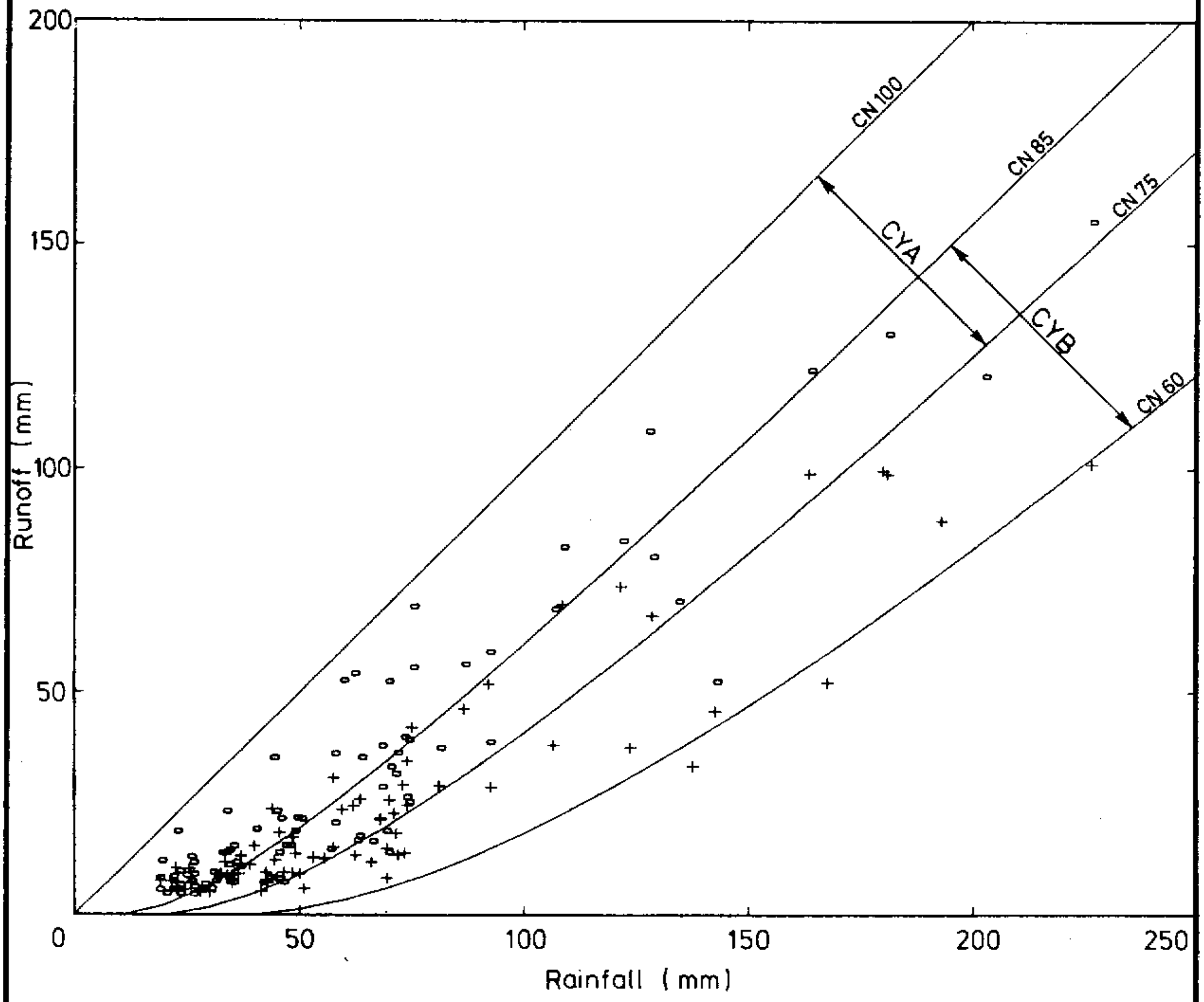


Figure 33 - Relationship Between the 1984 to 1988 Rainfall and Runoff for the Two Plots at Clear Water Bay Road (CWA and CWB)



Legend :

▭	CYA - grass (hydroseeded)	Data from 1984 to 1988
+	CYB - grass (turfed)	
CN85	SCS (1972) curves with curve numbers containing about 90% of the data	

Figure 34 - Relationship Between the 1984 to 1988 Rainfall and Runoff for the Two Plots at Chuk Yuen (CYA and CYB)

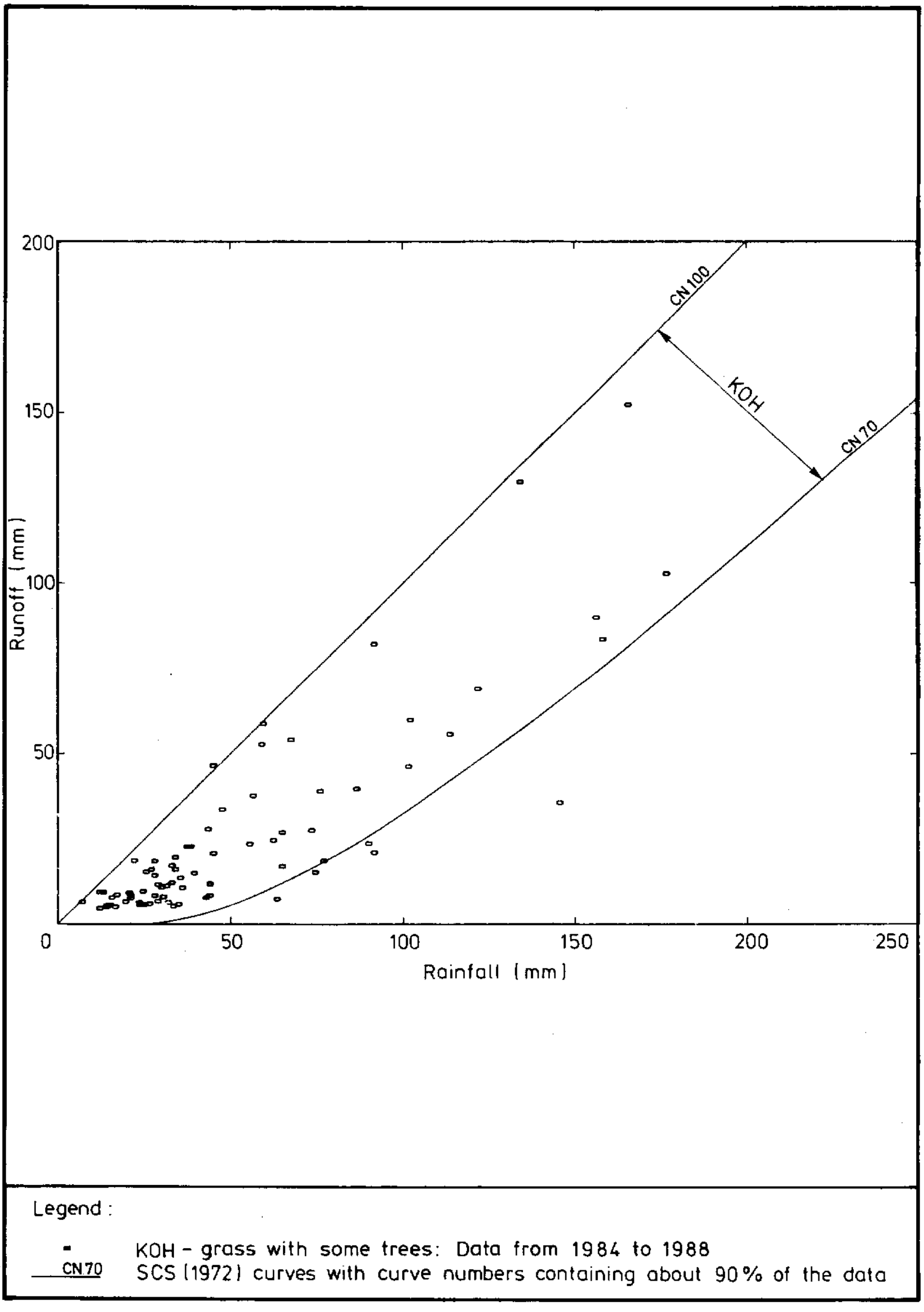


Figure 35 - Relationship Between the 1984 to 1988 Rainfall and Runoff for the Plot at Kohima Barracks (KOH)

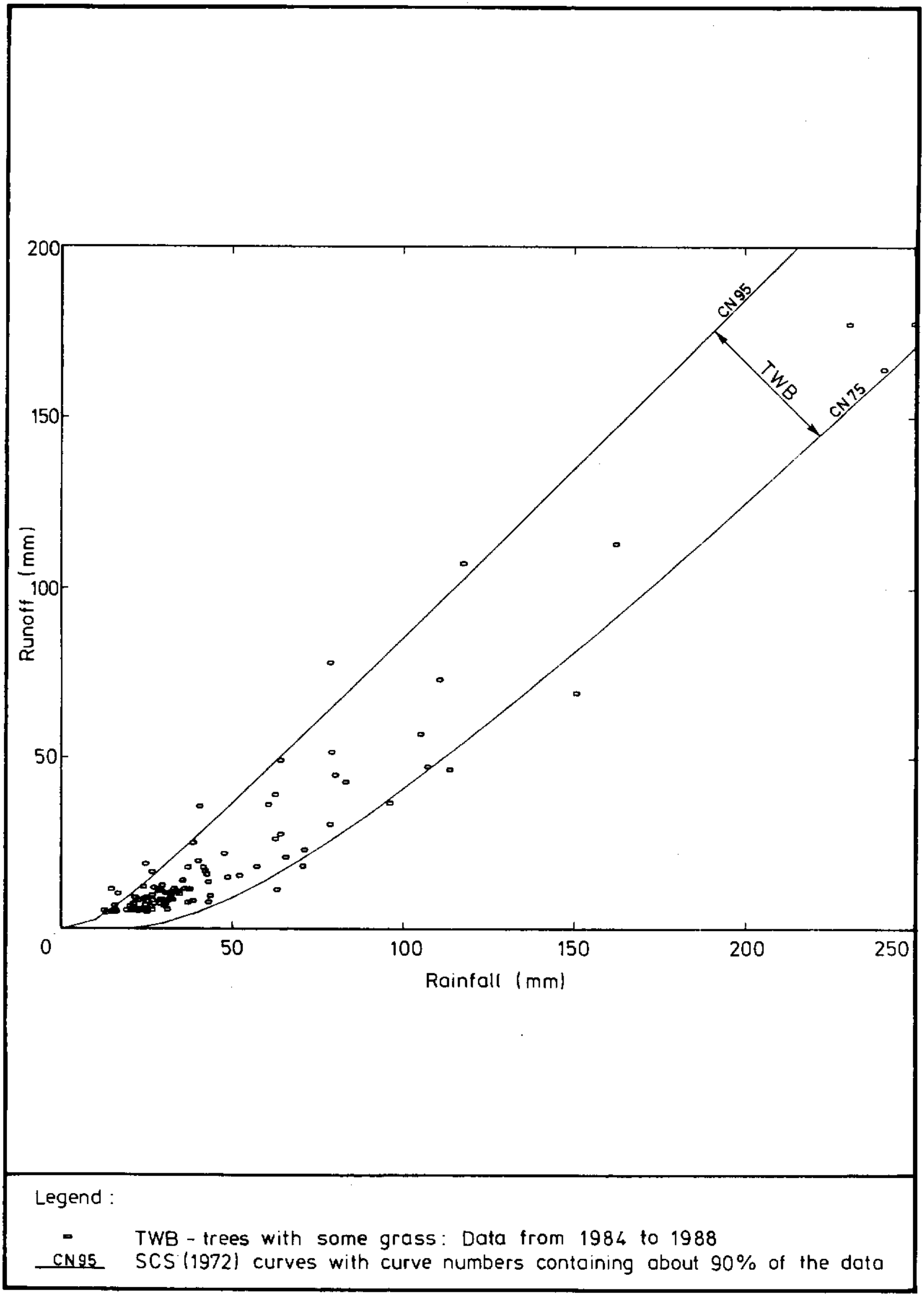
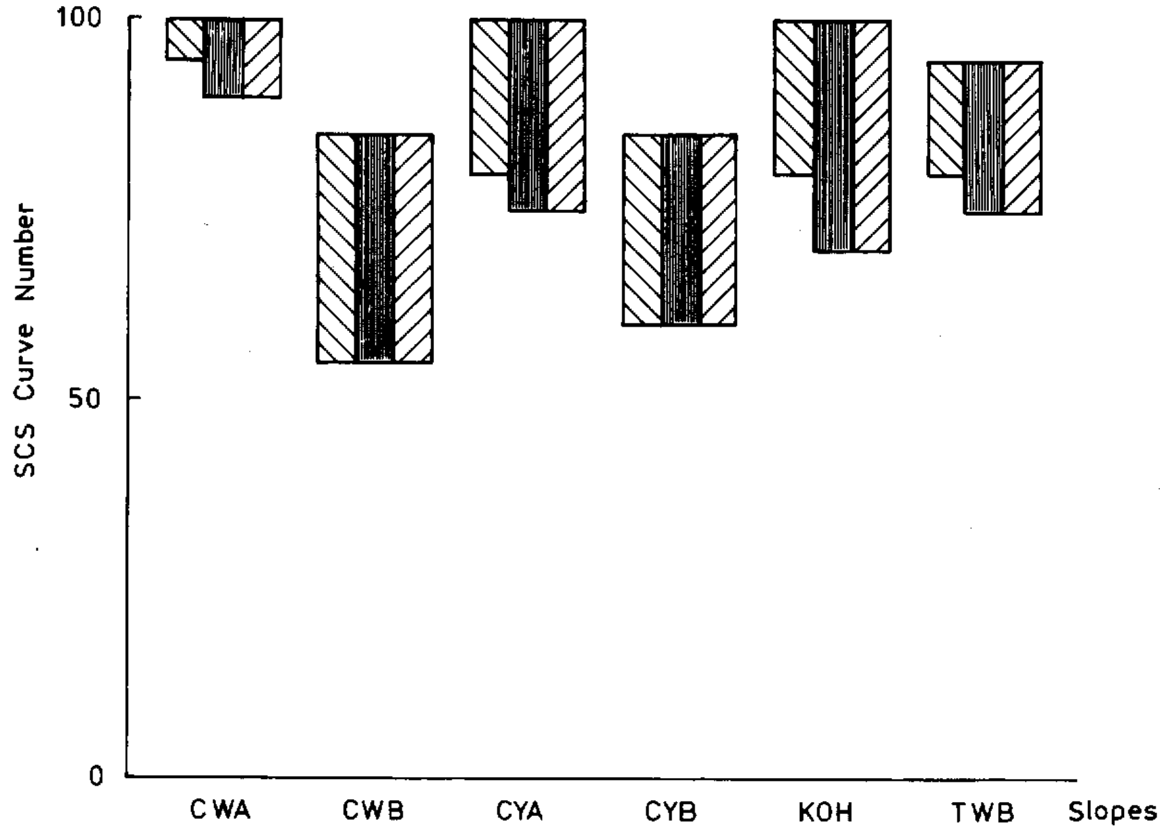


Figure 36 - Relationship Between the 1984 to 1988 Rainfall and Runoff for the Plot at Tsuen Wan (TWB)



Slope	Surface Cover	SCS Curve Number		
		1984-85	1986-88	1984-88
CWA	Chunam	100-95	100-90	100-90
CWB	Grass with some trees	85-55	85-55	85-55
CYA	Grass (hydroseeded)	100-80	100-75	100-75
CYB	Grass (turfed)	85-60	85-60	85-60
KOH	Grass with some trees	100-80	100-70	100-70
TWB	Trees with some grass	95-80	95-75	95-75

Legend:

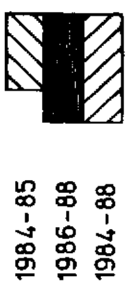
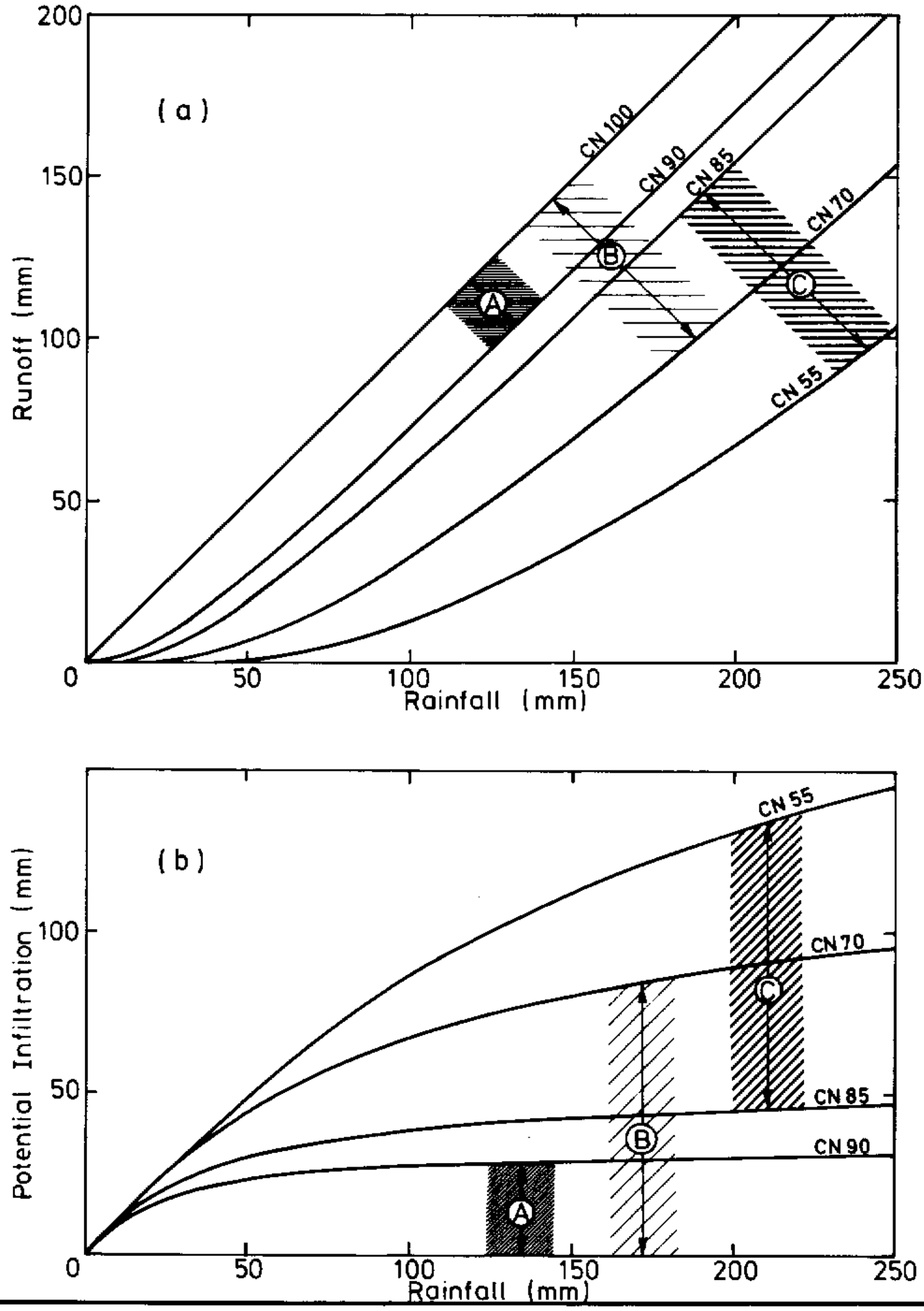


Figure 37 - Comparison of the SCS Curve Number for the Six Slopes



Legend :

Ⓐ	Chunam (CWA)	*	Volcanic soil fill slope, all others are weathered granite cup slopes
Ⓑ	Grass (hydroseeded) (CYA) Grass with some trees (KOH)* Trees with some grass (TWB)	CN55	Curve number
Ⓒ	Grass with some trees (CWB) Grass (turfed) (CYB)		

Notes: (1) The runoff curves take the form of SCS curves in Figure 3.
(2) The limits shown cover about 90% of all data for each slope.

Figure 38 - Summary of Long Term Rainfall-Runoff Relationships for Various Surface Covers and Soil Types

LIST OF PLATES

Negative No. SP 8909423 **Date :** 20.10.89

Plate 1 - Slope at Clear Water Bay Road (CWA)

Negative No. SP 8909421 **Date :** 20.10.89

Plate 2 - Slope at Clear Water Bay Road (CWB)

Negative No. SP 8909504 Date : 20.10.89

Plate 3 - Slope at Chuk Yuen (CYA)

Negative No. SP 8909502 Date : 20.10.89

Plate 4 - Slope at Chuk Yuen (CYB)

Negative No. SP 8909418 Date : 20.10.89

Plate 5 - Slope at Kohima Barracks (KOH)

Negative No. SP 8909413 Date : 20.10.89

Plate 6 - Slope at Tsuen Wan (TWA)

Negative No. SP 8909412 Date : 20.10.89

Plate 7 - Slope at Tsuen Wan (TWB)

APPENDIX A

SCS CURVE NUMBER METHOD

The Soil Conservation Service (SCS) of the US Department of Agriculture (Soil Conservation Service, 1972) developed a semi-empirical method for the estimation of runoff from various types of catchment area. The basic assumption is that the following equation can be applied to all runoff situations :

$$\frac{P - Q - I_a}{S} = \frac{Q}{P - I_a}$$

where P = storm rainfall, Q = runoff, I_a = initial abstraction and S = the potential maximum retention at the start of the storm.

Runoff can be estimated from :

$$Q = \frac{(P - I_a)^2}{(P - I_a) + S}$$

In the general condition the initial abstraction is assumed to be 20% of the maximum retention :

$$I_a = 0.2S$$

therefore :

$$Q = \frac{(P - 0.2S)^2}{(P + 0.8S)}$$

This method relies on a series of runoff curves (Figure 3) with different curve numbers. The curve number (CN) is related to the maximum retention (S) as follows :

$$S = 25.4 \left(\frac{1000}{CN} - 10 \right)$$

where S is in the unit of mm.

APPENDIX B

SUMMARY OF 1986 TO 1988 RAINFALL AND RUNOFF DATA

APPENDIX B

LIST OF TABLES

Table B1 - Summary of 1986 to 1988 Rainfall and Runoff Data for the Plot at Clear Water Bay Road (CWA) (Sheet 1 of 3)

Code	Date/Time	Rainfall (mm)	Rain Durat-ion (min)	Rainfall Intensity (mm/hr)		Runoff (mm)	Antecedent Rainfall (mm)	
				Avg.	Max.		5-day	15-day
CWA204	8604210045	91.0	1065	5.1	60.0	72.8	6.0	7.0
CWA205	8604220630	25.0	105	14.3	48.0	20.1	94.5	98.0
CWA208	8605101415	8.5	75	6.8	22.0	3.6	N.A.	N.A.
CWA209	8605110815	171.5	1650	6.2	64.0	161.9	N.A.	N.A.
CWA211	8605140445	21.0	285	4.4	26.0	16.2	189.0	N.A.
CWA215	8605200415	33.0	195	10.2	36.0	34.3	25.0	N.A.
CWA217	8605211615	22.5	465	2.9	10.0	17.7	97.5	N.A.
CWA218	8605220300	6.0	105	3.4	8.0	4.7	97.5	309.5
CWA223	8606010030	29.0	120	14.5	38.0	28.3	8.0	127.0
CWA225	8606041315	8.5	105	4.9	18.0	8.2	51.5	118.5
CWA232	8606122130	12.5	135	5.6	20.0	10.3	28.0	N.A.
CWA235	8606131130	2.5	30	5.0	6.0	1.3	34.0	N.A.
CWA238	8606180545	1.0	15	4.0	4.0	0.6	31.5	N.A.
CWA241	8606212215	8.0	135	3.6	14.0	2.9	34.0	N.A.
CWA244	8606251630	85.0	465	11.0	50.0	82.7	112.5	165.0
CWA245	8606260315	6.0	75	4.8	20.0	1.7	113.0	165.5
CWA248	8606261115	22.5	135	10.0	28.0	19.5	128.0	180.5
CWA249	8606270230	3.0	90	2.0	10.5	1.3	144.5	204.0
CWA250	8607030830	78.5	420	11.2	50.0	79.3	2.0	167.5
CWA251	8607040330	135.5	525	15.5	62.0	136.2	80.0	241.5
CWA253	8607070300	25.5	210	7.3	66.0	20.2	220.0	372.0
CWA255	8607110945	242.0	1695	8.6	70.0	227.8	46.0	306.5
CWA256	8607121630	27.5	210	7.9	62.0	27.9	284.5	532.5
CWA257	8607132145	4.0	90	2.7	10.0	1.4	288.0	536.5
CWA258	8607140145	31.5	135	14.0	34.0	31.4	288.0	536.5
CWA261	8607171245	2.5	75	2.0	4.0	0.1	47.0	577.5
CWA264	8607201100	3.5	30	7.0	10.0	2.5	30.5	328.5
CWA267	8607210600	2.5	30	5.0	8.0	1.4	30.0	385.0
CWA270	8607240400	4.0	30	8.0	10.0	1.8	43.0	374.0
CWA273	8607250330	4.5	30	9.0	16.0	4.3	42.0	382.0
CWA276	8608100830	133.0	1335	6.0	46.0	105.0	24.0	26.5
CWA277	8608110830	119.5	960	7.5	42.0	95.7	157.0	159.5
CWA278	8608162000	10.5	60	10.5	14.0	5.8	18.0	287.5
CWA281	8608200615	8.0	45	10.7	20.0	3.1	18.0	295.0
CWA282	8608201245	26.5	75	2.1	18.0	9.5	51.5	328.5
CWA284	8609032130	23.5	60	23.5	48.0	20.0	37.0	161.0
CWA286	8609041215	5.0	120	2.5	6.0	2.0	58.0	160.0
CWA289	8609060200	23.0	405	3.4	20.0	18.3	73.0	159.0
CWA290	8609061700	2.0	15	8.0	8.0	0.9	119.0	204.5
CWA291	8609061900	20.5	165	7.5	24.0	12.8	119.0	204.5
CWA294	8609071530	18.0	180	6.0	18.0	11.3	144.0	156.0
CWA295	8609081430	6.5	30	13.0	24.0	2.7	126.5	163.5
CWA296	8609161445	22.0	90	14.7	56.0	14.3	43.0	195.0
CWA297	8609161745	20.5	90	13.7	32.0	17.6	43.0	195.0
CWA298	8610281230	25.0	135	11.1	28.0	16.2	0.0	43.0
CWA301	8703160300	54.5	705	4.6	46.0	31.9	5.0	5.5
CWA305	8703220215	2.5	60	2.5	4.0	0.7	153.0	212.5
CWA306	8703250200	26.5	930	1.8	18.0	15.1	19.0	216.5

Table B1 - Summary of 1986 to 1988 Rainfall and Runoff Data for the Plot at Clear Water Bay Road (CWA) (Sheet 2 of 3)

Code	Date/Time	Rainfall (mm)	Rain Duration (min)	Rainfall Intensity (mm/hr)		Runoff (mm)	Antecedent Rainfall (mm)	
				Avg.	Max.		5-day	15-day
CWA307	8704051715	89.0	600	8.9	62.0	61.9	91.5	124.0
CWA311	8704130015	4.0	60	4.0	6.0	2.2	39.5	285.5
CWA314	8705031000	16.0	75	12.8	22.0	11.3	2.5	3.5
CWA315	8705071800	49.5	315	9.4	44.0	49.4	74.0	75.0
CWA316	8705160800	77.0	1275	3.6	44.0	52.6	1.5	93.0
CWA318	8705220315	25.5	75	20.4	56.0	19.9	45.0	167.5
CWA319	8705221330	51.0	135	22.7	84.0	46.0	121.0	219.0
CWA320	8705251600	16.5	105	9.4	46.0	13.2	152.5	249.0
CWA322	8705281815	6.5	360	1.1	8.0	4.5	106.0	338.5
CWA324	8706040830	51.0	900	3.4	38.0	42.5	17.5	270.0
CWA325	8706060230	50.0	585	5.1	18.0	36.7	67.0	313.5
CWA326	8706070930	35.0	810	2.6	24.0	33.8	113.0	270.0
CWA329	8706182330	19.0	825	1.4	18.0	18.8	12.5	159.0
CWA332	8707040400	4.0	195	1.2	10.0	2.4	21.0	51.0
CWA335	8707080030	3.0	30	6.0	10.0	2.3	33.0	49.5
CWA340	8707181730	5.5	15	22.0	22.0	4.3	28.0	76.0
CWA342	8707221900	65.0	240	16.3	98.0	58.2	97.0	131.5
CWA344	8707240545	26.0	285	5.5	44.0	21.6	97.0	132.0
CWA345	8707250600	20.2	600	2.0	14.0	12.6	121.5	153.0
CWA346	8707252230	65.5	720	5.5	72.0	64.2	144.0	175.0
CWA347	8707291530	201.5	2040	5.9	70.0	180.0	223.5	374.5
CWA348	8708150645	19.5	45	26.0	46.0	12.9	0.5	12.0
CWA351	8708160445	28.0	855	2.0	40.0	18.9	28.5	40.0
CWA352	8708170100	64.5	615	6.3	72.0	39.6	121.0	125.5
CWA353	8708201500	26.0	5	34.7	74.0	18.5	119.0	148.5
CWA354	8708220215	4.0	210	1.1	8.0	2.2	96.5	153.0
CWA357	8708231815	5.0	30	10.0	18.0	4.3	45.0	166.0
CWA360	8708310945	8.5	75	6.8	18.0	3.0	15.0	158.0
CWA363	8709181015	25.5	75	20.4	46.0	16.1	N.A.	N.A.
CWA364	8709211945	75.0	510	8.8	64.0	55.8	N.A.	N.A.
CWA365	8709241145	25.0	75	20.0	68.0	21.0	N.A.	N.A.
CWA368	8709261230	3.5	165	1.3	4.0	1.8	62.5	N.A.
CWA369	8710280500	41.0	465	5.3	20.0	30.0	8.5	12.0
CWA402	8804070330	10.0	195	3.1	14.0	11.7	N.A.	N.A.
CWA404	8804120730	22.0	285	4.6	40.0	14.9	N.A.	N.A.
CWA406	8804211700	4.0	60	4.0	12.0	2.4	34.0	N.A.
CWA409	8804221345	1.0	60	1.0	2.0	0.6	39.5	72.0
CWA421	8806210915	4.0	45	5.3	12.0	1.4	21.5	26.5
CWA424	8806240245	50.5	990	3.1	16.0	45.7	86.0	110.5
CWA427	8806291400	5.0	225	1.3	8.0	1.8	113.5	251.5
CWA428	8806301045	10.5	195	3.2	10.0	8.3	120.0	258.0
CWA431	8807120600	10.0	45	13.3	28.0	8.0	15.5	60.5
CWA432	8807121745	22.5	240	5.6	32.0	11.0	40.5	76.0
CWA436	8807190300	215.5	1770	7.3	82.0	193.3	9.5	55.5
CWA438	8807212330	2.0	15	8.0	8.0	0.7	227.0	278.0
CWA440	8808021445	77.5	1005	4.6	54.0	73.2	58.0	N.A.
CWA442	8808041100	9.0	240	2.3	16.0	6.5	N.A.	N.A.
CWA445	8808101515	15.0	30	30.0	36.0	15.1	N.A.	N.A.

Table B1 - Summary of 1986 to 1988 Rainfall and Runoff Data for the Plot at Clear Water Bay Road (CWA) (Sheet 3 of 3)

Code	Date/Time	Rainfall (mm)	Rain Durat-ion (min)	Rainfall Intensity (mm/hr)		Runoff (mm)	Antecedent Rainfall (mm)	
				Avg.	Max.		5-day	15-day
CWA446	8808110015	43.5	360	7.3	40.0	38.6	N.A.	N.A.
CWA448	8808121045	18.0	150	7.2	26.0	15.1	76.0	N.A.
CWA449	8808140515	38.5	570	4.1	58.0	17.8	111.0	N.A.
CWA450	8808150745	31.0	330	5.6	28.0	21.6	140.0	N.A.
CWA452	8808171815	23.0	450	3.1	26.0	17.6	105.5	N.A.
CWA454	8808190630	29.0	300	5.8	28.0	29.8	164.5	N.A.
CWA455	8808201500	13.5	135	6.0	30.0	14.2	147.0	N.A.
CWA458	808300445	10.0	90	6.7	22.0	10.8	12.5	201.5
CWA460	8808310100	62.0	690	5.4	42.0	52.4	66.0	232.0
CWA463	8809162115	44.0	225	11.7	62.0	32.8	57.5	69.0
CWA464	8809230830	8.5	135	3.8	16.0	3.7	1.5	66.0
CWA467	8810020115	8.5	195	2.6	12.0	5.4	11.0	33.0

Legend :

8604210045
- 45 — Minute
- 00 — Hour
- 21 — Day
- 04 — Month
- 86 — Year

N.A. Not available

Table B2 - Summary of 1986 to 1988 Rainfall and Runoff Data for the Plot at Clear Water Bay Road (CWB) (Sheet 1 of 3)

Code	Date/Time	Rainfall (mm)	Rain Duration (min)	Rainfall Intensity (mm/hr)		Runoff (mm)	Antecedent Rainfall (mm)	
				Avg.	Max.		5-day	15-day
CWB203	8604210045	91.0	1065	5.1	60.0	35.0	6.0	7.0
CWB204	8604220630	25.0	105	14.3	48.0	13.0	94.5	98.0
CWB208	8605110815	171.5	1650	6.2	64.0	42.4	N.A.	N.A.
CWB209	8605121915	6.5	60	6.5	10.0	1.0	189.0	N.A.
CWB210	8605140445	21.0	285	4.4	26.0	4.7	189.0	N.A.
CWB214	8605200415	33.0	195	10.2	36.0	8.3	25.0	N.A.
CWB215	8605210445	13.0	300	2.6	8.0	1.1	60.0	N.A.
CWB216	8605211615	22.5	465	2.9	10.0	1.9	97.5	N.A.
CWB218	8605230100	3.0	105	1.7	4.0	0.5	114.0	325.0
CWB220	8606010030	29.0	120	14.5	38.0	9.9	8.0	127.0
CWB221	8606040345	13.5	210	3.9	10.0	2.2	37.0	131.5
CWB223	8606051230	7.5	30	15.0	24.0	1.5	N.A.	N.A.
CWB225	8606130245	3.0	30	6.0	10.0	1.0	28.0	N.A.
CWB230	8606250715	5.5	30	11.0	20.0	1.9	16.0	68.5
CWB232	8606270230	3.0	90	2.0	10.0	0.3	144.5	204.0
CWB233	8607030830	78.5	420	11.2	50.0	22.8	2.0	167.5
CWB234	8607040330	135.5	525	15.5	62.0	33.8	80.0	241.5
CWB235	8607070300	25.5	210	7.3	66.0	5.8	220.0	272.0
CWB237	8607110945	242.0	1695	8.6	70.0	35.5	46.0	306.5
CWB238	8607121630	27.5	210	7.9	62.0	9.9	284.5	523.5
CWB239	8607140145	31.5	135	14.0	34.0	6.8	288.0	536.5
CWB240	8607160630	4.5	45	6.0	10.0	1.0	309.0	567.5
CWB242	8607191645	5.0	30	10.0	14.0	1.1	20.5	373.0
CWB244	8607201100	3.5	30	7.0	10.0	1.3	30.5	382.5
CWB246	8607211400	14.0	60	14.0	22.0	1.5	47.0	399.0
CWB248	8607241030	4.0	30	8.0	12.0	3.2	47.0	378.0
CWB250	8608092300	23.5	480	2.9	18.0	6.8	10.5	13.0
CWB251	8608100830	133.0	465	4.8	40.0	48.0	24.0	26.5
CWB252	8608110830	119.5	960	7.5	42.0	18.8	157.0	159.5
CWB253	8608162000	10.5	60	10.5	14.0	4.0	18.0	287.5
CWB255	8608171730	2.5	30	5.0	6.0	0.4	18.0	295.0
CWB257	8608201245	26.5	75	2.1	18.0	3.7	51.5	348.5
CWB258	8608212030	14.0	90	9.3	42.0	3.8	57.0	344.5
CWB259	8608230845	73.5	195	22.6	82.0	32.1	50.5	345.5
CWB261	8609032130	23.5	60	23.5	48.0	10.7	37.0	161.0
CWB262	8609040030	7.5	90	5.0	22.0	1.5	37.0	161.0
CWB264	8609050200	5.5	60	5.5	12.0	0.3	58.0	160.0
CWB266	8609060200	23.0	405	3.4	20.0	2.4	23.0	159.0
CWB268	8609061900	20.5	165	7.5	24.0	4.9	119.0	204.5
CWB269	8609070115	2.0	15	8.0	8.0	0.3	119.0	204.5
CWB271	8609071530	18.0	180	6.0	18.0	2.6	144.0	156.0
CWB273	8609161445	22.0	90	14.7	56.0	10.3	43.0	195.0
CWB274	8609161745	20.5	90	13.7	32.0	8.2	43.0	195.0
CWB275	8610281230	25.0	135	11.1	28.0	11.1	0.0	43.0
CWB301	8703160300	54.5	705	4.6	46.0	27.6	5.0	5.5
CWB302	8703170100	123.0	1020	7.2	88.0	84.3	59.5	60.0
CWB303	8703180315	14.5	465	1.9	16.0	2.7	183.5	185.5
CWB305	8705031000	16.0	75	12.8	22.0	6.5	2.5	3.5

Table B2 - Summary of 1986 to 1988 Rainfall and Runoff Data for the Plot at Clear Water Bay Road (CWB) (Sheet 2 of 3)

Code	Date/Time	Rainfall (mm)	Rain Duration (min)	Rainfall Intensity (mm/hr)		Runoff (mm)	Antecedent Rainfall (mm)	
				Avg.	Max.		5-day	15-day
CWB306	8705160800	77.0	1275	3.6	44.0	18.1	3.0	94.5
CWB307	8705221330	51.0	135	22.7	84.0	19.0	121.0	219.0
CWB308	8705230830	28.5	210	8.1	46.0	5.8	123.5	221.5
CWB310	8705260730	10.5	225	2.8	28.0	2.6	152.5	249.0
CWB311	8705270845	64.5	690	5.6	58.0	17.5	162.5	260.0
CWB313	8706040830	50.5	900	3.4	38.0	11.0	17.5	270.0
CWB314	8706050215	49.5	450	6.6	18.0	6.8	67.0	313.5
CWB315	8706060915	10.5	210	3.0	14.0	1.2	120.0	365.5
CWB316	8706070930	35.0	810	2.6	24.0	3.4	113.0	270.0
CWB318	8706182330	19.0	825	1.4	18.0	11.0	12.5	159.0
CWB320	8707070230	12.5	330	2.3	12.0	2.1	31.0	33.0
CWB322	8707082330	7.5	30	15.0	18.0	1.9	41.0	62.0
CWB324	8707221900	65.0	240	16.3	98.0	18.9	97.0	131.5
CWB325	8707240545	26.0	285	5.5	44.0	5.4	97.0	132.0
CWB326	8707250600	20.2	600	2.0	14.0	1.9	121.5	153.0
CWB327	8707252230	65.5	720	5.5	72.0	17.0	144.0	175.0
CWB328	8707291530	201.5	2040	5.9	70.0	84.8	223.5	374.5
CWB329	8708010230	5.0	165	1.8	18.0	0.7	288.5	525.0
CWB330	8708150645	19.5	45	26.0	46.0	8.2	19.0	30.5
CWB332	8708152115	2.0	30	4.0	6.0	0.5	28.5	40.0
CWB333	8708160045	17.0	60	17.0	40.0	5.8	38.5	50.0
CWB335	8708170100	64.5	615	6.3	72.0	20.9	68.5	74.5
CWB336	8708201500	26.0	5	34.7	74.0	8.7	119.0	148.5
CWB337	8708231815	5.0	30	10.0	18.0	0.2	45.0	166.0
CWB338	8708291915	11.0	45	14.7	26.0	2.9	16.0	183.0
CWB340	8709020015	8.5	165	3.1	22.0	1.5	26.5	78.0
CWB341	8709170145	8.5	30	17.0	24.0	3.6	N.A.	N.A.
CWB342	8709181015	25.5	75	20.4	46.0	10.1	N.A.	N.A.
CWB343	8709211945	75.0	510	8.8	64.0	22.4	N.A.	N.A.
CWB344	8709241145	25.0	75	20.0	68.0	8.0	N.A.	N.A.
CWB346	8709252030	12.5	30	25.0	40.0	3.2	126.5	N.A.
CWB347	8710280500	41.0	465	5.3	20.0	18.5	7.0	N.A.
CWB348	8710282100	18.0	525	2.1	8.0	2.5	52.0	N.A.
CWB402	8804070330	10.0	195	3.1	14.0	3.0	N.A.	N.A.
CWB404	8804120730	22.0	285	4.6	40.0	11.6	22.0	N.A.
CWB406	8804201430	17.5	105	10.0	32.0	4.4	29.0	N.A.
CWB408	8804220030	2.0	15	8.0	8.0	0.2	36.0	79.5
CWB415	8806210915	4.0	45	5.3	12.0	0.7	21.5	26.5
CWB417	8806230100	57.5	960	3.6	34.0	20.8	23.0	35.5
CWB418	8806240245	50.5	990	3.1	16.0	7.8	79.0	93.5
CWB419	8806260345	95.5	690	8.3	50.0	18.8	123.0	145.0
CWB420	8806272300	4.5	60	4.5	16.0	0.3	214.0	245.5
CWB422	8806301045	10.5	195	3.2	10.0	1.6	119.0	257.0
CWB424	8807110700	7.0	285	1.5	2.0	1.8	2.5	143.0
CWB425	8807121745	22.5	240	5.6	32.0	7.1	8.5	53.5
CWB427	8807130445	4.0	30	8.0	14.0	0.5	49.0	84.5
CWB429	8807201230	5.0	15	20.0	20.0	0.3	226.0	275.5
CWB432	8808031515	12.5	150	5.0	14.0	0.6	97.0	N.A.

Table B2 - Summary of 1986 to 1988 Rainfall and Runoff Data for the Plot at Clear Water Bay Road (CWB) (Sheet 3 of 3)

Code	Date/Time	Rainfall (mm)	Rain Duration (min)	Rainfall Intensity (mm/hr)		Runoff (mm)	Antecedent Rainfall (mm)	
				Avg.	Max.		5-day	15-day
CWB435	8808140515	38.5	570	4.1	58.0	4.5	114.0	N.A.
CWB436	8808150745	31.0	330	5.6	28.0	5.3	140.0	N.A.
CWB437	8808250630	8.0	45	10.6	26.0	3.5	44.5	332.0
CWB439	8809041815	7.0	135	3.1	14.0	1.8	70.0	154.5
CWB441	8809230830	8.5	135	3.8	16.0	4.0	1.5	66.0

Legend :

8604210045
- 45 — Minute
- 00 — Hour
- 21 — Day
- 04 — Month
- 86 — Year

N.A. Not available

Table B3 - Summary of 1986 to 1988 Rainfall and Runoff Data for the Plot at Chuk Yuen (CYA) (Sheet 1 of 3)

Code	Date/Time	Rainfall (mm)	Rain Duration (min)	Rainfall Intensity (mm/hr)		Runoff (mm)	Antecedent Rainfall (mm)	
				Avg.	Max.		5-day	15-day
CYA201	8603240145	7.5	90	5.0	10.0	1.0	4.0	8.5
CYA202	8603250700	5.5	45	7.3	16.0	0.6	3.0	8.5
CYA203	8603281030	17.0	210	4.9	16.0	2.8	4.5	13.0
CYA204	8604210030	73.5	1050	4.2	30.0	26.9	1.0	1.0
CYA205	8604220600	23.0	135	10.2	60.0	7.2	75.5	76.0
CYA206	8605110815	92.0	690	8.0	74.0	39.3	N.A.	N.A.
CYA207	8605140500	24.5	210	7.0	30.0	3.2	163.5	N.A.
CYA208	8605200400	45.5	300	9.1	46.0	22.1	29.0	N.A.
CYA209	8606010130	32.5	75	26.0	64.0	14.4	2.0	121.0
CYA210	8606040330	18.5	210	5.3	20.0	0.8	18.5	111.5
CYA211	8606041300	11.5	120	5.8	34.0	0.6	40.5	100.5
CYA212	8606060530	163.5	450	21.8	68.0	122.4	N.A.	N.A.
CYA213	8606061915	24.5	135	10.9	32.0	9.4	187.5	210.5
CYA214	8606171700	31.0	75	24.8	68.0	8.1	30.0	258.0
CYA215	8606181615	13.0	30	26.0	48.0	4.0	40.0	272.5
CYA216	8606182000	16.5	210	4.7	46.0	3.3	40.0	272.5
CYA217	8606251600	73.0	405	10.8	46.0	40.4	80.5	139.5
CYA218	8607031030	70.0	315	13.3	58.0	33.7	5.5	113.5
CYA219	8607040330	181.0	585	18.6	96.0	130.5	46.5	143.0
CYA220	8607070300	21.0	225	5.6	36.0	2.4	206.0	300.0
CYA221	8607081315	26.0	90	17.3	52.0	9.6	195.0	330.0
CYA222	8607111015	127.5	1650	6.7	66.0	109.0	89.0	304.0
CYA223	8607132130	32.0	585	3.3	18.0	2.1	213.5	455.0
CYA224	8607211415	9.0	45	12.0	24.0	0.6	41.5	325.0
CYA225	8607311915	12.5	30	25.0	26.0	3.5	13.0	57.5
CYA226	8608212045	26.0	75	20.8	80.0	6.7	48.5	300.5
CYA227	8608301600	7.5	30	15.0	18.0	1.0	28.5	117.0
CYA228	8609032200	12.5	45	16.7	32.0	0.9	41.5	119.0
CYA229	8609041830	21.5	165	7.8	18.0	6.2	38.5	117.5
CYA230	8609061915	25.5	135	11.3	28.0	13.4	92.0	149.5
CYA231	8609071545	23.5	270	5.2	22.0	4.9	125.0	153.5
CYA232	8609161445	68.0	270	15.1	100.0	29.1	52.5	182.0
CYA233	8610281230	28.0	135	12.4	34.0	6.3	27.5	54.5
CYA301	8704051645	69.5	585	7.6	42.0	52.8	61.0	84.0
CYA302	8704060900	106.5	960	6.7	36.0	69.1	65.0	88.0
CYA303	8704120915	49.0	135	21.8	80.0	22.3	12.0	176.0
CYA304	8704131315	18.5	570	2.0	10.0	1.6	66.5	239.5
CYA305	8705080945	23.0	210	6.6	28.0	5.1	52.0	53.0
CYA306	8705160900	12.0	60	12.0	40.0	1.2	6.5	75.0
CYA307	8705161215	36.5	315	6.9	52.0	11.4	55.0	124.0
CYA308	8705162100	35.5	315	6.8	64.0	12.3	55.0	124.0
CYA309	8705220300	17.0	75	13.6	20.0	2.4	33.0	149.0
CYA310	8705221315	26.0	120	13.0	56.0	5.0	70.5	168.5
CYA311	8705222300	18.5	60	18.5	52.0	6.1	70.5	168.5
CYA312	8705230900	33.5	120	16.8	56.0	14.4	75.5	173.5
CYA313	8705251545	13.0	60	13.0	34.0	0.4	102.0	186.5
CYA314	8705270600	74.0	720	6.2	52.0	25.8	106.0	193.0
CYA315	8706011830	13.5	135	6.0	20.0	1.7	21.5	192.5

Table B3 - Summary of 1986 to 1988 Rainfall and Runoff Data for the Plot at Chuk Yuen (CYA) (Sheet 2 of 3)

Code	Date/Time	Rainfall (mm)	Rain Duration (min)	Rainfall Intensity (mm/hr)		Runoff (mm)	Antecedent Rainfall (mm)	
				Avg.	Max.		5-day	15-day
CYA316	8706040915	35.0	150	14.0	36.0	7.9	11.0	191.5
CYA317	8706050315	35.0	375	5.6	14.0	7.8	49.5	225.5
CYA318	8706060800	15.0	180	5.1	22.0	0.9	79.5	252.5
CYA319	8706070900	32.5	450	4.3	44.0	2.4	85.5	207.5
CYA320	8706071815	8.0	15	32.0	32.0	0.6	119.5	217.0
CYA321	8706191215	75.0	330	13.6	56.0	56.0	113.5	195.0
CYA322	8706191800	34.0	195	10.5	36.0	11.7	113.5	195.0
CYA323	8707020930	10.5	135	4.7	18.0	4.9	14.0	142.0
CYA324	8707081945	5.5	75	4.4	12.0	4.8	28.5	66.5
CYA325	8707100345	3.5	3	7.0	8.0	1.5	36.5	76.5
CYA326	8707170800	3.0	15	12.0	12.0	0.1	2.0	74.5
CYA327	8707171730	33.5	2310	0.9	16.0	23.7	12.5	61.5
CYA328	8707221145	134.0	720	11.2	90.0	70.9	51.0	85.5
CYA329	8707240600	19.0	45	25.3	68.0	12.6	116.5	157.5
CYA330	8707250915	75.0	1500	3.0	40.0	69.6	120.5	164.0
CYA331	8707281045	47.5	32	9.0	54.0	16.1	91.0	229.5
CYA333	8708150645	10.0	45	13.0	24.0	2.8	2.5	7.0
CYA335	8708161645	63.0	195	2.8	26.0	18.2	47.0	51.0
CYA336	8708201445	21.0	75	16.8	40.0	2.7	78.5	106.5
CYA337	8708221245	4.5	90	3.0	10.0	0.6	27.5	117.5
CYA338	8708291900	12.5	30	25.0	34.0	1.3	12.0	130.0
CYA339	8709020000	30.5	165	11.1	40.0	4.8	9.5	42.5
CYA340	8709241145	12.5	30	25.0	44.0	0.6	N.A.	N.A.
CYA341	8709250900	18.5	30	37.0	40.0	4.7	N.A.	N.A.
CYA342	8709252100	9.0	60	9.0	34.0	0.6	N.A.	N.A.
CYA401	8804070530	12.0	60	12.0	26.0	1.5	N.A.	N.A.
CYA402	8804080230	10.0	30	20.0	32.0	1.0	N.A.	N.A.
CYA403	8804120815	18.0	225	4.8	38.0	1.8	27.0	N.A.
CYA404	8804200930	13.0	45	17.3	38.0	1.6	3.5	44.5
CYA405	8804281900	18.0	90	12.0	48.0	2.3	14.0	N.A.
CYA406	8805111830	13.5	60	13.5	34.0	0.9	8.0	N.A.
CYA407	8805120545	22.5	135	10.0	36.0	3.0	8.0	N.A.
CYA408	8805210445	5.5	180	1.8	8.0	0.3	1.0	N.A.
CYA409	8805260915	30.0	90	20.0	64.0	6.4	9.5	65.0
CYA410	8806130700	10.0	30	20.0	38.0	1.2	4.0	4.0
CYA411	8806140800	5.5	105	3.1	8.0	0.3	10.5	10.5
CYA412	8806170530	5.0	15	20.0	20.0	0.3	14.0	16.0
CYA413	8806221200	9.0	30	60.0	20.0	1.9	12.0	25.5
CYA414	8806230545	66.0	720	4.0	56.0	17.0	14.0	35.0
CYA415	8806240815	41.5	555	4.5	20.0	7.8	67.5	88.5
CYA416	8806260715	62.5	345	10.8	68.0	17.1	119.5	143.5
CYA417	8806271845	20.0	60	20.0	48.0	3.0	162.5	192.5
CYA418	8807190300	69.0	300	19.4	60.0	19.4	2.0	39.5
CYA419	8807201130	11.5	165	4.2	26.0	0.4	162.0	200.0
CYA420	8807220115	3.5	30	7.0	14.0	0.3	162.0	200.5
CYA421	8808021445	45.0	390	6.9	52.0	8.7	55.0	265.5
CYA422	8807271600	81.0	285	17.1	132.0	38.0	44.5	213.0
CYA423	8808031510	15.0	165	5.5	24.0	0.5	77.5	154.5

Table B3 - Summary of 1986 to 1988 Rainfall and Runoff Data for the Plot at Chuk Yuen (CYA) (Sheet 3 of 3)

Code	Date/Time	Rainfall (mm)	Rain Duration (min)	Rainfall Intensity (mm/hr)		Runoff (mm)	Antecedent Rainfall (mm)	
				Avg.	Max.		5-day	15-day
CYA424	8808041040	13.0	240	3.3	18.0	0.3	80.0	157.0
CYA425	8808100815	17.0	75	13.6	32.0	1.3	4.5	143.0
CYA426	8808110045	46.0	840	3.3	26.0	7.8	33.5	174.5
CYA427	8808121045	22.5	135	10.0	34.0	2.9	79.0	175.5
CYA428	8808140100	63.5	885	4.3	38.0	35.8	106.5	198.0
CYA429	8808300200	6.0	255	1.4	18.0	0.8	21.0	167.0
CYA430	8808301045	32.0	405	4.7	40.0	3.8	42.5	188.5
CYA431	8808310830	57.5	240	14.4	66.0	36.7	72.5	184.0
CYA432	8809041815	13.0	30	26.0	42.0	1.2	75.5	154.0
CYA433	8809111100	8.0	90	5.3	12.0	0.2	29.0	171.0
CYA434	8809162215	31.5	105	30.0	48.0	4.0	20.5	67.5
CYA435	8810020300	10.0	330	1.8	8.0	0.3	17.0	32.0

Legend :

8603240145
- 86 — Year
- 03 — Month
- 24 — Day
- 01 — Hour
- 45 — Minute

N.A. Not available

Table B4 - Summary of 1986 to 1988 Rainfall and Runoff Data for the Plot at Chuk Yuen (CYB) (Sheet 1 of 3)

Code	Date/Time	Rainfall (mm)	Rain Duration (min)	Rainfall Intensity (mm/hr)		Runoff (mm)	Antecedent Rainfall (mm)	
				Avg.	Max.		5-day	15-day
CYB201	8603240145	7.5	90	5.0	10.0	0.7	4.0	8.5
CYB202	8603250700	5.5	45	7.3	16.0	0.7	3.0	8.5
CYB203	8603281030	17.0	210	4.9	16.0	2.3	4.5	13.0
CYB204	8604210030	73.5	1050	4.2	30.0	14.1	1.0	1.0
CYB205	8604220600	23.0	135	10.2	60.0	5.7	75.5	76.0
CYB206	8605110815	123.5	930	8.0	74.0	37.7	N.A.	N.A.
CYB207	8605120500	48.5	405	7.2	34.0	17.5	110.5	N.A.
CYB208	8605140500	24.5	210	7.0	30.0	2.3	163.5	N.A.
CYB209	8605200400	45.5	300	9.1	46.0	18.6	29.0	N.A.
CYB210	8606010130	32.5	75	26.0	64.0	8.7	2.0	121.0
CYB211	8606040330	18.5	210	5.3	20.0	1.7	18.5	111.5
CYB212	8606041300	11.5	120	5.8	34.0	0.7	40.5	100.5
CYB213	8606060530	163.5	450	21.8	68.0	99.0	N.A.	N.A.
CYB214	8606061915	24.5	135	10.9	32.0	5.8	187.5	210.5
CYB215	8606071615	18.0	135	8.0	20.0	1.3	214.5	234.5
CYB216	8606171700	31.0	75	24.8	68.0	3.9	30.0	258.0
CYB217	8606181615	13.0	30	26.0	48.0	1.9	40.0	272.5
CYB218	8606182000	16.5	210	4.7	46.0	1.9	40.0	272.5
CYB219	8606251600	73.0	405	10.8	46.0	29.3	80.5	139.5
CYB220	8607031030	70.0	315	13.3	58.0	25.8	5.5	113.5
CYB221	8607040330	181.0	585	18.6	96.0	98.9	46.5	143.0
CYB222	8607070300	21.0	225	5.6	36.0	0.9	206.0	300.0
CYB223	8607081315	26.0	90	17.3	52.0	7.4	195.0	330.0
CYB224	8607111015	193.0	2100	5.5	66.0	88.5	89.0	304.0
CYB225	8607140030	22.5	405	3.3	16.0	2.0	213.5	455.0
CYB226	8607201130	14.0	150	5.6	30.0	1.6	34.5	309.0
CYB227	8607211415	9.0	45	12.0	24.0	3.6	41.5	325.0
CYB228	8607311915	12.5	30	25.0	26.0	0.9	13.0	57.5
CYB229	8608100430	8.0	45	10.7	18.0	0.3	17.0	22.0
CYB230	8608100830	22.5	285	4.7	22.0	0.9	25.0	38.0
CYB231	8608101430	92.5	795	7.0	46.0	28.8	136.0	149.0
CYB232	8608110415	19.0	90	12.7	52.0	7.8	145.0	158.0
CYB233	8608110815	72.0	960	4.5	42.0	13.7	161.0	174.0
CYB234	8608212045	26.0	75	20.8	80.0	4.5	48.5	300.5
CYB235	8608230915	37.0	120	18.5	46.0	13.4	51.0	304.0
CYB236	8608300245	13.0	75	10.4	22.0	0.5	8.0	97.5
CYB237	8608301600	7.5	30	15.0	18.0	0.9	28.5	117.0
CYB238	8609032200	12.5	45	16.7	32.0	0.5	41.5	119.0
CYB239	8609041830	21.5	165	7.8	18.0	2.6	38.5	117.5
CYB240	8609050700	9.5	120	4.8	12.0	0.7	48.5	127.5
CYB241	8609061915	25.5	135	11.3	28.0	10.5	92.0	149.5
CYB242	8609071545	23.5	270	5.2	22.0	2.4	125.0	153.5
CYB243	8609161445	68.0	270	15.1	100.0	21.5	52.5	182.0
CYB244	8610281230	28.0	135	12.4	34.0	5.1	27.5	54.5
CYB301	8703160515	51.0	555	5.8	52.0	6.1	0.5	0.5
CYB302	8703160515	137.5	600	13.8	112.0	33.5	54.5	54.5
CYB303	8703180545	35.5	210	10.1	62.0	9.4	163.5	163.5
CYB304	8703250215	25.5	255	6.0	40.0	1.3	8.0	197.5

Table B4 - Summary of 1986 to 1988 Rainfall and Runoff Data for the Plot at Chuk Yuen (CYB) (Sheet 2 of 3)

Code	Date/Time	Rainfall (mm)	Rain Duration (min)	Rainfall Intensity (mm/hr)		Runoff (mm)	Antecedent Rainfall (mm)	
				Avg.	Max.		5-day	15-day
CYB305	8704051645	69.5	585	7.6	42.0	15.1	61.0	84.0
CYB306	8704060900	106.5	960	6.7	36.0	38.3	65.0	88.0
CYB307	8704120915	49.0	135	21.8	80.0	13.9	12.0	176.0
CYB308	8704131315	18.5	570	2.0	10.0	3.1	66.5	239.5
CYB309	8705071730	53.0	225	14.0	44.0	13.1	49.0	50.0
CYB310	8705080945	23.0	210	6.6	28.0	4.5	52.0	53.0
CYB311	8705160900	12.0	60	12.0	40.0	0.9	6.5	75.0
CYB312	8705161215	36.5	315	7.0	52.0	9.4	55.0	124.0
CYB313	8705162100	35.5	315	6.8	64.0	9.3	55.0	124.0
CYB314	8705220300	17.0	75	13.6	20.0	1.2	33.0	149.0
CYB315	8705221315	26.0	120	13.0	56.0	4.4	70.5	168.5
CYB316	8705222300	18.5	60	18.5	52.0	4.4	70.5	168.5
CYB317	8705230900	33.5	120	16.8	56.0	12.0	75.5	173.5
CYB318	8705251545	13.0	60	13.0	34.0	1.0	102.0	186.5
CYB319	8705270600	74.0	720	6.2	52.0	24.7	106.0	193.0
CYB320	8706011830	13.5	135	6.0	20.0	1.1	21.5	192.5
CYB321	8706040915	35.0	150	14.0	36.0	9.1	11.0	191.5
CYB322	8706050315	35.0	375	5.6	14.0	7.1	49.5	225.5
CYB323	8706060800	15.0	180	5.1	22.0	3.0	79.5	252.5
CYB324	8706070900	32.5	450	4.3	44.0	9.4	85.5	207.5
CYB325	8706071815	8.0	15	32.0	32.0	3.0	119.5	217.0
CYB326	8706190030	12.0	225	3.2	12.0	1.4	11.0	130.5
CYB327	8706191215	75.0	330	13.6	56.0	42.3	113.5	195.0
CYB328	8706191800	34.0	195	10.5	36.0	9.0	113.5	195.0
CYB329	8707020930	10.5	135	4.7	18.0	4.3	14.0	142.0
CYB330	8708150645	9.5	60	9.5	20.0	0.7	2.5	7.0
CYB331	8708151700	18.5	285	3.9	28.0	3.2	27.5	32.0
CYB332	8708160445	12.5	30	25.0	32.0	1.1	28.0	32.5
CYB333	8708170115	55.5	435	7.7	72.0	12.9	47.0	51.0
CYB334	8708201430	19.0	45	25.3	40.0	1.4	78.5	106.5
CYB335	8708291915	13.5	45	18.0	40.0	0.4	12.0	130.0
CYB336	8709180945	13.5	90	9.0	16.0	1.6	N.A.	N.A.
CYB337	8710280630	42.5	360	7.1	16.0	9.7	10.0	N.A.
CYB401	8804070530	12.0	60	12.0	26.0	1.2	N.A.	N.A.
CYB402	8804080230	10.0	30	20.0	32.0	0.6	N.A.	N.A.
CYB403	8804120815	18.0	225	4.8	38.0	2.9	30.0	N.A.
CYB404	8804200930	13.0	45	17.3	38.0	1.2	3.5	N.A.
CYB405	8804281900	18.0	90	12.0	48.0	1.3	14.0	N.A.
CYB406	8805111830	13.5	60	13.5	34.0	1.0	8.0	N.A.
CYB407	8805120545	22.5	135	10.0	36.0	2.3	8.0	N.A.
CYB408	8805210445	5.5	180	1.8	8.0	0.2	1.0	N.A.
CYB409	8805260915	30.0	90	20.0	64.0	5.2	0.0	38.5
CYB410	8806130700	10.0	30	20.0	38.0	0.6	4.0	4.0
CYB411	8806140800	5.5	105	3.1	8.0	0.2	10.5	10.5
CYB412	8806221200	9.0	30	60.0	20.0	0.4	11.0	32.0
CYB413	8806230545	66.0	720	4.0	56.0	12.1	16.0	37.0
CYB414	8806240815	41.5	555	4.5	20.0	5.4	75.0	96.0
CYB415	8806260715	62.5	345	10.8	68.0	13.5	119.5	143.5

Table B4 - Summary of 1986 to 1988 Rainfall and Runoff Data for the Plot at Chuk Yuen (CYB) (Sheet 3 of 3)

Code	Date/Time	Rainfall (mm)	Rain Duration (min)	Rainfall Intensity (mm/hr)		Runoff (mm)	Antecedent Rainfall (mm)	
				Avg.	Max.		5-day	15-day
CYB416	8806271845	20.0	60	20.0	48.0	2.2	162.5	192.5
CYB417	8806300315	15.0	540	1.7	22.0	0.3	76.5	191.5
CYB418	8807100815	12.0	45	16.0	36.0	0.8	11.0	96.5
CYB419	8807190300	167.5	1770	5.7	52.0	52.2	2.0	39.5
CYB420	8807201115	12.0	180	4.0	32.0	0.2	162.0	200.0
CYB421	8807271600	81.0	285	17.1	132.0	29.1	44.5	213.0
CYB422	8808021445	45.0	390	6.9	52.0	3.9	55.0	26.5
CYB423	8808100815	17.0	75	13.6	32.0	0.4	4.5	143.0
CYB424	8808031510	15.0	165	5.5	24.0	0.3	77.5	154.5
CYB425	8808110045	46.0	840	3.3	26.0	3.8	33.5	174.5
CYB426	8808121045	22.5	135	10.0	34.0	3.0	79.0	175.5
CYB427	8808140100	63.5	885	4.3	38.0	26.1	128.5	220.0
CYB428	8808150700	39.0	360	6.5	34.0	11.5	169.5	267.5
CYB430	8808190630	18.0	300	3.6	14.0	1.5	175.5	295.5
CYB431	8808200845	8.5	45	11.3	22.0	0.3	127.5	300.0
CYB432	8808210910	10.5	75	8.4	14.0	0.3	101.0	310.0
CYB433	8808250700	4.0	30	8.0	12.0	0.0	22.0	317.0
CYB434	8808301045	32.0	405	4.7	40.0	3.8	42.5	188.5
CYB435	8808310830	57.5	240	14.4	66.0	30.9	72.5	184.0
CYB436	8809041815	13.0	30	26.0	42.0	0.6	75.5	154.0
CYB437	8809111100	8.0	90	5.3	12.0	0.1	29.0	171.0
CYB438	8809162215	31.5	105	30.0	48.0	3.1	20.5	67.5
CYB439	8810020300	10.0	330	1.8	8.0	0.1	17.0	32.0

Legend :

8603240145
- 86 — Year
- 03 — Month
- 24 — Day
- 01 — Hour
- 45 — Minute

N.A. Not available

Table B5 - Summary of 1986 to 1988 Rainfall and Runoff Data for the Plot at Kohima Barracks (KOH) (Sheet 1 of 3)

Code	Date/Time	Rainfall (mm)	Rain Duration (min)	Rainfall Intensity (mm/hr)		Runoff (mm)	Antecedent Rainfall (mm)	
				Avg.	Max.		5-day	15-day
KOH201	8604210045	89.5	1020	5.3	34.0	24.4	1.5	2.5
KOH202	8604220645	26.5	165	9.6	70.0	16.6	91.0	92.5
KOH203	8604231215	6.5	75	3.6	18.0	1.7	123.0	125.5
KOH204	8605030115	35.5	210	5.0	8.0	11.1	2.5	125.5
KOH206	8605101345	19.0	105	10.9	46.0	7.0	N.A.	N.A.
KOH207	8605110800	165.0	2175	4.6	70.0	153.0	N.A.	N.A.
KOH208	8605140500	15.0	255	3.5	30.0	2.2	186.0	N.A.
KOH209	8605182215	7.0	285	1.5	14.0	0.6	16.5	N.A.
KOH210	8605200400	16.0	195	4.9	16.0	5.5	8.0	N.A.
KOH211	8605210300	20.5	1245	1.0	4.0	8.9	24.5	N.A.
KOH218	8606180215	13.5	180	4.5	24.0	5.9	12.0	N.A.
KOH219	8606251800	67.0	1170	3.9	28.0	54.5	76.0	140.0
KOH220	8606262315	11.5	405	1.7	18.0	5.0	94.5	164.0
KOH221	8607030830	27.5	435	3.7	20.0	8.8	3.5	141.5
KOH222	8607040345	113.0	600	11.3	84.0	56.1	30.0	139.5
KOH223	8607070300	32.5	285	6.8	42.0	12.6	143.5	247.0
KOH224	8607102000	10.0	45	13.3	28.0	1.3	46.0	220.0
KOH225	8607110930	155.5	2130	4.4	34.0	90.3	47.5	221.5
KOH227	8607140230	6.0	60	6.0	10.0	2.5	172.0	350.0
KOH228	8607201245	2.0	15	8.0	8.0	0.3	9.5	222.0
KOH229	8607210215	3.0	30	6.0	8.0	0.4	9.5	222.0
KOH230	8607211345	7.0	90	4.7	12.0	2.5	20.5	234.0
KOH231	8607230300	7.5	210	2.1	14.0	1.8	20.5	200.5
KOH232	8607311915	18.0	45	24.0	46.0	1.4	18.5	48.0
KOH233	8608090245	3.5	15	14.0	14.0	0.2	1.5	20.0
KOH234	8608092245	157.5	3135	3.0	34.0	84.0	10.5	29.5
KOH235	8608200630	4.5	30	9.0	16.0	0.3	4.5	167.0
KOH236	8608201300	15.0	765	0.9	10.0	1.4	22.5	184.5
KOH237	8608212015	15.0	150	6.0	42.0	1.9	34.5	201.0
KOH238	8608221130	14.0	45	18.7	26.0	1.5	35.0	201.5
KOH239	8608230845	73.0	180	24.3	106.0	28.2	48.5	215.0
KOH240	8609032130	31.0	270	6.9	48.0	4.1	17.0	138.5
KOH241	8609041830	17.5	150	7.0	26.0	3.5	38.5	142.0
KOH242	8609060330	15.0	315	2.9	20.0	0.9	45.0	132.0
KOH243	8609062045	16.0	465	2.1	24.0	2.2	50.5	125.0
KOH244	8609071530	20.5	105	11.7	42.0	8.1	158.0	59.5
KOH245	8609081430	12.0	45	16.0	40.0	3.6	146.0	63.0
KOH246	8609161445	19.5	255	4.6	22.0	3.0	21.0	86.5
KOH247	8610281230	18.0	135	8.0	28.0	2.3	18.5	27.0
KOH301	8703160330	63.0	660	5.7	24.0	7.9	1.5	2.0
KOH302	8703170100	47.0	840	3.4	48.0	34.2	64.5	65.0
KOH303	8703180330	62.0	450	8.3	116.0	25.2	111.0	112.0
KOH304	8703211030	26.0	990	1.6	16.0	6.4	122.0	123.5
KOH305	8703250200	24.0	930	1.6	16.0	10.0	N.A.	N.A.
KOH307	8704120615	75.5	2685	1.7	36.0	39.5	4.5	N.A.
KOH308	8705071800	34.5	600	3.5	28.0	6.3	44.0	45.0
KOH309	8705081000	14.5	240	3.6	16.0	6.0	47.0	48.0
KOH310	8705160815	91.0	1470	3.7	62.0	21.7	1.0	63.0

Table B5 - Summary of 1986 to 1988 Rainfall and Runoff Data for the Plot at Kohima Barracks (KOH) (Sheet 2 of 3)

Code	Date/Time	Rainfall (mm)	Rain Durat-ion (min)	Rainfall Intensity (mm/hr)		Runoff (mm)	Antecedent Rainfall (mm)	
				Avg.	Max.		5-day	15-day
KOH311	8705220300	24.5	135	10.8	26.0	6.2	40.0	151.5
KOH312	8705221330	101.0	1245	4.9	107.2	46.7	59.5	168.5
KOH313	8705251600	16.5	60	16.5	42.0	9.0	100.5	199.5
KOH314	8705260715	5.5	30	11.0	18.0	1.6	100.5	199.5
KOH315	8706011845	105.0	135	4.7	12.0	2.1	34.0	197.0
KOH316	8706040815	44.5	300	8.9	38.0	46.9	N.A.	N.A.
KOH317	8706050245	58.5	480	7.3	20.0	53.1	N.A.	N.A.
KOH318	8706060900	32.5	120	16.3	48.0	17.8	N.A.	N.A.
KOH319	8706070915	27.5	660	2.5	14.0	19.0	N.A.	N.A.
KOH320	8707020615	13.5	270	3.0	32.0	0.9	0.5	15.0
KOH321	8707021145	10.0	45	13.3	30.0	2.2	14.0	28.5
KOH322	8707070600	11.5	210	3.3	28.0	9.9	41.0	44.0
KOH323	8707072230	13.0	210	3.7	30.0	2.7	27.0	54.0
KOH324	8707080715	10.0	330	1.8	18.0	1.0	29.0	56.0
KOH325	8707090400	6.0	90	4.0	10.0	1.7	27.0	61.0
KOH326	8707100400	6.5	30	13.0	20.0	1.6	28.0	64.5
KOH327	8707181745	7.0	30	14.0	24.0	0.9	29.0	67.0
KOH328	8707190345	5.5	150	2.2	16.0	0.4	29.0	67.0
KOH329	8707220230	4.0	30	8.0	14.0	1.4	35.0	70.0
KOH330	8707221100	3.5	30	7.0	12.0	1.3	46.5	81.5
KOH331	8707221915	64.5	255	15.2	64.0	27.5	105.0	136.0
KOH332	8707230815	10.0	375	1.6	4.0	2.2	106.0	137.0
KOH333	8707240545	43.5	90	29.0	74.0	12.3	102.5	143.5
KOH334	8707250600	5.0	30	10.0	10.0	0.8	139.5	183.0
KOH335	8707251200	10.0	315	1.9	24.0	3.0	146.5	190.0
KOH336	8707260015	44.5	645	4.1	38.0	21.3	177.0	213.5
KOH337	8707280200	25.0	225	6.7	28.0	15.9	123.0	241.0
KOH338	8707281115	38.0	300	7.6	42.0	23.4	123.5	241.5
KOH339	8707291545	176.0	1290	8.2	72.0	103.1	180.0	355.0
KOH340	8707301530	37.0	405	5.5	42.0	23.3	330.0	525.0
KOH341	8708150700	19.5	45	26.0	46.0	1.5	0.0	2.0
KOH342	8708160500	16.0	60	16.0	40.0	2.8	0.0	1.0
KOH343	8708161700	9.0	195	2.8	24.0	1.8	0.0	1.0
KOH344	8708170115	64.5	600	6.5	72.0	17.6	0.0	1.0
KOH345	8708201530	9.5	30	19.0	28.0	4.6	11.0	12.0
KOH346	8708250545	6.0	30	12.0	22.0	0.8	N.A.	N.A.
KOH347	8708311015	12.5	60	12.5	34.0	2.2	0.0	N.A.
KOH348	8709212230	25.5	345	4.3	26.0	4.2	N.A.	N.A.
KOH349	8709241430	27.0	45	36.0	68.0	2.0	N.A.	N.A.
KOH350	8709252045	12.5	30	25.0	34.0	1.0	N.A.	N.A.
KOH351	8710280500	24.5	375	12.0	3.9	2.5	5.5	N.A.
KOH402	8804070700	1.0	15	4.0	4.0	1.5	N.A.	N.A.
KOH403	8804080200	6.2	75	5.0	24.0	0.4	N.A.	N.A.
KOH404	8804120800	18.3	135	8.1	58.0	2.7	2.5	N.A.
KOH405	8804201330	12.0	150	4.8	25.0	2.9	12.5	N.A.
KOH406	8804211600	10.5	840	0.8	6.0	0.3	19.5	N.A.
KOH407	8804281900	4.0	15	16.0	16.0	0.6	4.0	31.5
KOH411	8805140400	15.5	495	1.9	10.0	3.6	53.0	58.0

Table B5 - Summary of 1986 to 1988 Rainfall and Runoff Data for the Plot at Kohima Barracks (KOH) (Sheet 3 of 3)

Code	Date/Time	Rainfall (mm)	Rain Durat-ion (min)	Rainfall Intensity (mm/hr)		Runoff (mm)	Antecedent Rainfall (mm)	
				Avg.	Max.		5-day	15-day
KOH414	8805260800	23.5	285	5.0	76.0	6.1	9.5	83.5
KOH423	8806230630	76.5	360	12.8	46.0	19.2	0.5	3.0
KOH419	8807120545	33.0	930	2.1	34.0	5.7	8.0	N.A.
KOH420	8807130900	20.0	45	26.7	64.0	3.8	42.0	N.A.
KOH421	8807140400	6.5	345	1.1	22.0	0.9	61.5	N.A.
KOH422	8807190200	121.0	1740	4.2	50.0	69.3	7.0	68.5
KOH429	8808031515	13.5	465	1.7	20.0	5.4	72.0	N.A.
KOH430	8808040700	8.5	60	8.5	14.0	2.4	73.0	N.A.
KOH431	8808101500	8.5	60	8.5	14.0	0.5	10.5	N.A.
KOH432	8808110030	29.5	405	4.4	32.0	11.2	29.0	N.A.
KOH433	8808112030	7.5	120	3.8	20.0	2.0	48.0	N.A.
KOH434	8808120145	23.0	1005	1.4	16.0	6.8	51.5	140.5
KOH435	8808140100	43.5	855	3.1	38.0	8.9	75.0	163.0
KPH436	8808150645	20.5	390	3.2	14.0	8.1	116.0	204.0
KOH437	8808160315	13.0	1035	0.8	8.0	0.3	126.5	223.5
KOH438	8808171815	31.5	435	4.3	28.0	6.8	108.0	228.5
KOH439	8808180800	39.0	675	3.5	26.0	15.5	112.5	233.0
KOH440	8808190700	35.0	270	7.8	30.0	14.0	157.0	244.5
KOH441	8808200545	14.5	690	1.3	28.0	3.6	141.0	258.5
KOH442	8808211000	6.0	30	12.0	12.0	1.9	137.0	273.5
KOH443	8808301000	42.5	375	6.8	48.0	8.3	8.0	169.0
KOH444	8808310300	55.0	540	6.1	48.0	24.1	47.5	191.0
KOH445	8809041700	11.5	60	11.5	18.0	1.1	70.0	126.0
KOH446	8809230815	8.5	105	4.9	20.0	0.2	1.5	31.5
KOH447	8809231830	9.5	30	19.0	28.0	1.1	21.0	51.0
KOH448	8810011330	4.0	195	1.2	6.0	0.3	5.0	32.0
KOH449	8810020030	1.5	105	0.9	2.0	0.3	5.0	32.0

Legend :

8604210045
- 45 — Minute
- 00 — Hour
- 21 — Day
- 04 — Month
- 86 — Year

N.A. Not available

Table B6 - Summary of 1986 to 1988 Rainfall and Runoff Data for the Plot at Tsuen Wan (TWB) (Sheet 1 of 4)

Code	Date/Time	Rainfall (mm)	Rain Duration (min)	Rainfall Intensity (mm/hr)		Runoff (mm)	Antecedent Rainfall (mm)	
				Avg.	Max.		5-day	15-day
TWB201	8603220700	6.5	30	13.0	24.0	0.9	3.5	4.5
TWB202	8603281330	19.5	150	7.8	18.0	7.0	42.5	47.0
TWB203	8604201430	13.0	255	3.1	22.0	3.1	7.0	7.0
TWB204	8604210030	113.0	855	7.9	100.0	47.0	74.5	74.5
TWB205	8604220615	22.0	135	9.8	36.0	8.8	112.0	112.0
TWB206	8605061615	17.0	255	4.0	10.0	3.1	N.A.	N.A.
TWB207	8605110815	230.0	1710	8.1	76.0	177.7	N.A.	N.A.
TWB208	8605140545	26.5	195	8.2	42.0	7.8	201.5	N.A.
TWB209	8605190400	31.5	480	3.9	24.0	10.3	31.5	N.A.
TWB210	8605200415	29.0	180	9.7	34.0	13.1	66.0	N.A.
TWB211	8605210600	22.0	1320	1.0	6.0	4.9	106.5	N.A.
TWB212	8605221445	5.5	60	5.5	8.0	1.3	129.0	354.5
TWB213	8606040345	24.5	195	7.5	28.0	6.2	6.5	85.5
TWB214	8606041145	41.0	300	8.2	56.0	18.4	42.5	121.5
TWB215	8606060615	95.5	345	16.6	46.0	37.3	N.A.	N.A.
TWB216	8606061900	29.5	165	10.7	38.0	8.6	N.A.	N.A.
TWB217	8606070615	30.5	720	2.5	22.0	6.0	N.A.	N.A.
TWB218	8606130015	37.0	120	18.5	42.0	12.0	9.0	N.A.
TWB220	8606181715	65.0	480	8.1	46.0	21.4	49.0	N.A.
TWB221	8606251630	70.5	465	9.1	52.0	23.6	92.0	168.0
TWB222	8606260645	20.5	420	2.9	44.0	7.7	95.0	171.0
TWB223	8607031045	70.0	300	14.0	72.0	18.8	3.5	166.5
TWB224	8607040415	78.0	405	11.6	50.0	31.1	74.0	199.5
TWB225	8607041315	3.5	15	14.0	14.0	0.5	138.5	263.5
TWB226	8607070515	11.5	30	23.0	24.0	0.9	139.0	263.5
TWB227	8607111130	249.0	1620	9.2	62.0	177.9	25.5	197.0
TWB228	8607132200	36.5	90	24.3	46.0	18.5	194.5	358.0
TWB229	8607140415	15.0	75	12.0	24.0	5.9	196.5	360.0
TWB230	8607170245	8.0	165	2.9	28.0	1.3	206.5	375.0
TWB232	8607201330	6.0	30	12.0	20.0	1.9	26.5	263.0
TWB233	8607211400	28.0	45	37.3	54.0	11.5	53.0	289.5
TWB234	8607230345	12.5	30	25.0	48.0	2.6	49.5	276.0
TWB235	8608021415	10.0	45	13.3	20.0	2.2	12.5	63.0
TWB236	8608100000	11.0	420	1.6	10.0	2.5	14.5	27.5
TWB238	8608212030	30.0	30	60.0	64.0	7.8	65.0	318.5
TWB239	8608230830	63.5	165	23.1	80.0	28.1	60.5	324.5
TWB240	8609041900	22.0	150	8.8	26.0	5.6	35.0	134.5
TWB241	8609050030	3.5	15	14.0	14.0	0.4	35.0	134.5
TWB242	8609050215	10.0	150	4.0	18.0	1.6	36.5	136.0
TWB243	8609050700	16.0	165	5.8	20.0	3.9	44.5	144.0
TWB244	8609060315	8.0	120	4.0	12.0	0.8	45.0	144.5
TWB245	8609062045	20.0	90	13.3	20.0	5.7	106.0	168.5
TWB246	8609070445	16.0	90	10.7	32.0	4.9	109.5	172.0
TWB247	8609071600	28.5	165	10.4	36.0	11.9	153.0	154.5
TWB248	8609161630	51.5	195	15.8	52.0	16.1	55.5	208.5
TWB249	8610281200	43.0	165	15.6	64.0	10.1	51.0	80.5
TWB301	8703160515	32.0	225	8.5	52.0	8.9	1.0	1.5
TWB302	8703161315	12.0	60	12.0	32.0	5.7	47.0	47.5

Table B6 - Summary of 1986 to 1988 Rainfall and Runoff Data for the Plot at Tsuen Wan (TWB) (Sheet 2 of 4)

Code	Date/Time	Rainfall (mm)	Rain Duration (min)	Rainfall Intensity (mm/hr)		Runoff (mm)	Antecedent Rainfall (mm)	
				Avg.	Max.		5-day	15-day
TWB303	8703162315	12.5	165	4.6	18.0	5.1	47.0	47.5
TWB304	8703170645	110.0	525	12.6	66.0	73.4	62.0	62.5
TWB305	8703180430	62.0	345	10.8	58.0	39.6	164.0	164.5
TWB306	8703250145	28.5	150	11.4	76.0	9.0	9.0	235.0
TWB307	8704051630	78.0	435	10.8	32.0	78.4	80.5	124.5
TWB308	8704061430	40.0	225	10.6	22.0	36.3	187.0	227.0
TWB309	8704120700	34.0	255	4.0	52.0	10.6	17.0	204.5
TWB310	8704131330	24.0	510	2.8	16.0	9.5	61.0	265.0
TWB311	8704140215	3.0	45	4.0	6.0	1.9	61.0	265.5
TWB312	8705030915	36.5	105	20.9	80.0	8.1	0.0	4.0
TWB313	8705071700	62.5	240	15.6	94.0	11.9	76.0	80.0
TWB314	8705080830	13.5	285	2.8	12.0	0.9	80.0	84.0
TWB315	8705161130	106.5	345	12.0	80.0	47.8	1.0	97.0
TWB316	8705162030	15.5	195	4.8	38.0	5.4	98.5	194.5
TWB317	8705170015	23.5	135	10.4	48.0	12.7	98.5	194.5
TWB318	8705220030	24.5	330	4.5	26.0	5.3	43.5	212.5
TWB319	8705221245	26.0	150	10.4	54.0	6.0	90.5	236.0
TWB320	8705222245	20.5	75	16.4	50.0	6.2	90.5	236.0
TWB321	8705230830	62.0	105	35.4	50.0	26.8	90.5	236.0
TWB322	8705260815	60.0	120	30.0	108.0	36.7	127.0	272.5
TWB323	8705271000	35.5	75	28.4	94.0	12.2	173.0	315.0
TWB324	8705271430	31.5	210	9.0	18.0	10.9	156.5	372.5
TWB325	8706011815	17.5	135	7.8	30.0	2.6	33.5	280.5
TWB326	8706060815	23.5	165	8.6	24.0	5.7	75.5	320.5
TWB327	8706070700	56.5	540	6.3	34.0	18.6	88.0	278.0
TWB328	8706071745	6.0	30	12.0	18.0	1.4	124.0	258.5
TWB329	8706191200	24.0	105	13.7	48.0	19.4	21.5	145.5
TWB330	8706200645	14.0	255	3.3	12.0	12.0	56.5	159.0
TWB331	8707180730	22.5	135	10.0	36.0	4.5	12.5	56.5
TWB332	8707181100	7.0	75	5.6	26.0	1.4	26.5	70.5
TWB333	8707181515	5.0	15	20.0	20.0	1.1	40.0	78.0
TWB334	8707181700	4.5	15	18.0	18.0	1.6	40.0	78.0
TWB335	8707190530	9.0	60	9.0	22.0	1.3	40.0	78.0
TWB336	8707190845	5.5	75	4.4	20.0	1.1	45.0	83.0
TWB337	8707220130	7.5	30	15.0	20.0	1.8	49.0	76.5
TWB338	8707221115	22.5	240	5.6	38.0	6.3	50.5	78.0
TWB339	8707221645	8.0	45	10.6	14.0	2.9	149.5	173.5
TWB340	8707221900	82.5	390	13.2	44.0	43.3	149.5	173.5
TWB341	8707240600	5.0	15	20.0	20.0	2.7	124.0	174.0
TWB342	8707250945	24.0	360	4.0	20.0	7.4	122.0	169.5
TWB343	8707260015	7.0	45	9.3	24.0	1.8	149.5	196.0
TWB344	8707271545	15.5	30	31.0	42.0	2.1	59.5	217.0
TWB345	8707281115	63.5	300	12.7	62.0	49.5	64.0	221.5
TWB346	8707290600	161.5	1080	9.0	58.0	113.5	121.5	285.0
TWB347	8708140630	7.5	30	15.0	24.0	1.6	0.0	182.0
TWB348	8708141545	23.5	45	31.5	40.0	9.1	1.0	3.5
TWB349	8708142000	5.0	15	20.0	20.0	1.5	1.0	3.5
TWB350	8708150345	8.5	150	3.4	28.0	2.3	1.5	4.0

Table B6 - Summary of 1986 to 1988 Rainfall and Runoff Data for the Plot at Tsuen Wan (TWB) (Sheet 3 of 4)

Code	Date/Time	Rainfall (mm)	Rain Duration (min)	Rainfall Intensity (mm/hr)		Runoff (mm)	Antecedent Rainfall (mm)	
				Avg.	Max.		5-day	15-day
TWB351	8708160000	35.0	465	4.5	30.0	14.7	66.0	68.0
TWB352	8708201445	11.0	75	8.8	18.0	2.9	73.0	106.5
TWB353	8708221345	10.0	45	13.3	30.0	2.2	34.0	128.0
TWB354	8708221915	7.0	225	1.9	18.0	1.8	34.0	128.0
TWB355	8708231430	13.5	210	3.9	22.0	2.0	48.0	142.0
TWB356	8708250700	14.0	285	2.9	14.0	1.8	49.0	143.0
TWB357	8708291900	20.0	30	40.0	44.0	4.9	23.5	164.5
TWB358	8708311045	8.0	30	16.0	24.0	1.5	16.0	132.0
TWB359	8709151515	11.0	120	5.5	36.0	1.4	N.A.	N.A.
TWB360	8709160445	4.5	30	9.0	14.0	1.1	N.A.	N.A.
TWB361	8709252015	11.0	75	8.8	30.0	3.8	N.A.	N.A.
TWB362	8710151415	7.0	195	2.2	14.0	1.4	N.A.	N.A.
TWB363	8710280530	30.0	390	4.6	10.0	10.9	13.0	N.A.
TWB401	8804070545	8.5	90	5.7	26.0	4.9	N.A.	N.A.
TWB402	8804080315	7.5	30	15.0	16.0	2.2	N.A.	N.A.
TWB403	8804120830	9.5	180	3.2	10.0	3.3	28.0	N.A.
TWB404	8804281845	16.0	180	5.3	44.0	10.7	20.5	N.A.
TWB405	8805050245	26.5	615	2.6	38.0	12.5	6.5	N.A.
TWB406	8805111800	12.0	45	16.0	38.0	2.3	20.5	N.A.
TWB407	8805140745	9.5	135	4.2	4.0	1.2	32.5	N.A.
TWB408	8805221310	10.5	30	21.0	40.0	1.6	8.0	51.0
TWB409	8805260915	25.5	60	25.5	58.0	6.9	13.5	51.0
TWB411	8806110915	7.0	90	4.7	16.0	0.5	0.0	23.0
TWB412	8806130715	4.0	15	16.0	16.0	0.2	1.5	1.5
TWB413	8806170540	6.0	270	0.1	4.0	0.5	1.5	3.0
TWB415	8806231545	11.5	270	2.6	6.0	4.9	57.5	66.5
TWB416	8806240830	48.0	495	5.8	40.0	15.6	N.A.	N.A.
TWB417	8806260745	23.5	315	4.3	26.0	6.2	N.A.	N.A.
TWB418	8806271000	38.0	555	4.1	20.0	8.6	N.A.	N.A.
TWB420	8806300645	8.5	840	0.6	4.0	3.5	N.A.	N.A.
TWB421	8807190345	240.0	345	23.1	28.0	164.7	20.5	62.5
TWB422	8807192115	117.0	885	7.9	30.0	107.7	157.5	203.0
TWB423	8807271545	28.5	270	6.3	36.0	7.7	50.0	269.0
TWB424	8807281415	15.0	30	30.0	44.0	2.4	64.5	282.0
TWB425	8808021545	42.0	420	6.0	60.0	16.4	54.0	318.0
TWB426	8808031530	12.0	180	4.0	20.0	2.0	54.5	333.0
TWB427	8808041000	16.5	315	3.1	20.0	2.0	57.0	33.5
TWB428	8808091400	7.0	150	2.8	12.0	0.9	21.0	163.5
TWB429	8808100915	13.0	45	17.3	28.0	3.1	28.5	171.0
TWB430	8808101530	7.0	60	7.0	18.0	3.2	33.5	178.0
TWB431	8808110045	15.0	780	1.2	28.0	7.2	42.0	186.5
TWB432	8808120015	37.0	675	3.3	18.0	12.1	52.0	196.5
TWB433	8808130415	39.5	285	8.3	30.0	20.3	115.5	210.0
TWB434	8808140200	38.0	855	2.7	24.0	25.5	122.5	202.5
TWB435	8808161715	5.5	150	2.2	4.0	1.5	169.5	294.5
TWB437	8808190615	21.0	300	4.2	24.0	9.6	223.0	368.0
TWB438	8808200530	24.5	450	3.3	24.0	5.3	186.0	363.0
TWB440	8808291645	8.0	45	10.7	18.0	1.8	0.0	210.0

Table B6 - Summary of 1986 to 1988 Rainfall and Runoff Data for the Plot at Tsuen Wan (TWB) (Sheet 4 of 4)

Code	Date/Time	Rainfall (mm)	Rain Duration (min)	Rainfall Intensity (mm/hr)		Runoff (mm)	Antecedent Rainfall (mm)	
				Avg.	Max.		5-day	15-day
TWB441	8808300100	42.5	945	2.7	36.0	8.2	0.0	210.0
TWB442	8808310100	47.0	750	3.8	60.0	22.4	45.5	216.5
TWB443	8809041715	41.5	165	15.0	96.0	17.3	98.0	148.0
TWB444	8809131145	26.0	90	17.3	68.0	8.8	16.0	167.5

Legend :

8603220700
- 00 — Minute
- 07 — Hour
- 22 — Day
- 03 — Month
- 86 — Year

N.A. Not available

APPENDIX C

SUMMARY OF THE RESULTS FROM MULTIPLE REGRESSION ANALYSIS OF THE 1986 TO 1988 AND 1984 TO 1988 DATA

APPENDIX C

LIST OF TABLES

Table C1 - Summary of the Results from Multiple Regression Analysis of 1986 to 1988 Data for the Plot at Clear Water Bay Road (CWA)

No. of cases = 108

Slope	No. of Variables	Rain a	Dur b	MaxInt c	Ante5 d	Ante15 e	Const f	Multiple Regression Coefficient
CWA	1	0.908					-2.768	0.9909*
	1		4.924				0.181	0.8384
	1			1.194			-9.640	0.6472
	1				0.024		25.444	0.0401
	1					-0.011	31.453	0.0346
	2	0.966	-0.430				-2.305	0.9916
	2	0.921		-0.040			-1.954	0.9911
	2	0.903			0.010		-3.429	0.9907
	2	0.907				0.012	-5.254	0.9921*
	2		4.029	0.619			-14.274	0.8901
	2		4.818		0.031		-2.174	0.8233
	2		4.900			0.017	-2.561	0.8240
	2			1.202	-0.031		-6.979	0.6572
	2			1.229		0.019	-13.444	0.6520
	3	1.007	-0.548	-0.077			-0.603	0.9921
	3	0.968	-0.487		0.008		-2.706	0.9916
	3	0.967	-0.460			0.011	-4.498	0.9929*
	3	0.916		-0.038	0.011		-2.809	0.9908
	3	0.910		-0.008	0.012		-5.067	0.9921
	3		3.867	0.638	0		-13.940	0.8791
	3		3.968	0.690		0.029	-21.304	0.8878
	4	1.006	-0.583	-0.075	0.011		-1.351	0.9920
	4	0.992	-0.533	-0.048		0.010	-3.253	0.9931*

Notes:

(1) The runoff can be estimated from
Runoff (mm) = a.rainfall (mm) + b.duration (hr) +
c.max intensity (mm/hr)
+ d.5-day antecedent rainfall (mm)
+ e.15-day antecedent rainfall (mm)
+ f(constant).

(2) For an equation with n variables, all possible combinations of the three variables plus one of the antecedent rainfalls were used in the regression analysis, and the set which provided the highest multiple regression coefficient is marked *.

Table C2 - Summary of the Results from Multiple Regression Analysis of 1986 to 1988 Data for the Plot at Clear Water Bay Road (CWB)

No. of cases = 101

Slope	No. of Variables	Rain a	Dur b	MaxInt c	Ante5 d	Ante15 e	Const f	Multiple Regression Coefficient
CWB	1	0.335					-1.143	0.8925*
	1		1.594				1.219	0.7124
	1			0.434			-4.201	0.6662
	1				-0.003		9.738	0.0160
	1					-0.012	12.612	0.1029
	2	0.363	-0.206				-0.975	0.8940
	2	0.301		0.088			-2.884	0.8983*
	2	0.352			-0.011		-0.732	0.8931
	2	0.350				-0.006	-0.095	0.8943
	2		1.185	0.295			-6.047	0.8236
	2		1.617		-0.006		1.455	0.6941
	2		1.634			-0.005	2.402	0.7050
	2			0.444	-0.018		-2.903	0.6707
	2			0.455		-0.009	-2.754	0.6802
	3	0.314	-0.074	0.083			-2.715	0.8984
	3	0.376	-0.175		-0.011		-0.546	0.8942
	3	0.371	-0.159			-0.007	0.111	0.8952
	3	0.317		0.089	-0.013		-2.223	0.8987
	3	0.313		0.093		-0.006	-1.908	0.9000*
	3		1.182	0.310	-0.016		-5.145	0.8162
	3		1.187	0.314		-0.005	-5.423	0.8225
	4	0.326	-0.055	0.085	-0.013		-2.099	0.8988
	4	0.319	-0.035	0.090		-0.006	-1.812	0.9000*

Notes:

(1) The runoff can be estimated from
Runoff (mm) = a.rainfall (mm) + b.duration (hr) + c.max intensity (mm/hr) + d.5-day antecedent rainfall (mm) + e.15-day antecedent rainfall (mm) + f(constant).

(2) For an equation with n variables, all possible combinations of the three variables plus one of the antecedent rainfalls were used in the regression analysis, and the set which provided the highest multiple regression coefficient is marked *.

Table C3 - Summary of the Results from Multiple Regression Analysis of 1986 to 1988 Data for the Plot at Chuk Yuen (CYA)

No. of cases = 108

Slope	No. of Variables	Rain a	Dur b	MaxInt c	Ante5 d	Ante15 e	Const f	Multiple Regression Coefficient
CYA	1	0.685					-9.137	0.9382*
	1		2.311				3.309	0.5668
	1			0.567			-8.580	0.5276
	1				0.045		10.208	0.1056
	1					0.018	10.680	0.0713
	2	0.664	0.209				-9.357	0.9392
	2	0.733		-0.112			-6.374	0.9417*
	2	0.669			0.004		-8.979	0.9277
	2	0.670				-0.040	-8.716	0.9270
	2		2.096	0.505			-15.395	0.7344
	2		2.171		0.022		1.780	0.5984
	2		2.159			0.010	1.901	0.5945
	2			0.503	0.026		-8.056	0.5256
	2			0.519		-0.012	-5.064	0.5239
	3	0.723	0.066	-0.104			-6.619	0.9418*
	3	0.632	0.327		0.003		-9.187	0.9305
	3	0.633	0.324			-0.001	-8.966	0.9299
	3	0.712		-0.094	0.005		-6.804	0.9308
	3	0.714		-0.097		0.004	-7.048	0.9301
	3		2.032	0.460	0.006		-14.389	0.7606
	3		2.029	0.478		-0.017	-12.063	0.7619
	4	0.675	0.221	-0.068	0.004		-7.557	0.9318*
	4	0.677	0.217	-0.069		0.003	-7.693	0.9311

Notes:

(1) The runoff can be estimated from
Runoff (mm) = a.rainfall (mm) + b.duration (hr) + c.max intensity (mm/hr) + d.5-day antecedent rainfall (mm) + e.15-day antecedent rainfall (mm) + f(constant).

(2) For an equation with n variables, all possible combinations of the three variables plus one of the antecedent rainfalls were used in the regression analysis, and the set which provided the highest multiple regression coefficient is marked *.

Table C4 - Summary of the Results from Multiple Regression Analysis of 1986 to 1988 Data for the Plot at Chuk Yuen (CYB)

No. of cases = 119

Slope	No. of Variables	Rain a	Dur b	MaxInt c	Ante5 d	Ante15 e	Const f	Multiple Regression Coefficient
CYB	1	0.441					-5.857	0.9321*
	1		2.049				0.288	0.6374
	1			0.423			-6.792	0.5418
	1				0.022		7.493	0.0812
	1					0.008	7.891	0.0492
	2	0.542	-0.871				-5.452	0.9466*
	2	0.452		-0.031			-5.052	0.9326
	2	0.416			0.004		-5.499	0.9342
	2	0.418				0.014	-7.482	0.9377
	2		1.738	0.325			-10.908	0.7551
	2		1.946		0.003		-0.168	0.6872
	2		1.938			0.010	-1.322	0.6864
	2			0.371	0.017		-6.479	0.5435
	2			0.377		0.005	-6.417	0.5464
	3	0.650	-1.301	-0.156			-1.209	0.9564*
	3	0.493	-0.604		0.007		-5.519	0.9424
	3	0.497	-0.617			0.015	-7.451	0.9463
	3	0.421		-0.012	0.004		-5.192	0.9343
	3	0.425		-0.018		0.014	-7.058	0.9379
	3		1.712	0.290	0.001		-10.173	0.8013
	3		1.696	0.293		0.007	-11.298	0.8018
	4	0.589	-1.006	-0.117	0.008		-2.507	0.9488
	4	0.606	-1.068	-0.134		0.017	-4.257	0.9543*

Notes:

(1) The runoff can be estimated from
Runoff (mm) = a.rainfall (mm) + b.duration (hr) + c.max intensity (mm/hr) + d.5-day antecedent rainfall (mm) + e.15-day antecedent rainfall (mm) + f(constant).

(2) For an equation with n variables, all possible combinations of the three variables plus one of the antecedent rainfalls were used in the regression analysis, and the set which provided the highest multiple regression coefficient is marked *.

Table C5 - Summary of the Results from Multiple Regression Analysis of 1986 to 1988 Data for the Plot at Kohima Barracks (KOH)

No. of cases = 123

Slope	No. of Variables	Rain a	Dur b	MaxInt c	Ante5 d	Ante15 e	Const f	Multiple Regression Coefficient
KOH	1	0.570					-4.837	0.8885*
	1		1.832				-0.088	0.7229
	1			0.460			-1.920	0.4491
	1				0.046		8.396	0.1426
	1					0.038	7.075	0.1812
	2	0.505	0.343				-5.211	0.8930
	2	0.585		-0.043			-3.937	0.8892
	2	0.493			0.035		-5.586	0.9166*
	2	0.489				0.018	-5.953	0.9115
	2		1.677	0.332			-9.321	0.7899
	2		1.564		0.050		-2.453	0.7500
	2		1.829			0.032	-4.150	0.7922
	2			0.395	0.030		-2.858	0.4888
	2			0.421		0.036	-6.097	0.5207
	3	0.506	0.341	-0.002			-5.171	0.8930
	3	0.426	0.359		0.037		-6.184	0.9240*
	3	0.404	0.478			0.020	-6.617	0.9204
	3	0.500		-0.021	0.036		-5.200	0.9169
	3	0.489		-0.001		0.018	-5.935	0.9115
	3		1.433	0.294	0.038		-9.937	0.8248
	3		1.651	0.285		0.031	-11.978	0.8551
	4	0.412	0.387	0.025	0.037		-6.700	0.9243*
	4	0.372	0.552	0.055		0.021	-7.940	0.9218

Notes:

(1) The runoff can be estimated from
Runoff (mm) = a.rainfall (mm) + b.duration (hr) +
c.max intensity (mm/hr)
+ d.5-day antecedent rainfall (mm)
+ e.15-day antecedent rainfall (mm)
+ f(constant).

(2) For an equation with n variables, all possible combinations of the three variables plus one of the antecedent rainfalls were used in the regression analysis, and the set which provided the highest multiple regression coefficient is marked *.

Table C6 - Summary of the Results from Multiple Regression Analysis of 1986 to 1988 Data for the Plot at Tsuen Wan (TWB)

No. of cases = 148

Slope	No. of Variables	Rain a	Dur b	MaxInt c	Ante5 d	Ante15 e	Const f	Multiple Regression Coefficient
TWB	1	0.694					-7.316	0.9586*
	1		3.864				-1.819	0.6458
	1			0.493			-2.190	0.3698
	1				0.045		11.241	0.0935
	1					0.011	12.927	0.0378
	2	0.685	0.114				-7.513	0.9587
	2	0.745		-0.188			-2.485	0.9665*
	2	0.677			0.020		-8.038	0.9555
	2	0.683				-0.001	-6.577	0.9567
	2		3.603	0.365			-13.192	0.7001
	2		3.558		0.025		-1.658	0.5944
	2		4.357			-0.004	-1.175	0.6589
	2			0.392	0.043		-2.292	0.3370
	2			0.399		0.002	0.186	0.3219
	3	0.759	-0.153	-0.196			-2.024	0.9666
	3	0.678	-0.009		0.020		-8.024	0.9555
	3	0.677	0.087			-0.001	-6.677	0.9567
	3	0.730		-0.192	0.019		-2.925	0.9657
	3	0.739		-0.208		0.002	-1.540	0.9679*
	3		3.358	0.304	0.024		-11.434	0.6445
	3		4.103	0.252		-0.009	-8.394	0.6881
	4	0.753	-0.272	-0.203	0.020		-2.204	0.9663
	4	0.754	-0.187	-0.214		0.003	-1.185	0.9681*

Notes:

(1) The runoff can be estimated from
Runoff (mm) = a.rainfall (mm) + b.duration (hr) + c.max intensity (mm/hr) + d.5-day antecedent rainfall (mm) + e.15-day antecedent rainfall (mm) + f(constant).

(2) For an equation with n variables, all possible combinations of the three variables plus one of the antecedent rainfalls were used in the regression analysis, and the set which provided the highest multiple regression coefficient is marked *.

Table C7 - Summary of the Results from Multiple Regression Analysis of 1984 to 1988 Data for the Plot at Clear Water Bay Road (CWA)

No. of cases = 166

Slope	No. of Variables	Rain a	Dur b	MaxInt c	Ante5 d	Ante15 e	Const f	Multiple Regression Coefficient
CWA	1	0.903					-2.328	0.9898*
	1		4.346				1.545	0.7750
	1			1.147			-7.574	0.6539
	1				0.024		24.151	0.0426
	1					0.007	25.732	0.0231
	2	0.945	-0.320				-1.827	0.9904
	2	0.916		-0.037			-1.646	0.9899
	2	0.899			0.012		-3.087	0.9896
	2	0.900				0.009	-3.942	0.9905*
	2		3.434	0.723			-14.671	0.8625
	2		4.217		0.003		1.584	0.7572
	2		4.235			0.009	0.530	0.7551
	2			1.142	0.003		-7.314	0.6606
	2			1.166		0.020	-11.115	0.6612
	3	0.982	-0.413	-0.071			-0.365	0.9908
	3	0.946	-0.367		0.013		-2.555	0.9904
	3	0.944	-0.344			0.009	-3.339	0.9912*
	3	0.910		-0.032	0.012		-2.555	0.9897
	3	0.905		-0.015		0.009	-3.639	0.9905
	3		3.277	0.741	-0.006		-13.803	0.8532
	3		3.308	0.775		0.017	-18.436	0.8577
	4	0.981	-0.448	-0.068	0.014		-1.299	0.9908
	4	0.970	-0.408	-0.051		0.008	-2.205	0.9914*

Notes:

(1) The runoff can be estimated from
Runoff (mm) = a.rainfall (mm) + b.duration (hr) + c.max intensity (mm/hr) + d.5-day antecedent rainfall (mm) + e.15-day antecedent rainfall (mm) + f(constant).

(2) For an equation with n variables, all possible combinations of the three variables plus one of the antecedent rainfalls were used in the regression analysis, and the set which provided the highest multiple regression coefficient is marked *.

Table C8 - Summary of the Results from Multiple Regression Analysis of 1984 to 1988 Data for the Plot at Clear Water Bay Road (CWB)

No. of cases = 157

Slope	No. of Variables	Rain a	Dur b	MaxInt c	Ante5 d	Ante15 e	Const f	Multiple Regression Coefficient
CWB	1	0.321					-1.395	0.8727*
	1		1.189				2.923	0.5175
	1			0.431			-4.321	0.6805
	1				-0.014		10.848	0.0632
	1					-0.010	11.992	0.0814
	2	0.397	-0.642				-0.291	0.8928*
	2	0.271		0.138			-4.177	0.8890
	2	0.328			-0.014		-0.570	0.8721
	2	0.328				-0.009	0.072	0.8734
	2		0.841	0.371			-7.292	0.7669
	2		1.176		-0.020		4.381	0.5023
	2		1.171			-0.011	5.147	0.5022
	2			0.434	-0.019		-2.907	0.6853
	2			0.442		-0.009	-2.879	0.6902
	3	0.345	-0.491	0.092			-2.402	0.8988*
	3	0.399	-0.615		-0.011		0.356	0.8908
	3	0.399	-0.622			-0.009	1.121	0.8925
	3	0.275		0.141	-0.015		-3.202	0.8889
	3	0.274		0.146		-0.009	-2.885	0.8909
	3		0.831	0.379	-0.022		-5.730	0.7654
	3		0.823	0.387		-0.010	-5.831	0.7683
	4	0.344	-0.459	0.098	-0.013		-1.717	0.8976
	4	0.343	-0.462	0.103		-0.009	-1.229	0.8997*

Notes:

(1) The runoff can be estimated from
Runoff (mm) = a.rainfall (mm) + b.duration (hr) + c.max intensity (mm/hr) + d.5-day antecedent rainfall (mm) + e.15-day antecedent rainfall (mm) + f(constant).

(2) For an equation with n variables, all possible combinations of the three variables plus one of the antecedent rainfalls were used in the regression analysis, and the set which provided the highest multiple regression coefficient is marked *.

Table C9 - Summary of the Results from Multiple Regression Analysis of 1984 to 1988 Data for the Plot at Chuk Yuen (CYA)

No. of cases = 162

Slope	No. of Variables	Rain a	Dur b	MaxInt c	Ante5 d	Ante15 e	Const f	Multiple Regression Coefficient
CYA	1	0.675					-8.454	0.9468*
	1		2.031				5.331	0.5346
	1			0.757			-12.142	0.6430
	1				-0.004		17.333	0.0086
	1					0.008	16.402	0.0342
	2	0.689	-0.126				-8.236	0.9471*
	2	0.678		-0.007			-8.295	0.9468
	2	0.667			-0.005		-7.986	0.9435
	2	0.667				-0.010	-8.069	0.9430
	2		1.710	0.679			-19.298	0.7822
	2		1.990		-0.007		5.424	0.5484
	2		1.967			-0.006	4.546	0.5440
	2			0.730	-0.011		-10.500	0.6467
	2			0.735		-0.007	-9.772	0.6488
	3	0.706	-0.166	-0.031			-7.440	0.9473*
	3	0.676	-0.077		-0.005		-7.864	0.9437
	3	0.677	-0.082			-0.001	-7.922	0.9432
	3	0.664		0.008	-0.005		-8.150	0.9436
	3	0.663		0.011		-0.001	-8.280	0.9430
	3		1.700	0.657	-0.013		-17.916	0.7960
	3		1.684	0.664		-0.008	-17.416	0.7956
	4	0.680	-0.085	-0.006	-0.005		-7.724	0.9437*
	4	0.679	-0.086	-0.003		-0.001	-7.853	0.9432

Notes:

(1) The runoff can be estimated from
Runoff (mm) = a.rainfall (mm) + b.duration (hr) + c.max intensity (mm/hr) + d.5-day antecedent rainfall (mm) + e.15-day antecedent rainfall (mm) + f(constant).

(2) For an equation with n variables, all possible combinations of the three variables plus one of the antecedent rainfalls were used in the regression analysis, and the set which provided the highest multiple regression coefficient is marked *.

Table C10 - Summary of the Results from Multiple Regression Analysis of 1984 to 1988 Data for the Plot at Chuk Yuen (CYB)

No. of cases = 173

Slope	No. of Variables	Rain a	Dur b	MaxInt c	Ante5 d	Ante15 e	Const f	Multiple Regression Coefficient
CYB	1	0.476					-6.770	0.9371*
	1		1.619				2.521	0.5297
	1			0.561			-9.957	0.6412
	1				0.007		11.057	0.0234
	1					0.013	9.776	0.0752
	2	0.538	-0.551				-5.970	0.9466*
	2	0.468		0.021			-7.280	0.9373
	2	0.468			0.005		-6.894	0.9370
	2	0.468				0.012	-8.619	0.9392
	2		1.287	0.490			-14.691	0.7628
	2		1.580		0.006		1.872	0.5468
	2		1.569			0.014	0.175	0.5474
	2			0.535	0.004		-9.621	0.6430
	2			0.539		0.010	-10.918	0.6491
	3	0.576	-0.658	-0.066			-4.243	0.9479*
	3	0.524	-0.480		0.005		-6.263	0.9449
	3	0.524	-0.478			0.012	-7.886	0.9471
	3	0.454		0.034	0.005		-7.688	0.9375
	3	0.456		0.032		0.012	-9.337	0.9397
	3		1.293	0.469	0.004		-14.610	0.7793
	3		1.282	0.474		0.011	-16.274	0.7820
	4	0.551	-0.558	-0.044	0.006		-5.124	0.9455
	4	0.553	-0.563	-0.049		0.012	-6.647	0.9478*

Notes:

(1) The runoff can be estimated from
Runoff (mm) = a.rainfall (mm) + b.duration (hr) +
c.max intensity (mm/hr)
+ d.5-day antecedent rainfall (mm)
+ e.15-day antecedent rainfall (mm)
+ f(constant).

(2) For an equation with n variables, all possible combinations of the three variables plus one of the antecedent rainfalls were used in the regression analysis, and the set which provided the highest multiple regression coefficient is marked *.

Table C11 - Summary of the Results from Multiple Regression Analysis of 1984 to 1988 Data for the Plot at Kohima Barracks (KOH)

No. of cases = 168

Slope	No. of Variables	Rain a	Dur b	MaxInt c	Ante5 d	Ante15 e	Const f	Multiple Regression Coefficient
KOH	1	0.665					-6.431	0.8975*
	1		2.307				-0.702	0.6706
	1			0.672			-5.955	0.4936
	1				0.025		12.352	0.0577
	1					0.020	12.059	0.0718
	2	0.645	0.126				-6.641	0.8978
	2	0.700		-0.105			-4.311	0.8996
	2	0.637			0.038		-8.395	0.8998*
	2	0.637				0.020	-9.092	0.8967
	2		2.008	0.473			-13.188	0.7503
	2		2.170		0.044		-3.071	0.6542
	2		2.535			0.036	-6.602	0.6982
	2			0.644	0.019		-6.829	0.5016
	2			0.674		0.018	-8.603	0.5131
	3	0.696	0.021	-0.103			-4.396	0.8996
	3	0.624	0.088		0.039		-8.587	0.8999*
	3	0.612	0.168			0.022	-9.508	0.8972
	3	0.670		-0.098	0.040		-6.539	0.9018
	3	0.669		-0.097		0.021	-7.197	0.8990
	3		1.875	0.464	0.037		-14.812	0.7411
	3		2.177	0.440	0.033		-17.456	0.7670
	4	0.671	-0.008	-0.099	0.040		-6.504	0.9018*
	4	0.657	0.070	-0.090		0.021	-7.509	0.8986

Notes:

(1) The runoff can be estimated from
Runoff (mm) = a.rainfall (mm) + b.duration (hr) +
c.max intensity (mm/hr)
+ d.5-day antecedent rainfall (mm)
+ e.15-day antecedent rainfall (mm)
+ f(constant).

(2) For an equation with n variables, all possible combinations of the three variables plus one of the antecedent rainfalls were used in the regression analysis, and the set which provided the highest multiple regression coefficient is marked *.

Table C12 - Summary of the Results from Multiple Regression Analysis of 1984 to 1988 Data for the Plot at Tsuen Wan (TWB)

No. of cases = 168

Slope	No. of Variables	Rain a	Dur b	MaxInt c	Ante5 d	Ante15 e	Const f	Multiple Regression Coefficient
TWB	1	0.679					-7.236	0.9564*
	1		3.597				-1.351	0.6394
	1			0.503			-2.685	0.3912
	1				0.072		9.851	0.1607
	1					0.028	10.275	0.1112
	2	0.671	0.097				-7.411	0.9565
	2	0.728		-0.174			-2.734	0.9634*
	2	0.658			0.018		-7.814	0.9536
	2	0.665				-0.002	-7.069	0.9543
	2		3.306	0.365			-12.853	0.6979
	2		3.243		0.021		-0.853	0.5938
	2		3.806			-0.002	-0.508	0.6404
	2			0.408	0.060		-3.996	0.3815
	2			0.415		0.015	-2.560	0.3586
	3	0.740	-0.121	-0.180			-2.364	0.9636
	3	0.662	-0.047		0.019		-7.755	0.9536
	3	0.662	0.030			0.002	-7.093	0.9543
	3	0.709		-0.177	0.019		-3.196	0.9625
	3	0.718		-0.192		0.007	-2.541	0.9642*
	3		3.015	0.313	0.016		-10.735	0.6493
	3		3.542	0.278		-0.009	-8.352	0.6785
	4	0.732	-0.262	-0.187	0.022		-2.584	0.9632
	4	0.735	-0.199	-0.199		0.008	-2.215	0.9645*

Notes:

(1) The runoff can be estimated from
Runoff (mm) = a.rainfall (mm) + b.duration (hr) + c.max intensity (mm/hr) + d.5-day antecedent rainfall (mm) + e.15-day antecedent rainfall (mm) + f(constant).

(2) For an equation with n variables, all possible combinations of the three variables plus one of the antecedent rainfalls were used in the regression analysis, and the set which provided the highest multiple regression coefficient is marked *.