

RAINFALL AND LANDSLIDES IN 1986

GEO REPORT No. 3

J. Premchitt

**GEOTECHNICAL ENGINEERING OFFICE
CIVIL ENGINEERING DEPARTMENT
HONG KONG**

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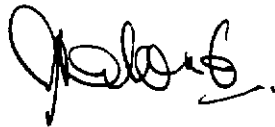
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PREFACE

In keeping with our policy of releasing information of general technical interest, we make available some of our internal reports in a series of publications termed the GEO Report series. The reports in this series, of which this is one, are selected from a wide range of reports produced by the staff of the Office and our consultants.

Copies of GEO Reports have previously been made available free of charge in limited numbers. The demand for the reports in this series has increased greatly, necessitating new arrangements for supply. In future a charge will be made to cover the cost of printing.

The Geotechnical Engineering Office also publishes guidance documents and presents the results of research work of general interest in GEO Publications. These publications and the GEO Reports are disseminated through the Government's Information Services Department. Information on how to purchase them is given on the last page of this report.



A. W. Malone
Principal Government Geotechnical Engineer
April 1995

FOREWORD

This report presents a general review of rainfall and landslides in 1986. Geotechnical Engineers of GCO District Divisions provided details of the notable landslides. Supplementary landslide data were provided by the Agriculture and Fisheries Department, Fire Services Department, Highways Office, Housing Department and Water Supplies Department. The Royal Observatory provided rainfall information. All contributions are gratefully acknowledged. Dr. J. Premchitt prepared this report.

J. B. Massey
(J.B. Massey)

Chief Geotechnical Engineer/Special Projects

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1. INTRODUCTION

This report reviews rainfall and landslide occurrence in Hong Kong throughout 1986. Rainfall information has been obtained from the Geotechnical Control Office (GCO) automatic rain gauge system and from the Royal Observatory (RO). Most of the landslide data have been taken from the records of incidents reported to the GCO during the year. Supplementary data have been obtained from other Government departments.

In this report, a landslide is defined as the collapse of a soil or rock mass, and includes the failure of fill slopes, cut slopes, retaining structures, natural slopes and rock or boulder falls. A major landslide is defined as a failure in which the volume of the collapsed mass exceeded 50 cu m.

The GCO received a total of 233 incident reports in 1986. Of these, 197 were classified as genuine landslides and eleven of them were major. The remaining incidents were minor ground or structural movements. This report will emphasize the cases of landslides reported to the GCO, since these were inspected by the GCO's Geotechnical Engineers and detailed information is available.

The arrangement of this report is similar to previous rainstorm and rainfall - landslides reports (GCO, 1982a, 1982b; Choot, 1984 and Premchitt, 1985, 1986). The report reviews rainfall and landslide occurrence throughout the whole one-year period rather than emphasizing any one specific rainstorm. This is a factual report and, apart from acknowledging that most of the landslides were initiated by heavy rainfall, it does not attempt to explain the mechanisms of failure nor to examine prediction of the magnitude of landslide events. Information and interpretation on the important aspects of landslide mechanisms and correlation between rainfall and landslides can be found elsewhere, for example Lumb (1975), Brand et al (1984) and Premchitt et al (1985). It is intended, however, that the data contained in this report may be used and interpreted by readers to further the understanding of rain-induced failures.

2. RAINFALL

2.1 The Rain gauge System

In the rugged terrain of Hong Kong, rainfall distribution over different geographical areas, as well as over different time periods, can vary dramatically during a rainstorm. The Royal Observatory has installed 165 rain gauges at strategic locations around the Territory in order to provide sufficient coverage for a meaningful analysis of rainfall distribution. These rain gauges range from a detailed automatic and instantaneous rate-of-rainfall recorder to rain gauges which are read manually once a month. The "principal" gauge is located at the Royal Observatory's headquarters in Tsim Sha Tsui, and a continuous rainfall record has been made at this location since 1884. Weather summaries and rainfall statistics are normally based on the measurements made at this "principal" location.

Since 1978, the GCO, in co-operation with the RO, has installed a number of automatic rain gauges which transmit the current rainfall data via telephone lines to the GCO's "Emergency Control" headquarters. Subsequent improvements have been made and at present there are 46 GCO gauges and 21 RO

gauges in this system, which provide up-to-date rainfall data every five minutes to the operation rooms of the GCO and RO. These data are also stored on computer tape for future reference. The locations of these automatic raingauges (Figure 1) were selected to supplement the network of other types of rainauge and to provide specific information in areas of particular geotechnical interest.

In this report, where a comparison is made for "daily" rainfalls, the 24-hour maximum rainfall will be used instead of daily rainfall, since the latter is based on an arbitrary fixed-period of midnight to midnight which does not necessarily represent the true rainstorm intensity. In addition, where a rainfall amount is quoted without reference to the location of measurement, this will be the amount measured at the RO headquarters.

2.2 Royal Observatory Records

The year's weather for 1986 was summarised by the Royal Observatory in the Monthly Weather Summary of December 1986. Their comments for the whole year are as follows :

On the whole, the year 1986 was normal in respect of weather conditions. In particular, the year's mean temperature recorded at the Royal Observatory was the same as the normal value of 22.8°C while the rainfall of the year, totalling 2 338.3 mm, was only 5 percent above normal. However, a record low temperature of 4.8°C for the month of March was set on 1 March and hoar frost was reported at Tai Mo Shan and Tate's Cairn on the first two days of the month. In addition, Typhoon Wayne set another record and became the first tropical cyclone to have necessitated the hoisting of warning signals in Hong Kong on three separate occasions, during the period 19 August to 5 September. A waterspout was reported near Tap Mun and a tornado was reported in Aberdeen on 21 August. The Gale or Storm Signal was hoisted twice in 1986, during the approach of Typhoon Peggy in July and Typhoon Wayne in August. Both typhoons caused some damage to Hong Kong.

The following are excerpts from the same report for the months in which the most intense rainfalls were recorded :

... Thundery showers on 21 and 22 April caused landslips in Mong Kok, Lai Chi Kok and Pok Fu Lam. Rainfall recorded on these two days at the Royal Observatory amounted to 106.3 mm, accounting for more than 90 percent of the month's total.

... The total rainfall recorded at the Royal Observatory from January to May was 615.0 mm, which was 10 per cent above the normal amount for the same period. As an active low pressure area approached, continuous heavy downpour and squally thunderstorms affected Hong Kong on 11 May. Over 200 mm of rainfall were recorded in Tai Lam Chung, Tai Mo Shan and Tai Po. The heavy downpour continued

into the morning of 12 May and there were 48 cases of flooding and 7 landslips during the day.

On the whole, June was a normal month in respect of temperature, cloudiness and precipitation. The total rainfall of 415.9 mm recorded at the Royal Observatory was near the month's normal of 431.8 mm. However, it was unevenly distributed and rainfall on two separate days account for 58 percent of the month's total : 6 June when a trough of low pressure passed rapidly through Hong Kong, and 25 June when a disturbance in the southwest monsoon affected the territory. Rainy weather continued after the downpour of 6 June. As a result, minor flooding in Western District and a landslip in Ngau Chi Wan were reported on 7 June. The latter necessitated the evacuation of 26 people. The disturbance on 25 June was accompanied by frequent squally showers. Two people were injured by falling billboards and one man was found missing from a parked towboat.

July was wetter than usual. A total of 547.3 mm of rainfall was recorded at the Royal Observatory, which was 73 percent above normal. 85 percent of the month's rainfall was associated with the rainstorm on 3 and 4 July and with Typhoon Peggy... Heavy showers and squally thunderstorms occurred on 3 July when a moisture-laden southwest monsoon affected the territory. In Diamond Hill, the balcony of an old building collapsed in the rain and 90 residents were evacuated. Heavy and frequent thundery showers recurred the next morning resulting in 39 cases of minor flooding and 5 landslips in various parts of Hong Kong. Typhoon Peggy crossed Luzon on 9 July and headed towards the South China coast. With light winds off the land ahead of Peggy, temperatures in Hong Kong shot up to a maximum of 34.8°C in the afternoon of 10 July, making the day the fourth hottest in July on record. On 11 July, the weather deteriorated rapidly under the influence of Peggy which made landfall near Shanwei in the afternoon. Strong to gale force winds accompanied by widespread and frequent squally showers battered the territory until the morning of 12 July. During the passage of Peggy, a six year old boy was drowned after falling overboard from his family boat in Ap Lei Chau and 26 people were injured. There were 20 cases of landslips and 78 reports of flooding over the territory on 12 July.

... On 9 to 11 August, Hong Kong was affected by squally heavy showers and thunderstorms as a tropical depression over the South China Sea moved towards Hainan. Over 300 mm of rainfall were recorded at Tai Po, Sha Tau Kok and Sai Kung.

Wayne, the longest lasting tropical cyclone ever

over the South China Sea and the Pacific, warranted the hoisting of warning signals in Hong Kong three times during the period 19 August to 5 September, during which time its track was most exceptional. ... On 21 August, after a very hot and sunny day, squally thunderstorms developed overland and moved southeastwards to affect Hong Kong in the evening. A waterspout was reported near Tap Mun and 2 fishing junks capsized killing 3 people. A tornado was also reported in Aberdeen around the same time. During the severe thunderstorms in the morning of 23 August, a total of 15 people were struck by lightning at three separate locations in Sai Kung and Tsuen Wan.

After crossing Taiwan, Wayne weakened to a tropical storm and moved southwestwards back into the South China Sea. As it headed westwards towards Dongsha, local signals were hoisted a second time on 25 August but lowered the next day as Wayne then moved southwestwards away from Hong Kong. Wayne then turned northeastwards to affect the Bashi Channel and the Philippines. It then strengthened to a typhoon, heading westwards again to affect Hong Kong a third time on 4 to 5 September.

A summary of heavy rainstorms in 1986 is given in Table 1. This table shows all periods (mutually exclusive) in which 24-hour rainfall at the RO exceeded 50 mm. It also shows the fifteen-day antecedent rainfalls which occurred prior to the 24-hour periods. The five highest 24-hour rainfalls are 202 mm on 3-4th July, 201 mm on 11-12th July, 175 mm on 6th June, 165 mm on 11-12th May and 123 mm on 10-11th August. Other detailed information in Table 1 will be discussed subsequently in separate sections.

The rainfall data as recorded at the RO, Tsim Sha Tsui, are presented in Figures 2 to 5. Cumulative rainfall since 1st January is shown in Figure 2. Daily and monthly rainfalls are shown in Figures 3 and 4 respectively. Figure 5 shows the hourly rainfall for the five highest 24-hour rainfalls of 1986.

2.3 Geotechnical Control Office Records

Rainfall data are available from the GCO's 46 automatic raingauges. Current rainfall data can be found in the GCO's Rainfall Data Acquisition Centre, and past data are kept in the Civil Engineering Library. A location map of these gauges is given in Figure 1.

In addition to the general RO rainstorm summary, data from some of the GCO raingauges are also given for the rainfall events in Table 1. The maximum rainfall recorded anywhere in the Territory on these occasions are given for three arbitrary durations of 24 hours, five hours and one hour.

The maximum 24-hour and one-hour rainfalls within the Territory during the year were 315 mm on 11-12th July and 79 mm on 6th June respectively.

Appendix B shows hourly rainfall data obtained from GCO's raingauges for the five heaviest rainstorms on 12th May, 6th June, 4th and 12th July, and 11th August.

2.4 Rainfall Distribution

Rainfall distribution within different time periods and geographical areas can be assessed by referring to detailed GCO and RO records. Records from GCO raingauges for the five heaviest rainstorms of 1986 are given in Appendix B.

Five rainfall maps, for 24-hour duration taken from RO records, are shown in Figures 6 to 10. These include all of the five heaviest rainstorms of the year. All of these rainstorms were discussed in the annual RO weather summary quoted in Section 2.2. Generally, rainfall was spread out fairly evenly over the Territory in these events. The distribution of rainfall had an important effect on the occurrence of landslides, and this will be discussed further in Section 3.4.

2.5 Warnings issued by the Royal Observatory

Relevant warnings issued by the RO, and the Landslip Warnings jointly issued by the GCO and the RO, are summarised in Table 2.

In 1986, there were 55 Thunderstorm Warnings, 13 Flood Warnings, five Landslip Warnings and six Tropical Storm Warnings. The highest Tropical Storm Warning Signal number raised in the year was No. 8, which was issued on two occasions, viz. 11-12th July (Typhoon Peggy) and 20-21th August (Typhoon Wayne). Most of these warnings were issued in the period from April to September.

Landslip Warnings were issued after consultation between the GCO and the RO on the basis of a predetermined rainfall criterion. The frequency of this warning in 1986 was the least among the rainfall-related warnings issued by the RO. The five warnings were issued on 11th May, 6th June, 4th and 12th July and 10th August (Table 2). A comparison of these five days with all other notable rainfall-landslide days is shown in Table 1. On these five days, of the total reported incidents for which time of landslide occurrence is known accurately (Section 3.1), 50 occurred after the warnings were issued, and twelve occurred before the warnings were issued. Those events not shown in Table 1 had rainfall of less than 50 mm in 24 hours, and less than five landslides in any one day.

2.6 Comparison with Past Rainstorms

Maximum rainfall amounts of various durations recorded at the GCO and RO raingauges for heavy rainstorms in 1986 are shown in comparison with the three recent major rainstorms of May and August 1982, and June 1983 in Table 1. The highest 24-hour rainfall at the RO in 1986 is only 50% of that in the May 1982 rainstorm. The highest one-hour rainfall recorded anywhere in 1986 is 79 mm, in comparison with more than 95 mm for the three major rainstorms.

The return periods of heavy rainstorms in 1986 were estimated and are

shown in Table 3, for rainfall durations of one hour to fifteen days. No rainstorms of very long return period occurred, but the rainfall during early June and early July is notable. It may be concluded that rainfall in the year 1986 was normal except for slightly heavier short period rainfalls (less than one day) on 6th June. The rainfall during 1984-1985 was also considered normal in comparison with previous years. Therefore, no major rainstorms have occurred in Hong Kong since the rainstorm of June 1983, a period of more than three years.

In Figure 2, cumulative rainfall for 1986 is shown in comparison with the average (1951-1980), the wettest year (1982) and the driest year (1963) since records began in 1884. The annual cumulative rainfall was close to the average amount. Figure 4 shows monthly rainfalls in 1986 in comparison with the recorded maximum (since 1884) and mean (1951-1980) monthly rainfalls. The monthly rainfall exceeded the mean values for the four months of February, May, July and November.

3. LANDSLIDES

3.1 Landslide Occurrence in 1986

The numbers of incidents reported to various Government departments during 1986 are shown in Table 4. The numbers of incidents affecting various types of area (building, road etc.) in Hong Kong, Kowloon and the New Territories are shown in Table 5. The numbers of major failures are also given in this table. There were eleven major landslides in 1986.

A list containing details of all 233 incidents reported to the GCO is provided in Appendix A. A location map for all of these incidents is shown in Drawing No. GCSP 12/1. Selected incidents are illustrated in Plates 1 to 43.

Wherever possible, the dates and times of the landslides were ascertained by the Geotechnical Engineers during site inspection. Some incidents were not reported for several days or weeks. Out of 233 incidents, the times of occurrence were known to within one day for 187 incidents. The daily numbers of these incidents are plotted in Figure 3. Of these 187 incidents, the times were ascertained further to within one hour for 81 incidents.

The highest daily number of incidents is 45 on 12th July and the next highest is 35 on 6th June. These occasions are included in Table 1, where the numbers of incidents reported in the newspapers and by the Fire Services Department are also shown for comparison. For those events not shown in Table 1, there were less than five incidents in any single day of the year.

It is likely that there were more failures which were not known to the GCO, including minor failures of no consequence, such as failures in remote areas, open spaces and construction sites. This should be borne in mind in reading the following landslide statistics.

3.2 Areas Affected by Incidents

The numbers of incidents, as reported to Government departments, which affected various categories of area are given in Table 5. It should be

noted that one incident may affect more than one area category. Landslide consequences, classified according to the type of failure, are shown in Table 6.

3.2.1 Squatter Areas

A total of 119 incidents affected squatter areas. Of these, 61 occurred in Kowloon, and most of them were in Kowloon East region including the Lam Tin Villages, Cheung Lung Tin Village, Sau On Village and Ma Wan Village.

Four major failures affected squatter areas. They are incidents K 6/5 (Plate 9; discussed in Section 4.4), K 7/12 (Plates 14 & 15; Section 4.7), ME 7/8 (Plates 32 & 33; Section 4.8) and MW 3/2 (Plates 3 & 4; Section 4.3). Examples of other minor failures in squatter areas are incidents K 8/4 (Plates 36 & 37; Section 4.13) and ME 7/14 (Plates 34 & 35). Incident K 7/12 resulted in injury to one person.

Incidents in squatter areas required permanent evacuation of 127 huts and temporary evacuation of 40 huts. 40% of these evacuations resulted from failures of soil cut slopes (Table 6).

The main causes of the large number of failures in squatter areas are indiscriminate cutting and filling on steep hillsides and the erection of flimsy huts in these areas. Another important factor is uncontrolled leakage and discharge from water supply, sewage and storm water pipes in these areas.

3.2.2 Buildings

There were 32 incidents affecting buildings. Two of these were major failures. They were incidents MW 7/3 (Plates 26 & 27; Section 4.10) and MW 12/2 (Plates 40 & 41; Section 4.14). Examples of minor failures affecting buildings are incidents HK 7/8 (Plates 24 & 25), HK 7/16 (Plates 22 & 23; Section 4.11) and ME 7/3 (Plates 30 & 31).

Incidents in this category resulted in partial closure of seven buildings. Three of these were caused by retaining wall failures (Table 6).

3.2.3 Roads and Access

54 incidents affected roads and access, five of which were major failures. They are MW 3/1 (Plates 1 & 2; Section 4.2), ME 7/4 (Plates 16 & 17; Section 4.6), MW 7/1 (Plates 18 to 20; Section 4.9) and HK 12/1 (Plates 42 & 43; Section 4.15). Examples of minor failures affecting roads and access are K 4/2 (Plate 5), ME 6/2 (Plates 7 & 8; Section 4.5), HK 7/5 (Plates 12 & 13) and HK 7/6 (Plates 28 & 29).

Due to these incidents, 58 sections of road or access were closed to traffic. Eighteen of them were caused by soil cut slope failures.

3.2.4 Construction Sites

There were six incidents affecting construction sites. One of these was a major failure: incident MW 12/2 (Plates 40 & 41; Section 4.14). Examples of minor failures affecting construction sites are incidents HK 5/3 (Plate 6) and MW 7/16 (Plate 21).

3.2.5 Catchwaters and Reservoirs

Incidents affecting catchwaters and reservoirs were dealt with separately by the Water Supplies Department (WSD). There were 36 incidents of this type, 31 of which occurred on 12th July.

3.2.6 Country Parks and Open Areas

Thirteen incidents in country parks and AFD Special Areas were reported by the Agriculture and Fisheries Department. These included seven major landslides in Plover Cove Country Park which occurred on 26th June. In addition, the GCO inspected nine incidents in open areas; two of these were major failures. They were incidents MW 7/14 (Plates 38 & 39) and HK 12/1 (Plates 42 & 43; Section 4.15). An example of a minor failure affecting an open area is incident HK 7/2 (Plates 10 & 11).

3.3 Types of Incidents

The GCO incidents were classified into six types of failure, and the number in each type is shown in Table 7. Damage resulting from these types of failure is shown in Table 6.

3.3.1 Fill Slopes

There were eighteen fill slope failures, forming eight percent of all incidents reported. Three of them were major: incidents MW 3/1 (Plates 1 & 2; Section 4.2), ME 7/4 (Plates 16 & 17; Section 4.6) and ME 7/8 (Plates 32 & 33; Section 4.8). Examples of minor fill slope failures are incidents HK 5/3 (Plate 6) and ME 7/14 (Plates 34 & 35).

3.3.2 Cut Slopes

There were 115 cut slope failures, forming 49% of incidents reported. These were classified further according to types of material, i.e. soil/rock and rock cut slope failures.

There were 93 soil cut slope failures. Four of these were major: incidents MW 3/2 (Plates 3 & 4; Section 4.3), MW 7/1 (Plates 18 to 20; Section 4.9), MW 7/3 (Plates 26 & 27; Section 4.10) and MW 7/14 (Plates 38 & 39; Section 4.12). An example of a minor soil cut slope failure is incident ME 7/3 (Plates 30 & 31).

There were fourteen soil/rock cut slope failures. Two of these were major, i.e. incidents K 7/12 (Plates 14 & 15; Section 4.7) and MW 12/2

(Plates 40 & 41; Section 4.14). Examples of minor soil/rock cut slope failures are incidents HK 7/6 (Plates 28 & 29), HK 7/8 (Plates 24 & 25) and K 8/4 (Plates 36 & 37; Section 4.13).

There were eight rock cut slope failures. None of these was major.

3.3.3 Retaining Walls

There were 26 retaining wall failures, forming eleven percent of all incidents reported. None of these was major. Examples of minor retaining wall failures are incidents ME 6/2 (Plates 7 & 8) and HK 7/2 (Plates 10 & 11).

3.3.4 Natural Slopes

There were nine natural slope failures, forming four percent of all incidents reported. Two of these were major: incidents K 6/5 (Plate 9; Section 4.4) and HK 12/1 (Plates 42 & 43; Section 4.15). An example of a minor natural slope failure is incident HK 7/5 (Plates 12 & 13).

3.3.5 Rock and Boulder Falls

There were 29 cases of rock and boulder falls, forming thirteen percent of all incidents reported, none of which was major. Examples of rock and boulder falls are incidents K 4/2 (Plate 5), MW 7/16 (Plate 21) and HK 7/16 (Plates 22 & 23; Section 4.11).

3.3.6 Other Failures

Other failures are incidents which cannot be properly classified into the above categories. These included cases of ground collapse, ground settlement and hut collapse. There were 36 failures of this type, forming fifteen percent of all incidents. None of these was major.

3.4 Rainfall-Landslide Relationships

The primary cause of a large majority of all failures was rainfall. Other failures were mostly isolated incidents caused by such factors as construction work, leakage of services and indiscriminate activities relating to earthworks and drainage alterations in squatter areas.

A simple relationship between rainfall and landslides is demonstrated by the plot of daily rainfall and daily number of landslide occurrences throughout 1986 in Figure 3. The majority of landslides tend to occur at times of heavy rainfall. The geographical distribution of rainfall also has a considerable influence on the occurrence of landslides in various areas. Figures 6 to 10 show the location of landslides for which dates of occurrence are known (see Section 3.1), imposed on the 24-hour rainfall maps of the corresponding time periods for the events on 12th May, 6th June, 4th July, 12th July and 11th August. A close relationship between landslides and rainfall distribution can be seen in these figures.

More detailed and comprehensive discussions on rainfall-landslide relationships and failure mechanisms can be found in Brand et al (1984) and Premchitt et al (1985), where extensive data over the past twenty years have been analysed.

4. NOTABLE INCIDENTS

4.1 Introduction

Fourteen out of the 233 incidents are discussed in more detail in this section. These are presented in chronological order. The nature of the incident is referenced under the caption of each incident. The selection of these incidents was based mainly on the size and consequences of failure.

4.2 Incident MW 3/1, Kwai Shing Circuit, Tsuen Wan

(Date : 3rd March. Major failure of a fill slope affecting road, Plates 1 & 2.)

This landslide occurred at about 4 pm on 4th March on the temporary cut face of a fill slope catalogued as 7SW-C/FR63. The failure was about 16 m long and 5 m high. The debris volume was about 200 cu m. At the time of failure, excavation work was being carried out on the slope for recompaction of the existing fill. The unsupported excavation, with a very steep cut face (near vertical), was considered to be the major cause of this failure. The landslide occurred on the top part of the slope, which supported Kwai Shing Circuit above. A large number of minor cracks on the road surface were observed in the vicinity. As a result of this failure, one lane of the road was closed temporarily.

4.3 Incident MW 3/2, DD 434 Ko Tan, Tsing Yi

(Date : Not known. Major failure of a soil cut slope affecting squatters, Plates 3 & 4.)

This landslide was reported to have occurred a few years ago and was brought to attention in March 1986 due to its progressive nature. The failure was about 20 m long and 7 m high, and the debris volume was estimated to be about 200 cu m. Subsequently, repair work was carried out on the slope. The work involved cutting back the failure scar and provision of surface protection and slope drainage. No damage was reported due to this failure.

4.4 Incident K 6/5, Sau Ming Village, Kowloon East

(Date : 6th June. Major failure of natural slope affecting squatters, Plate 9.)

This landslide occurred on the morning of 6th June, when there was a period of heavy rainfall (Table 1 and Figure 5). It occurred at mid-height of a natural slope, composed of residual soil and rock outcrops. The debris volume was more than 100 cu m and consisted of granite blocks of various size up to 1 m in diameter. The slide debris accumulated on the lower part of the slope, about 25 m from the failure scar, but there were no squatter huts in the immediate vicinity. The failure area was fenced off, and no evacuation was required. The primary cause of the failure was probably the

intense rainfall in the area, which was more than 70 mm in an hour (see Figure B2).

4.5 Incident ME 6/2, Ma Yau Tong Village, Sai Kung

(Date : 6th June. Retaining wall failure affecting access, Plates 7 & 8.)

This landslide occurred at about 8 am on 6th June, during the intense rainfall period (Figure 5). An 8 m long section of a 3 m high concrete retaining wall collapsed, and the volume of the failure debris was about 20 cu m. The wall supported a newly formed unpaved access road to a village house construction site. The access road was undermined, and the affected area had to be fenced off. Part of the construction material stored at the toe of the slope was buried in the slide debris. The area was a loose fill without any surface protection. Infiltration of rain water into these exposed surfaces was probably the main cause of this failure.

4.6 Incident ME 7/4, 15 MS Tai Po Road, Sha Tin

(Date : 11th July. Major failure of a fill slope affecting road, Plates 16 & 17.)

This failure occurred at about 7 pm on 11th July during the approach of Typhoon Peggy. The feature affected was a 29 m length of fill slope supporting Tai Po Road at approximately the 15th milestone. The volume of the failure debris was about 250 cu m, and it flowed down-slope to about 50 m away from the slide scar. Shortly after the time of failure, a heavy flow of storm water from the road into the failure area was observed. The water was gushing down from a hill slope on the opposite side of the road and flowing over the road into the affected area. The storm water drain at the top of the slope was also broken. Emergency work was carried out to divert the water away from the slip area immediately after the failure.

As a result of this failure, the Kowloon-bound lane was closed and repair work was carried out. This work involved cutting into original ground and back-filling with crushed rock.

4.7 Incident K 7/12, Ma Wan Village, Lei Yue Mun

(Date : 12th July. Major failure of soil/rock cut slope affecting squatters, one person injured, Plates 14 & 15.)

This major failure occurred at about 7 am on the 12th July during a heavy rainstorm associated with Typhoon Peggy. The failure occurred on top of a very steep (near vertical) 35 m high soil/rock cut slope, which was probably an old quarry face. The failure scar was about 9 m wide and the volume of the slide debris was approximately 300 cu m. This large volume of failure debris fell down the slope to a fenced-off area (sterile zone) behind the squatter village at the toe of the slope, and crashed through one wall of a hut. As a result, a child was injured. Subsequently, six huts in the vicinity were permanently evacuated and cleared from the area, and repair work was carried out on the failure.

- 4.8 Incident ME 7/8, 77 4th District, Pak Tin, Sha Tin
(Date : 12th July. Major failure of a fill slope affecting road and squatters, Plates 32 & 33.)

The failure occurred at about 7 am on 12th July during a period of intense rainfall. A fill slope on top of a natural slope (total height 8 m) failed, with a volume of slide debris of about 65 cu m. The failure affected a hut at the top of the slope and a WSD access road below. The probable cause of the failure was rainfall infiltration into the slope during the rainstorm. As a result of this failure, a part of the road was blocked and one hut was permanently evacuated.

- 4.9 Incident MW 7/1, MS 13 Route Twisk
(Date : 12th July. Major failure of a soil cut slope affecting road, Plates 18 to 20.)

This major landslide occurred at about 10 am on the 12th July, during a heavy rainstorm associated with Typhoon Peggy. The failure was reported to be progressive, starting as a small failure at 10 am. A massive slide took place at 12 am, with a further small failure on the northern side at 1 pm. It occurred on a 25 m high soil cut slope, catalogued as 6NE-D/C21. The slope was composed of weathered tuff and the debris volume was estimated to be about 80 cu m. The debris blocked both lanes of Route Twisk and the road was closed to all traffic for several hours. After removal of the debris, a barrier was erected in the middle of the road, and only one lane traffic was permitted while the repair was being carried out. For aesthetic reasons, pine trees which survived the failure were preserved. The repair work was completed by October.

- 4.10 Incident MW 7/3, 30 Kung Yip Street, Tsuen Wan
(Date : 12th July. Major failure of a soil cut slope affecting building, Plates 26 & 27.)

This failure occurred in the morning of 12th July during a heavy rainstorm. It occurred on the lower part of an 8 m high soil cut slope, catalogued as 7SW-C/C208. The volume of soil debris was approximately 50 cu m. The debris piled up against the ground floor of a factory building. No substantial damage to the building was observed. The debris was cleared from the area and the repair work was carried out subsequently.

- 4.11 Incident HK 7/16, Kennedy Town Police Quarters
(Date : 14th July. Boulder fall affecting carpark, Plates 22 & 23.)

This boulder fall incident occurred at about 6 pm on 14th July, two days after the heavy rainfall associated with Typhoon Peggy on 12th July. The failure involved three large boulders. The largest was about 3 m long and 1.5 m in diameter. The total volume was estimated to be more than 10 cu m. The boulders were dislodged from a height of 40 m on a steep slope behind Block "A" of the police quarters. One of them crashed on to a private car parked at the toe of the slope, and the car was destroyed. It was reported that the driver had parked the car and walked away only a few seconds before the boulders fell.

The boulders were subsequently removed from the area, and maintenance works to the slope were carried out by ASD and HyD in their respective areas of maintenance responsibility. Landslip preventive works to the slope and boulders were scheduled in the LPM Programme.

- 4.12 Incident MW 7/14, Lot 387 DD 302, Shek Tsai Po, Tai O, Lantau
(Date : Not known. Major failure of a soil cut slope in open area, Plates 38 & 39.)

This failure was reported to have occurred in July but the exact date was not known (probably during Typhoon Peggy). It occurred at about mid-height of a 50 m high soil cut slope, catalogued as 9SW-C/C1. The total volume of the failure debris was estimated to be about 150 cu m. The debris flow stopped about 20 m from an abandoned two-storey building. The open space at the toe of the slope appeared to be a disused soccer pitch.

- 4.13 Incident K 8/4, Ma Wan Village, Lei Yue Mun
(Date : 11th August. Soil/rock cut slope failure affecting squatters, Plates 36 & 37.)

This failure occurred at about 3 pm on 11th August during a heavy rainstorm (Figure 5). It occurred on the top part of a very steep, 15 m high slope (probably an old quarry face). There were also two disused tunnel openings at the lower part of the failure scar. The volume of slide debris was about 25 cu m. The debris broke through the back walls of a number of huts at the toe of the slope. As a result, thirteen huts were permanently evacuated and the vacated area was subsequently cleared.

- 4.14 Incident MW 12/2, Tai Lam Centre for Women, Tuen Mun
(Date : 4th December. Major failure of a soil/rock cut slope affecting building, Plates 40 & 41.)

This failure occurred in the vicinity of the Tai Lam Centre for Women during the course of the Phase II construction of security walls and guard towers. After continuous light rainfall from 2nd to 3rd December, a small slip was found on a 7 m high soil/rock cut slope behind the fence of the Centre. A 5 m long crack was also observed above the cutting. At about 8 am on 4th December, a major failure occurred at the site. The failure was 15 m long, 12 m high, and the debris volume involved was about 400 cu m. The debris was contained within the excavation, with some blocks of rock piled up against a hoarding which was erected for the on-going construction work. The primary cause of the failure was considered to be unsupported excavation work forming part of the construction.

Because of the remaining danger of further failure, half of the one-storey prison block facing the slip scar was temporarily evacuated, and the excavation work was halted pending completion of urgent remedial and protective works to the slope.

- 4.15 Incident HK 12/1, Sir Cecil's Ride, Wong Nai Chung
(Date : 19th December. Major failure of a natural slope affecting country park, Plates 42 & 43.)

This wash-out failure occurred on 19th December. The primary cause of the failure was the rupture of a water main. It occurred on a natural hill-slope below a covered service reservoir in the Wong Nai Chung Gap area. The total length of the debris path was about 40 m, and the volume of the failure debris was more than 50 cu m. Part of a country park trail (Sir Cecil's Ride) was damaged. The failure occurred on parts of the hill slope above and below the trail. A number of exposed loose boulders were also observed on the failure scar. As a result, the trail was closed pending the completion of repair work to the failure.

5. CONCLUSIONS

Rainfall amounts of various durations during 1986 can be considered as normal, except for slightly heavier short period (less than one day) rainfalls on 6th June. Over the whole year, 233 landslides and related incidents were reported to the GCO District Divisions, and the damage resulting from these incidents may be summarised as follows : one person injured, 167 huts evacuated, seven buildings partially closed, and 58 sections of road and access closed. Most of this damage occurred during or shortly after rainstorms. The five most intense and damaging storms occurred on 12th May, 6th June, 4th July, 12th July (Typhoon Peggy) and 11th August. The Landslip Warning was issued on each of these five occasions.

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Table 1 - Rainfall-Landslide Events in 1986 with 24-hour Rainfall Greater than 50 mm

Date	Maximum Rainfall (mm)								Landslide Consequences				
	Royal Observatory					GCO Raingauges			Number of Landslides			Persons Killed or Injured	Number Huts Evacuated Permanently
	24-hr	5-hr	1-hr	Antecedent		24-hr	5-hr	1-hr	GCO	Newspaper	FSD		
				4-day	15-day								
3-4 / 7	202	104	54	0	103	221	136	45	5	5	-	-	-
11-12 / 7	201	111	45	15	261	315	113	41	48	8	2	1 inj.	40
6 / 6	175	150	74	29	68	160	146	79	35	2	-	-	27
11-12 / 5	165	76	47	6	52	298	204	77	19	6	-	-	2
10-11 / 8	123	44	15	41	54	216	82	38	7	3	-	-	15
6-7 / 9	90	32	21	93	116	113	48	38	2	-	-	-	1
21 / 4	86	42	30	1	2	123	59	21	7	1	-	-	7
16 / 9	72	72	39	0	187	85	85	43	-	-	-	-	-
25-26 / 6	71	57	27	25	78	137	84	27	-	-	-	-	-
19-20 / 5	68	43	23	0	244	111	87	50	1	-	-	-	3
Recent Major Rainstorms (For Comparison Only)													
29 / 5 / 82	394	153	44	1	11	430	237	111	551	498	15	48	1153
16 / 8 / 82	362	159	68	0	346	370	290	95	138	62	6	9	200
17 / 6 / 83	347	274	69	2	77	460	303	101	155	114	5	2	149
Notes : (1) The events are arranged in order of magnitude of 24-hour rainfall at the Royal Observatory, Tsim Sha Tsui. (2) For the rest of 1986, there were less than 5 landslips reported to GCO on any one day. (3) Newspapers searched are South China Morning Post and Hong Kong Standard.													
Abbreviation : GCO = Geotechnical Control Office ; FSD = Fire Services Department ; RO = Royal Observatory													

Table 2 - Types and Dates of Warnings Issued by the Royal Observatory in 1986

Month	Dates of Warnings			
	Thunderstorm	Flood	* Landslip	Tropical Storm
January	-	-	-	-
February	18	-	-	-
March	27, 28	-	-	-
April	20, 21, 22	21	-	-
May	2, 3, 6, 11, 12, 13, 14, 30, 31	11, 12, 14	11 (9 p.m.) to 12 (4 a.m.)	-
June	3, 4, 6, 7, 13, 17, 18, 26	6, 25	6 (10 a.m.) to 7 (7 a.m.)	-
July	3, 4, 7, 8, 10, 11, 14, 20, 21, 31	3, 4, 12	4 (9 a.m. to 2 p.m.) 12 (7 a.m. to 7 p.m.)	9-12 (Nos. 1-8, Peggy)
August	1, 2, 5, 6, 9, 10, 11, 15, 16, 17, 21, 22, 23, 30	10, 11, 23	10 (10 p.m.) to 11 (6 p.m.)	9-11 (Nos. 1-3, Tropical Depression) 19-21 (Nos. 1-8, Wayne) 25-26 (No. 1, Wayne)
September	1, 3, 4, 6, 8, 16, 28	16	-	4-5 (Nos. 1-3, Wayne)
October	28	-	-	15-19 (Nos. 1-3, Ellen)
November	-	-	-	-
December	-	-	-	-
TOTAL NUMBER	55	13	5	6
Legend : * Landslip warnings were issued after consultation between GCO & RO.				

Table 3 - Maximum Rainfalls during 1986 and Estimated Return Periods

Duration	* Rainfall (mm)	Ending Time		† Estimated Return Period (Year)
		Date	Hours	
1 hour	73.9	6/6	1000	6
5 hours	149.8	6/6	1200	3
12 hours	159.1	6/6	1400	< 2
24 hours	201.6	4/7	1000	< 2
2 days	222.1	12/7	-	< 2
4 days	242.5	14/7	-	< 2
7 days	259.6	7/6	-	< 2
15 days	505.2	17/7	-	2
Legend : * Rainfall at Royal Observatory, Tsim Sha Tsui. † Gumbel equation, Peterson & Kwong (1981).				

Table 4 - Numbers of Incidents Reported to Various Offices/Departments during 1986

Office / Department	Total Number	Types of Incident		
		Landslide	Flooding	Others
Geotechnical Control Office	233	197	-	36
Water Supplies Department	36	36	-	-
Fire Services Department	14	3	7	4
Agriculture & Fisheries Department	13	13	-	-
Highways Department	*	*	over 1000 [†]	*
Housing Department (Housing Estates)	-	-	-	-
Legend : * Landslides reported to HyD were referred to GCO and are included in the GCO incidents. † Most of this flooding occurred in Kowloon and much of it was not related to rainstorms.				

Table 5 - Numbers of Incidents Affecting Different Areas in 1986

Affected Area	Hong Kong	Kowloon	New Territories	All Districts
Squatters	35	61 (2)	23 (2)	119 (4)
Buildings	10	6	20 (2)	36 (2)
Roads	24	21	34 (5)	79 (5)
Construction Sites	4	0	2 (1)	6 (1)
Catchwaters	0	0	0	0
Country Parks / Open Areas	3 (1)	4	2 (1)	9 (2)
Legend : () Number of major failures				
Note : One incident may affect more than one type of area .				

Table 6 - Consequences Related to Types of Failure in 1986

Type of Failure		No. of Huts Evacuated		Closure of Part of Building	Road/ Access Blocked	Injury
		Permanent	Temporary			
Fill Slope		6	7	1	8	-
Cut Slope	Soil	59	11	2	18	-
	Soil/Rock	19	-	1	9	1
	Rock	-	-	-	4	-
Retaining Wall		24	8	3	5	-
Natural Slope		3	-	-	4	-
Rock / Boulder Fall		3	3	-	6	-
Others		13	11	-	4	-
TOTAL		127	40	7	58	1

Table 7 - Numbers of Incidents Reported to GCO during
1986 Classified by Type of Failure

Type of Failure		Number	Percentage
Fill Slope		18 (3)	8 %
Cut Slope	Soil	93 (4)	40 %
	Soil / Rock	14 (2)	6 %
	Rock	8	3 %
Retaining Wall		26	11 %
Natural Slope		9 (2)	4 %
Rock / Boulder Fall		29	13 %
Others		36	15 %
TOTAL		233 (11)	100 %
Legend : () Number of major failures			

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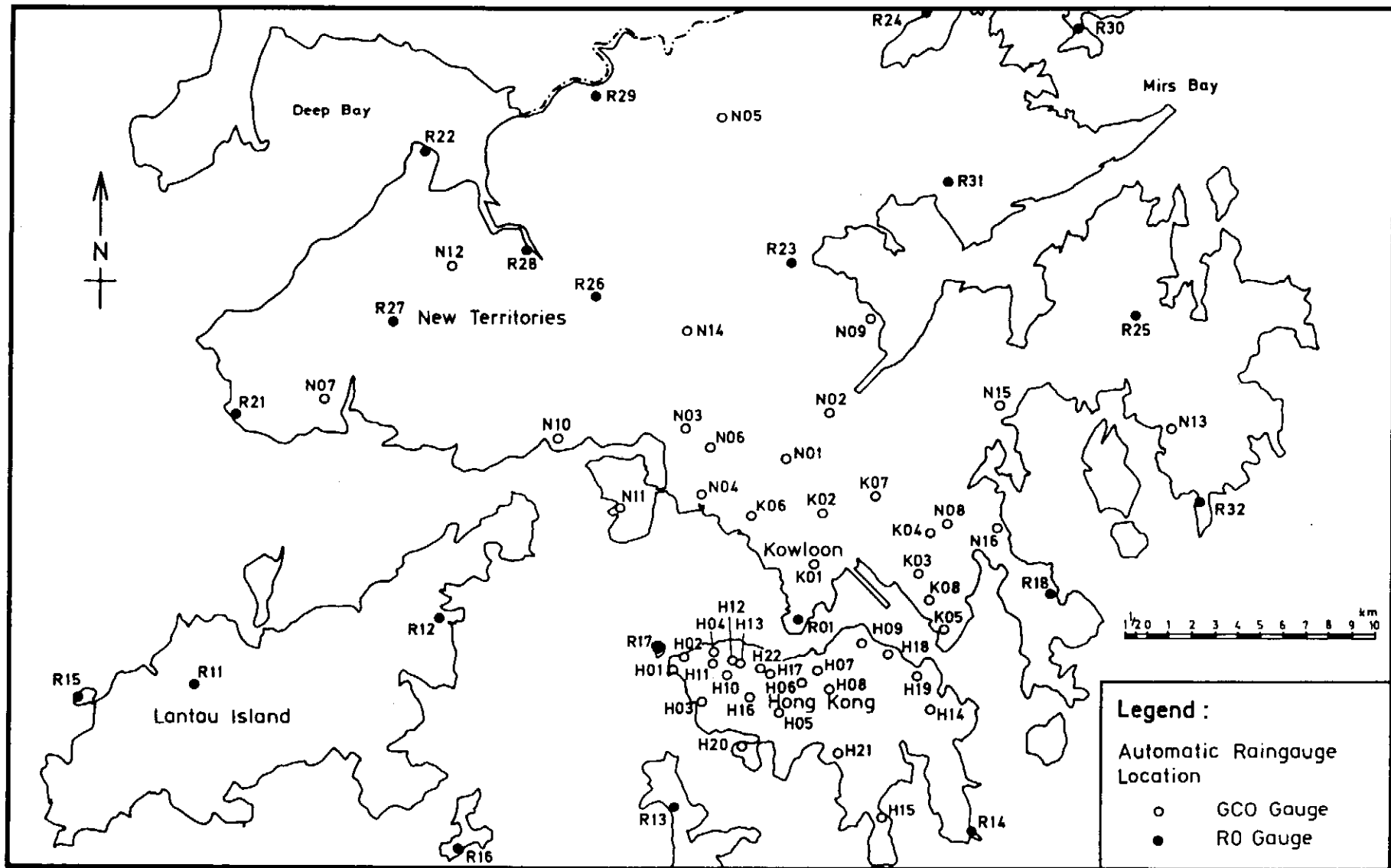


Figure 1 - Locations of GCO and RO Automatic Raingauges

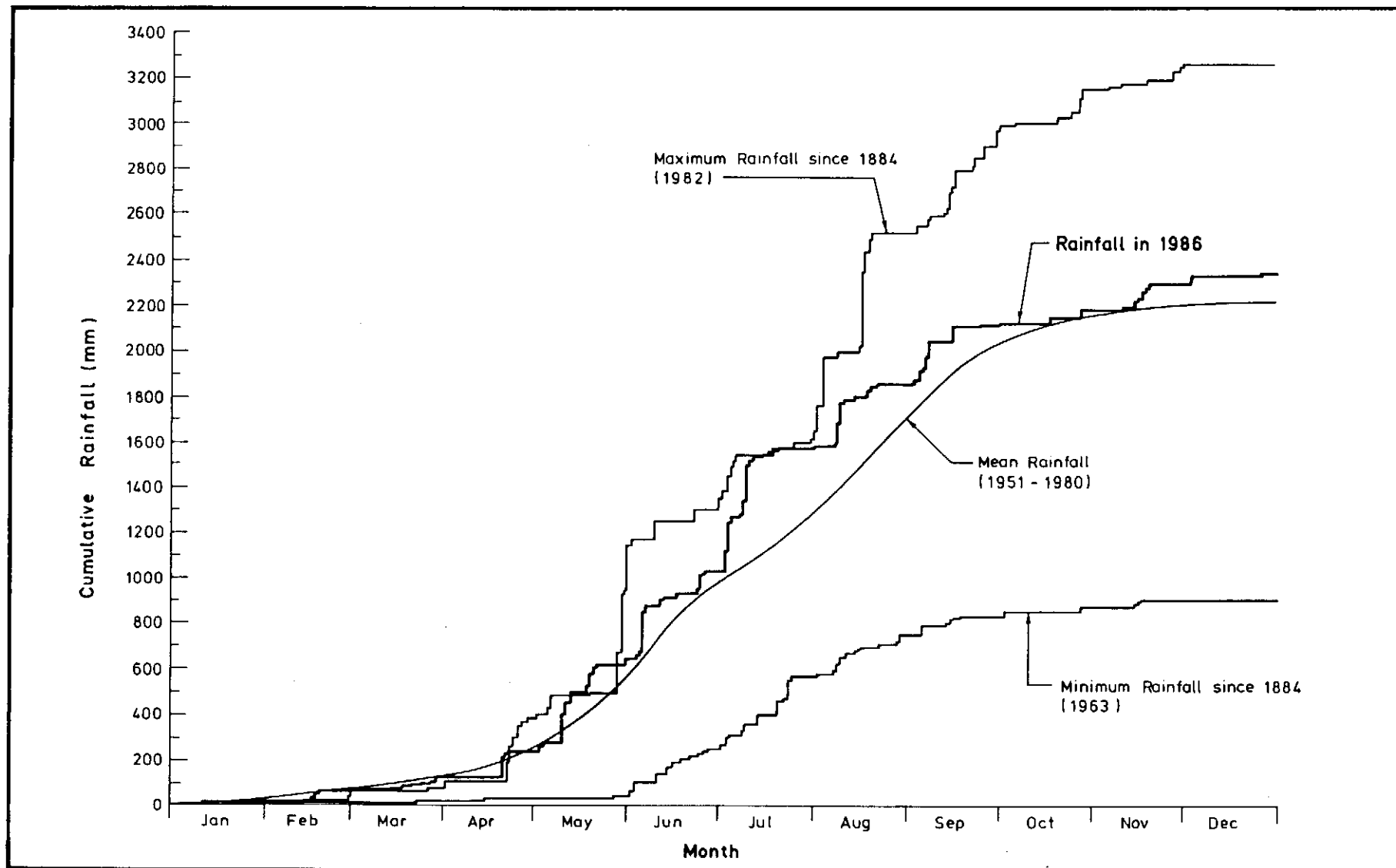


Figure 2 - Cumulative Rainfall since 1st January for 1986 and the Recorded Maximum Mean and Minimum Cumulative Rainfalls

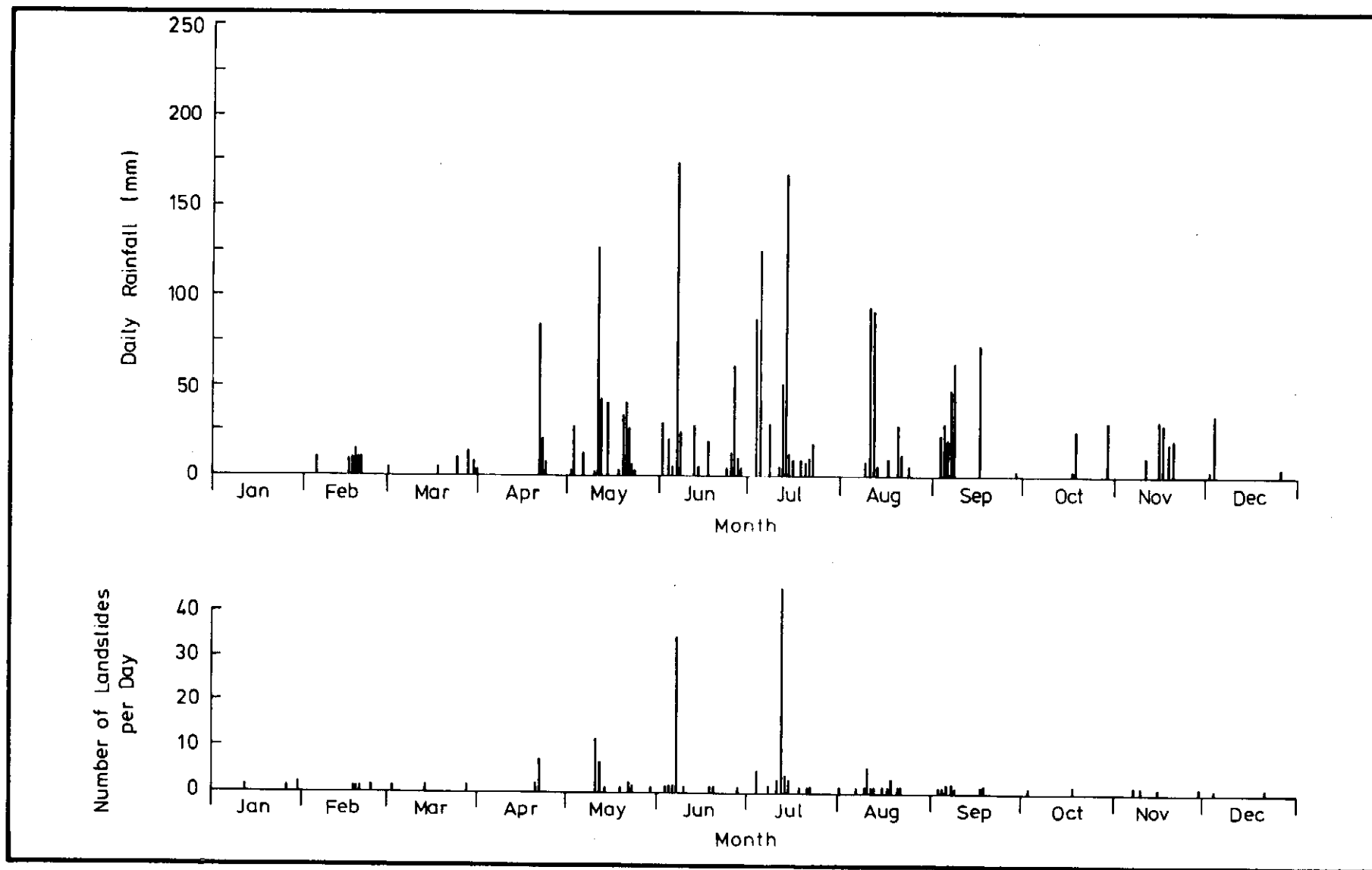


Figure 3 - Daily Rainfall and Distribution of Number of Landslides during 1986

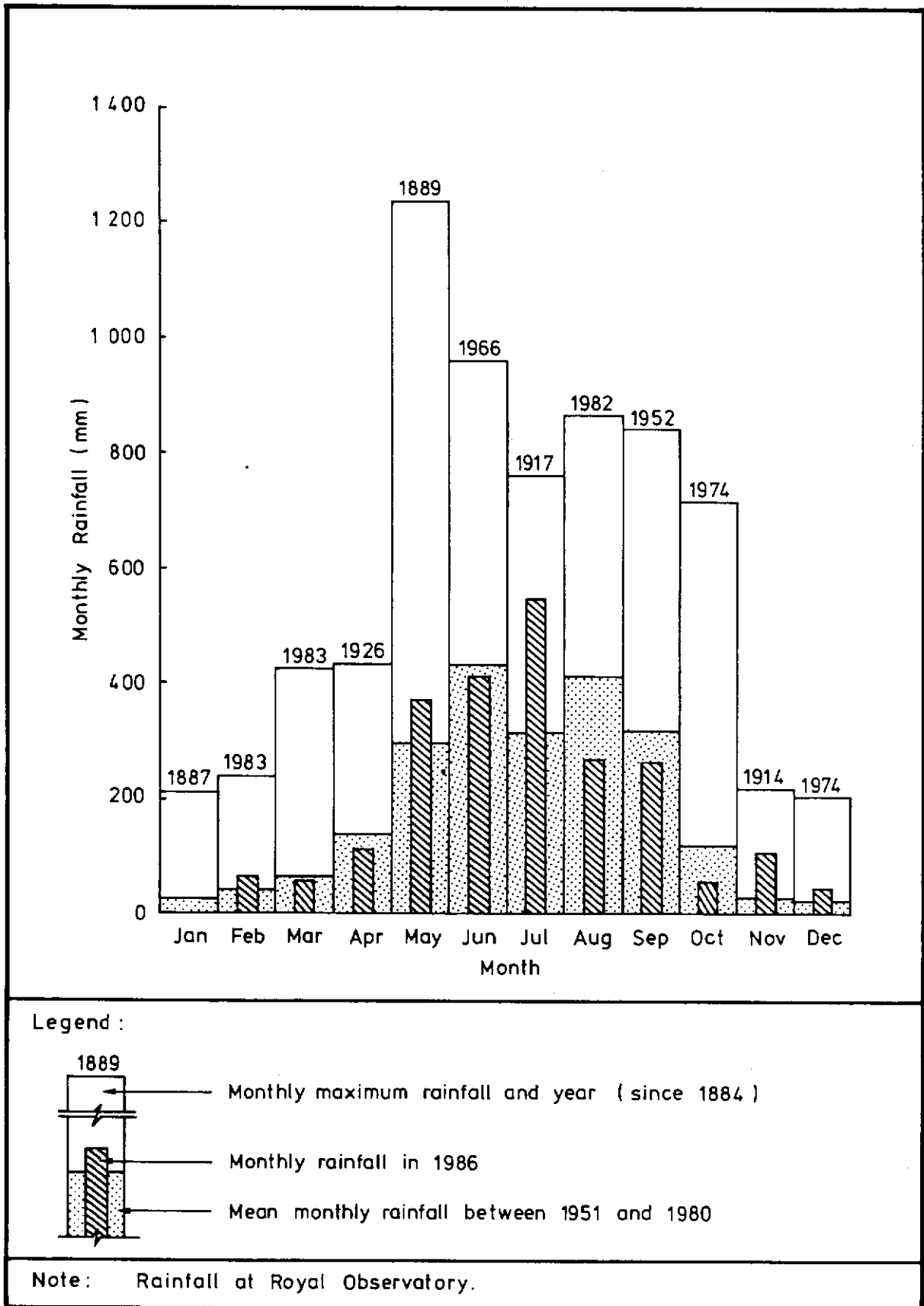


Figure 4 - Monthly Rainfalls in 1986 in Comparison with Recorded Maximum and Mean Monthly Rainfalls

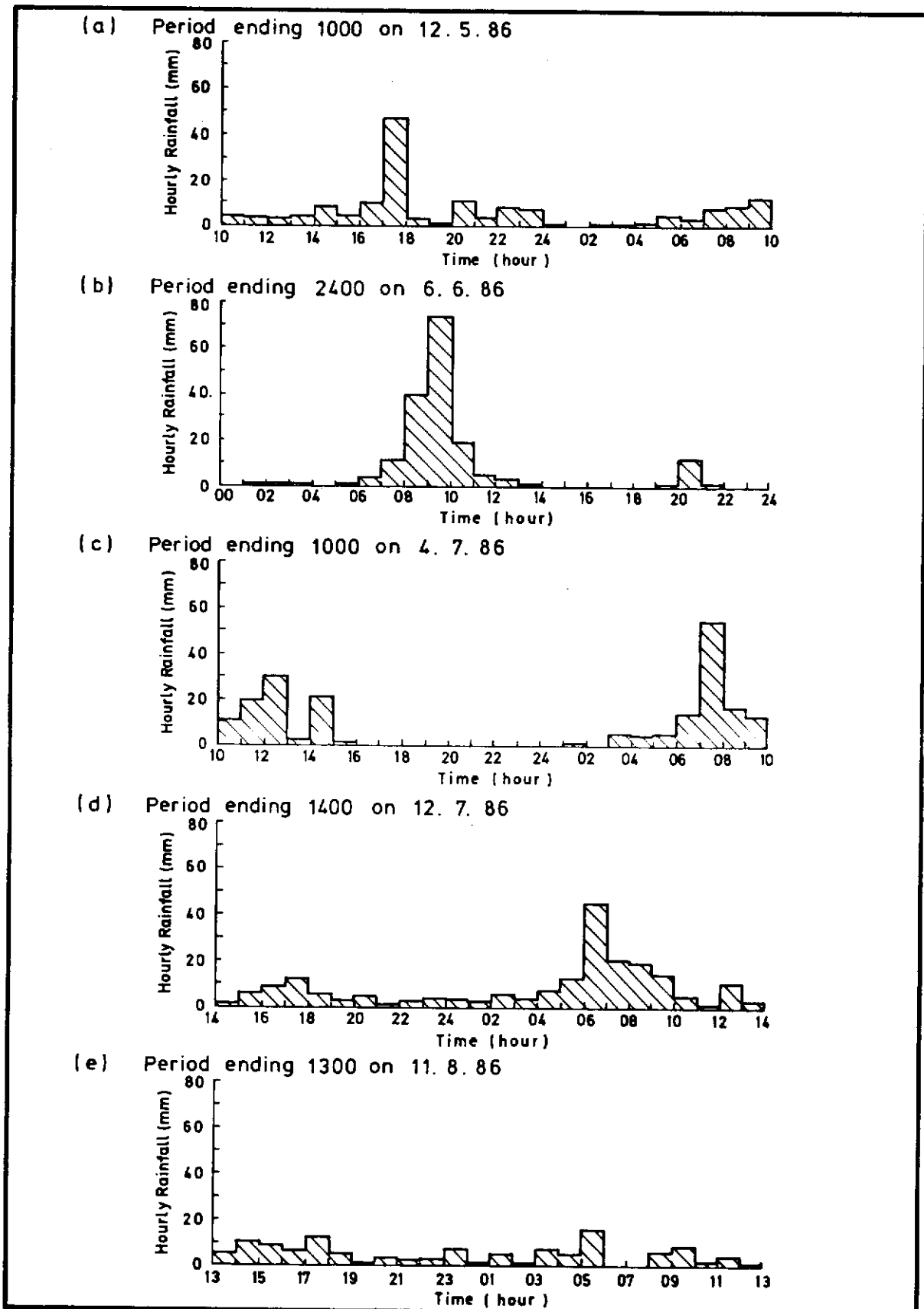


Figure 5 - Histograms of Hourly Rainfall at the Royal Observatory
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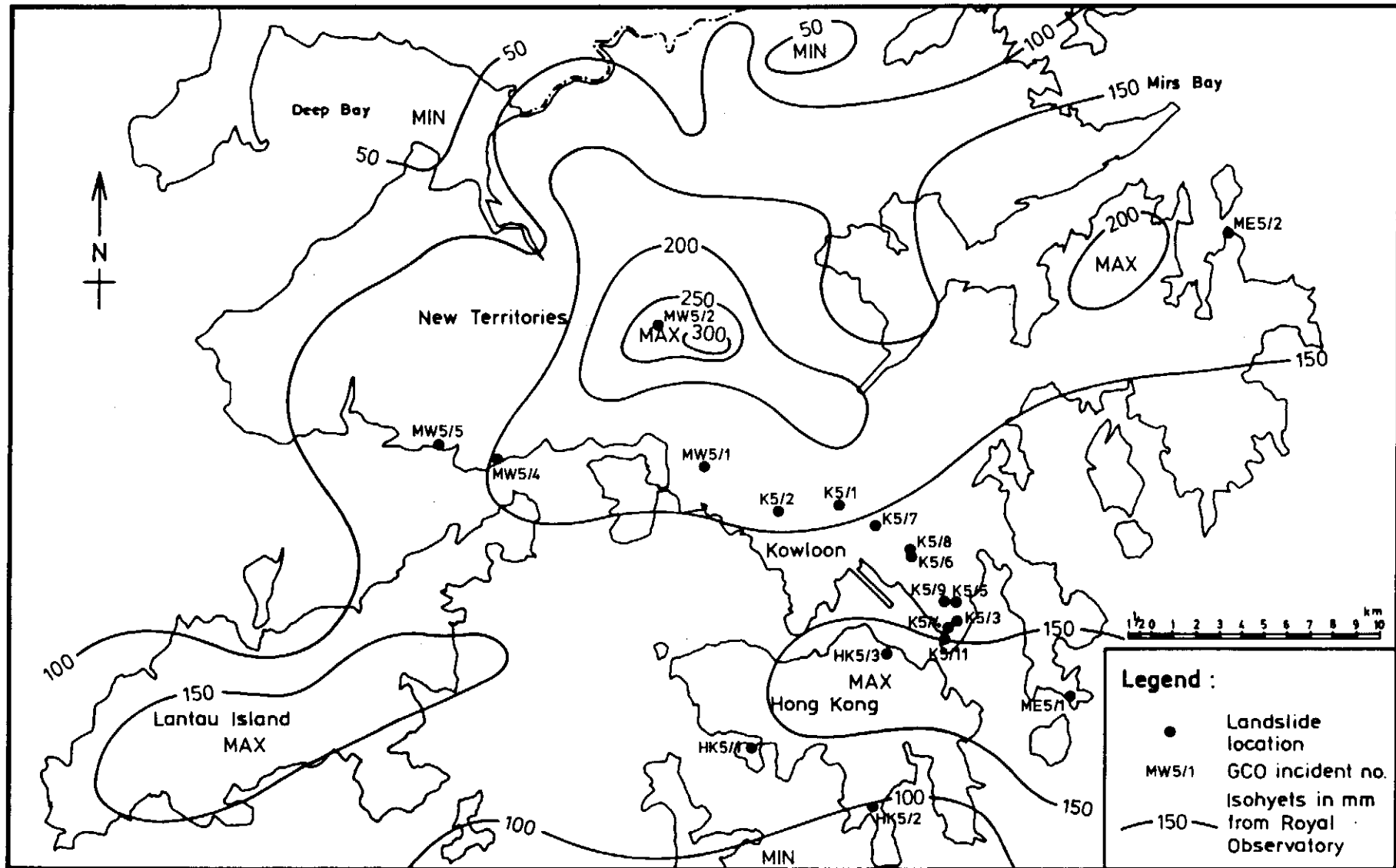


Figure 6 - 24-hour Rainfall Distribution Ending at 3 pm on 12th May 1986 and Locations of GCO Incidents

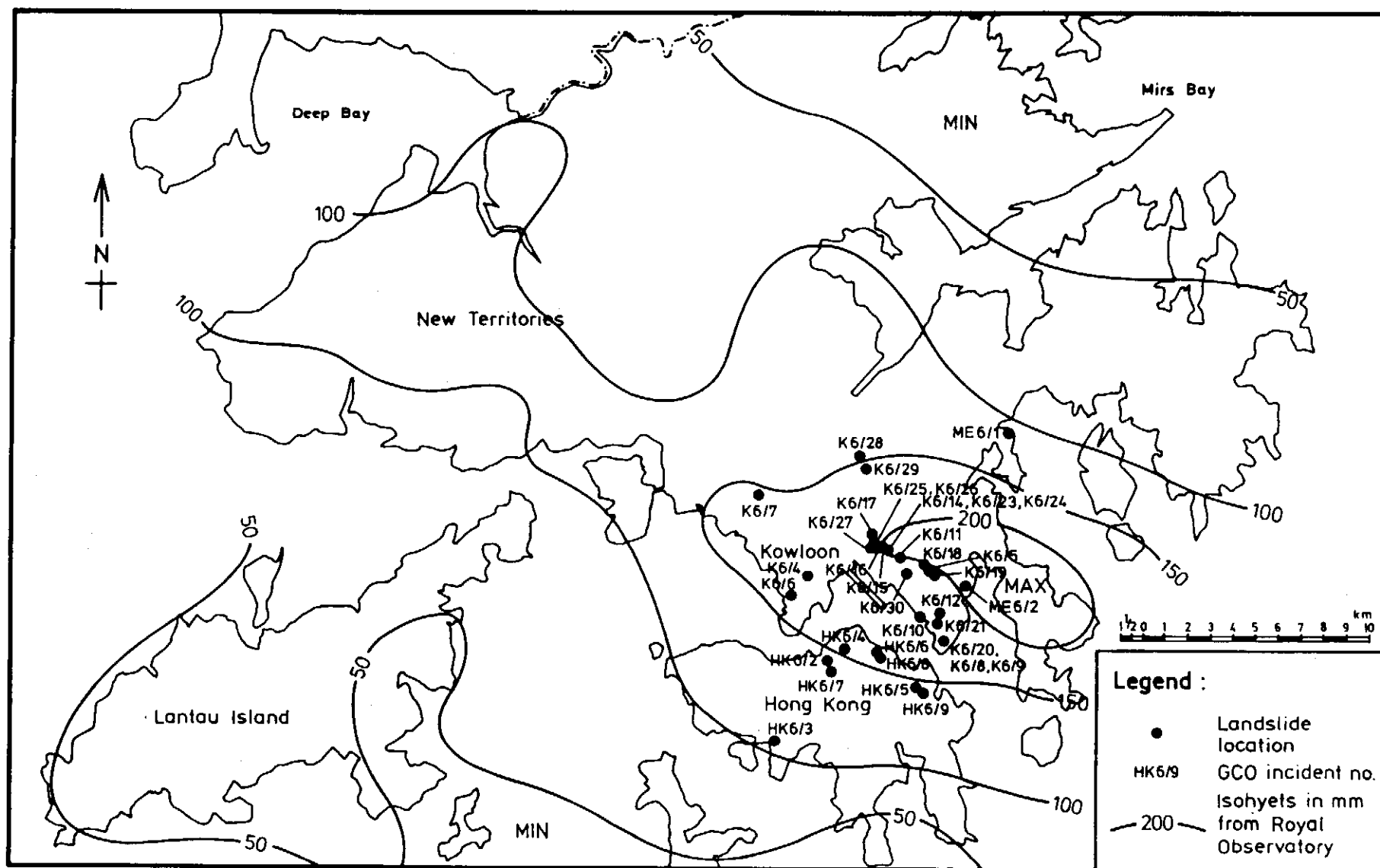


Figure 7 - 24-hour Rainfall Distribution Ending at 3pm on 6th June 1986 and Locations of GCO Incidents

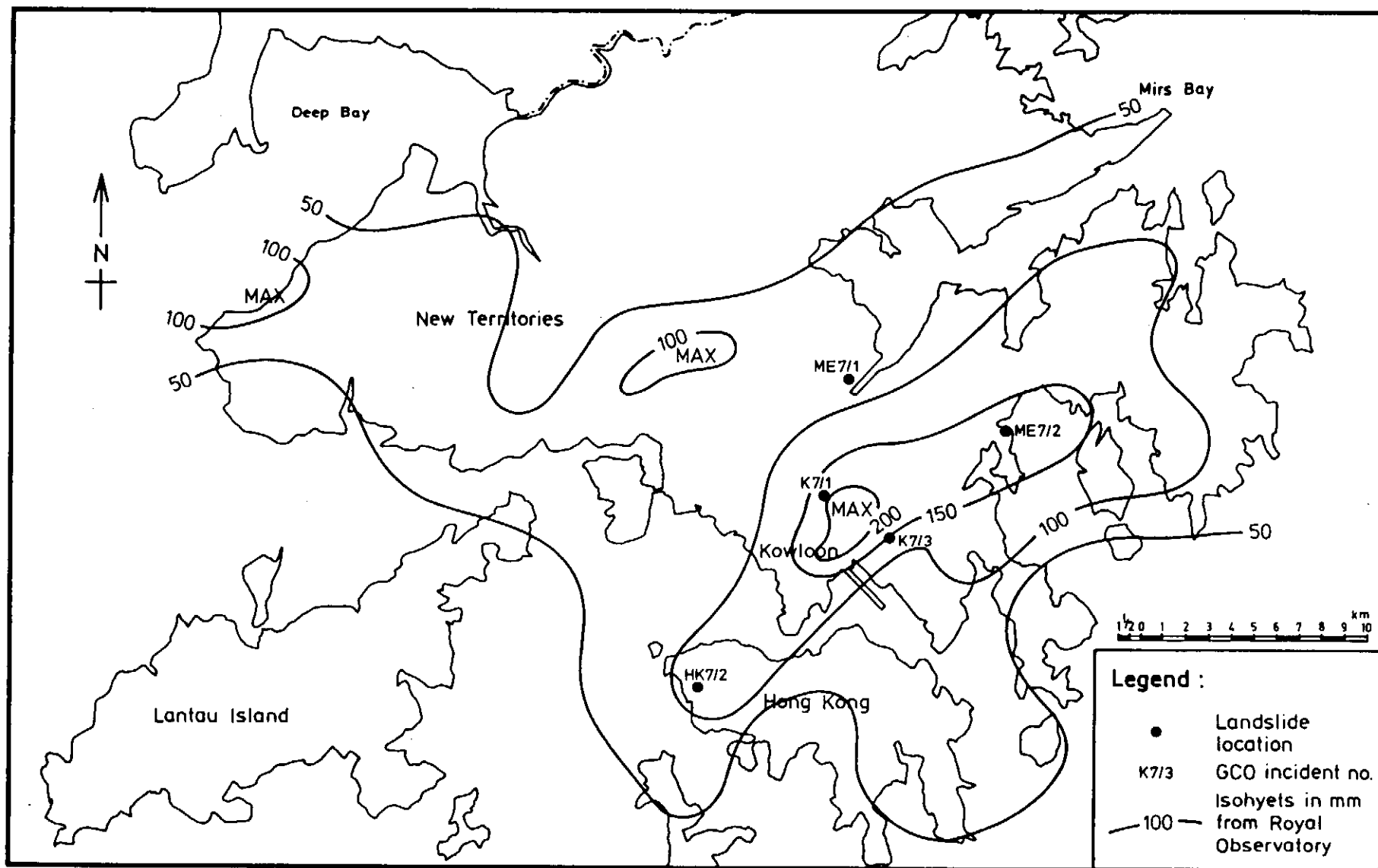


Figure 8 - 24-hour Rainfall Distribution Ending at 3pm on 4th July 1986 and Locations of GCO Incidents

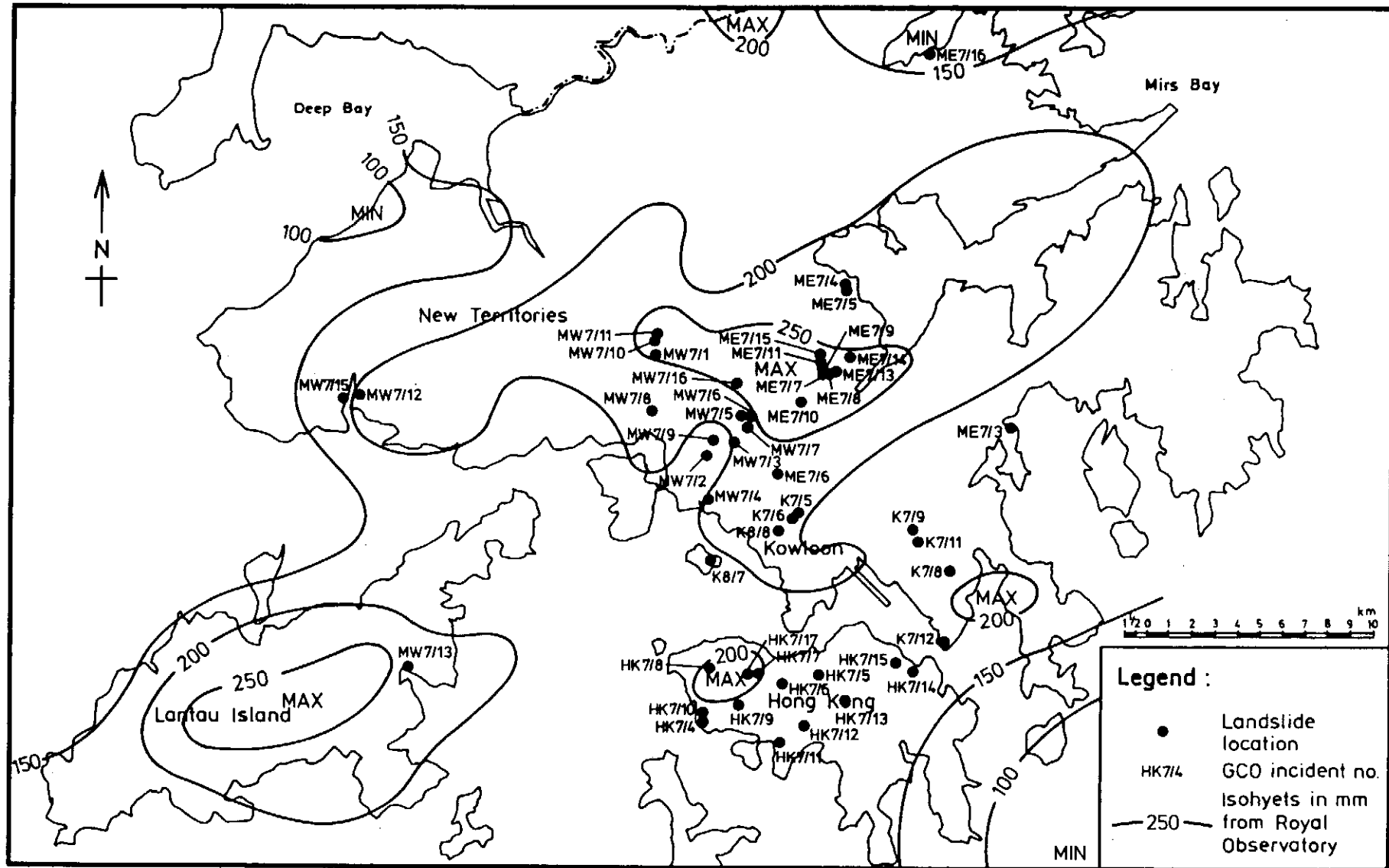


Figure 9 - 24-hour Rainfall Distribution Ending at 3pm on 12th July 1986 and Locations of GCO Incidents

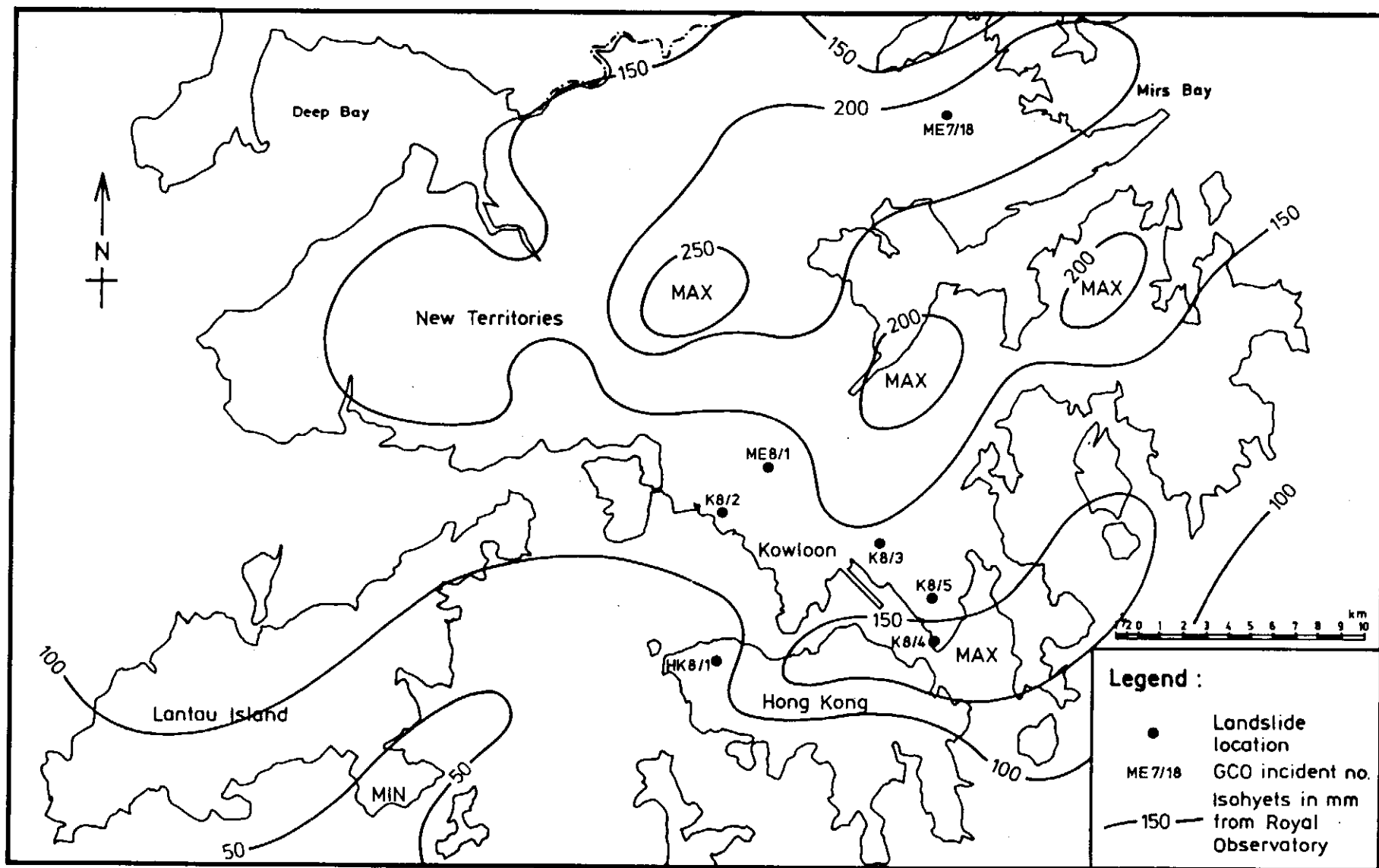


Figure 10 - 24-hour Rainfall Distribution Ending at 3pm on 11th August 1986 and Locations of GCO Incidents

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Plate : 1

Negative No. MW 8604615

Date : 4.3.86



Plate : 2

Negative No. MW 8604603

Date : 4.3.86

Description : Major failure of fill slope affecting road,
1 lane of road closed.

Plates 1 & 2 - Kwai Shing Circuit, Tsuen Wan (Incident No. MW 3/1)



Plate : 3

Negative No. MW 8612600

Date : 20.3.86



Plate : 4

Negative No. MW 8612603

Date : 20.3.86

Description : Major failure of soil cut slope affecting squatters.

Plates 3 & 4 - DD 434 Ko Tan, Tsing Yi (Incident No. MW 3/2)



Plate 5 : Negative No. SP 8701834 Date: 21.4.86

Description: Boulder fall affecting road, 1 lane of road closed.

Plate 5 - Butterfly Valley Road (Incident No. K 4/2)

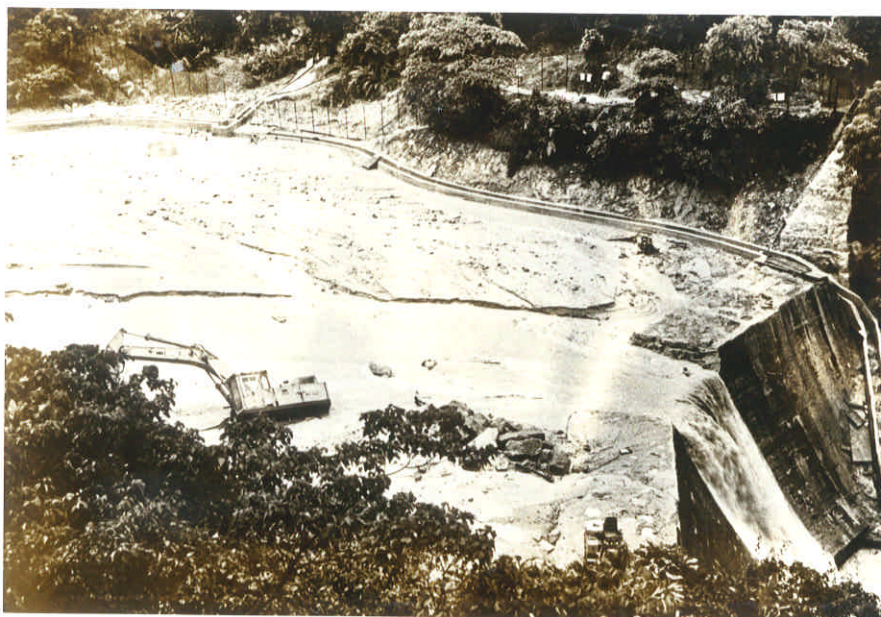


Plate 6 : Negative No. SP 8701833 Date: 11.5.86

Description: Erosion of fill area affecting construction site.

Plate 6 - Tai Koo Reservoir, Quarry Bay (Incident No. HK 5/3)



Plate 7 : Negative No. ME 8613111 Date : 6.6.86



Plate 8 : Negative No. ME 8613110 Date : 6.6.86

Description : Retaining wall failure affecting access.

Plates 7 & 8 - Ma Yau Tong Village, Sai Kung (Incident No. ME 6/2)



Plate 9 : Negative No. ME 8613708 Date: 9.6.86

Description: Major failure of natural slope affecting squatters.

Plate 9 - Sau Ming Village, Kowloon East (Incident No. K 6/5)



Plate : 10

Negative No. IW 8607306

Date : 7.7.86



Plate : 11

Negative No. IW 8607321

Date : 7.7.86

Description : Retaining wall failure affecting garden.

Plates 10 & 11 - Pokfulam Plant Nursery (Incident No. HK 7/2)



Plate : 12

Negative No. IE 8618200

Date : 12.7.86



Plate : 13

Negative No. IE 8618123

Date: 12.7.86

Description : Natural slope failure affecting roads, 2 lanes of road closed.

Plates 12 & 13 - Queen's Road East near Junction with Stubbs Road
(Incident No. HK 7/5)



Plate : 14

Negative No. ME 8617906

Date : 12.7.86

Plate : 15

Negative No. 42B86/34

Date : 16.7.86



Description : Major failure of soil/rock cut slope affecting squatters,
1 person injured, 6 huts permanently evacuated.

Plates 14 & 15 - Ma Wan Village, Lei Yue Mun (Incident No. K 7/12)



Plate 16: Negative No. ME 8617718 Date: 12.7.86



Plate 17: Negative No. ME 8617715 Date: 12.7.86

Description: Major failure of fill slope affecting road, 1 lane of road closed.

Plates 16 & 17 - MS 15 Tai Po Road, Tai Po Kau, Tai Po (Incident No. ME 7/4)



Plate 18 : Negative No. SP 8701808 Date: 12.7.86

Description: Major failure of soil cut slope (6NE-D/C21) affecting road,
both lanes of road blocked.

Plate 18 - MS 13 Route Twisk (Incident No. MW 7/1)



Plate : 19

Negative No. MW 8615524

Date : 15.7.86

Plate : 20

Negative No. 42A86/21

Date : 16.7.86



Description : Major failure of soil cut slope (6NE-D/C21) affecting road, both lanes of road blocked.

Plates 19 & 20 - MS 13 Route Twisk (Incident No. MW 7/1)



Plate 21: Negative No. HQ 8603015 Date: 12.7.86

Description: Boulder fall affecting construction site, 1 car destroyed.

Plate 21 - Wo Yi Hop Road, Tsuen Wan (Incident No. MW 7/16)



Plate : 22

Negative No. IW 8680A17

Date : 15.7.86

Plate : 23

Negative No. SP 8701832

Date : 14.7.86



Description : Boulder fall affecting car park, 1 car destroyed.

Plates 22 & 23 - Kennedy Town Police Quarters, Ka Wai Man Road
(Incident No. HK 7/16)



Plate 24: Negative No. ME 8618401 Date: 14.7.86



Plate 25: Negative No. IW 8608113 Date: 17.7.86

Description: Soil/rock cut slope failure affecting building lot.

Plates 24 & 25 - Lee Kwok Yiu Building, Hong Kong University
(Incident No. HK 7/8)

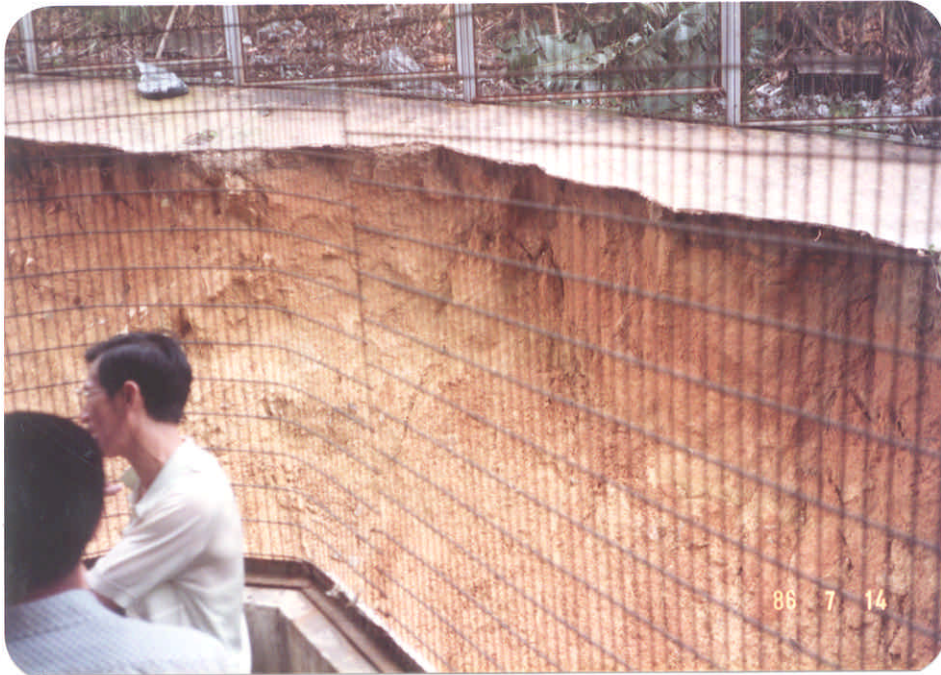


Plate 26: Negative No. ME 8615605 Date: 14.7.86



Plate 27: Negative No. MW 8616215 Date: 17.7.86

Description: Major failure of soil cut slope affecting factory.

Plates 26 & 27 - 30 Kung Yip Street, Tsuen Wan (Incident No. MW 7/3)



Plate 28: Negative No. IW 8608100 Date: 15.7.86



Plate 29: Negative No. IW 8608102 Date: 15.7.86

Description: Soil/rock cut slope failure affecting road,
1 lane of road blocked.

Plates 28 & 29 - 17, Magazine Gap Road (Incident No. HK 7/6)



Plate : 30

Negative No. ME 8618313

Date : 15.7.86



Plate : 31

Negative No. ME 8618309

Date : 15.7.86

Description : Soil cut slope failure affecting building,
1 building temporarily evacuated.

Plates 30 & 31 - Tan Cheung Lot 783 RP in DD 215, Sai Kung
(Incident No. ME 7/3)



Plate : 32

Negative No. ME 8618502

Date : 15.7.86

Plate : 33

Negative No. ME 8618522

Date : 15.7.86



Description : Major failure of fill slope affecting squatters and road,
1 hut permanently evacuated, 1 lane of road blocked.

Plates 32 & 33 - 77 District 4, Pak Tin Village, Shatin
(Incident No. ME 7/8)



Plate 34: Negative No. ME 8608007 Date: 13.7.86



Plate 35: Negative No. ME 8608009 Date: 13.7.86

Description: Fill slope failure affecting squatters, 2 huts permanently evacuated.

Plates 34 & 35 - 266 Ha Wo Che Village, Sha Tin
(Incident No. ME 7/14)



Plate 36: Negative No. ME 8621804 Date: 12.8.86



Plate 37: Negative No. ME 8621810 Date: 12.8.86

Description: Soil/rock cut slope failure affecting squatters, 13 huts permanently evacuated.

Plates 36 & 37 - Ma Wan Village, Lei Yue Mun (Incident No. K 8/4)



Plate 38: Negative No. MW 8625811 Date: 5.11.86



Plate 39: Negative No. MW 8625804 Date: 5.11.86

Description: Major failure of soil cut slope.

Plates 38 & 39 - Lot 387 DD 302, Shek Tsai Po, Tai O, Lantau (Incident No. MW 7/14)



Plate 40: Negative No. MW 8630024 Date: 5.12.86



Plate 41: Negative No. MW 8630009 Date: 5.12.86

Description: Major failure of soil/rock cut slope (6SW-D/CR29) affecting building, building temporarily evacuated.

Plates 40 & 41 - Tai Lam Centre for Women, Tuen Mun (Incident No. MW 12/2)



Plate 42: Negative No. IE 8635618 Date: 22.12.86



Plate 43: Negative No. IE 8635602 Date: 22.12.86

Description: Major failure of natural slope affecting natural park, footpath closed.

Plates 42 & 43 - Sir Cecil's Ride, Wong Nei Chung (Incident No. HK 12/1)

APPENDIX A
LIST OF INCIDENTS

APPENDIX A

LIST OF TABLES

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Table A1 - List of Incidents in Hong Kong Island Reported to GCO in 1986 (Sheet 1 of 5)

Incident No.	Location	Call Received		Failure			Area Affected	Consequence	Remarks
		Date	From	Date (Time)	Type	Scale			
HK 1/1	Junction of Tai Hang Road and Blue Pool Road	30/1	WSD	30/1 (10 am)	Subsidence	Minor	Road, footpath	1 lane closed	Wash out caused by a burst water-main
HK 2/1	Mount Parker Road, Quarry Bay	7/2	OAP Consult	NK	Soil cut slope	Minor	Squatters		
HK 4/1	Telegraph Bay Village, Pokfulam	21/4	DO	21/4 (9 am)	Retaining wall	Minor	Squatters	1 hut temporarily evacuated	
HK 4/2	Tai Wan Village (West), Pokfulam	22/4	DO	21/4 (1 am)	Soil cut slope	Minor	Squatters	5 huts permanently evacuated	
HK 4/3	52 Island Road, Repulse Bay	21/4	Police	NK	Rock cut slope	Minor	Access		
HK 5/1	30 and 40 San Shi Street, Ap Lei Chau	11/5	FSD	11/5 (pm)	Soil cut slope	Minor	Road, building lot	Footpath closed 1 building temporarily evacuated	
HK 5/2	Ma Hang Prison, Stanley	12/5	ASD	11/5 (6 pm)	Retaining wall	Minor	Building (prison)	1 building temporarily evacuated	
HK 5/3	Tai Koo Reservoir, Quarry Bay	11/5	Police	11/5	Fill slope	Minor	Construction site		Wash out by flood water
HK 5/4	Junction of Repulse Bay Road and Bellevue Drive (East End)	14/5	Police	NK	Rock cut slope	Minor	Road	Footpath closed 1 lane closed	
HK 5/5	Stanley Gap Road	22/5	HyD	22/5 (am)	Washout	Minor	Squatters		Wash out of fill on top of rock cut slope
HK 6/1	King's Road opposite Oil Street, North Point	5/6	BOO	5/6 (11 am)	Rock cut slope	Minor	Construction site	Traffic signal control box destroyed	Construction of staircase in progress
HK 6/2	59, Wan Chai Road	6/6	BOO	6/6 (10 am)	Retaining wall	Minor	Building lot, construction site, road	1 hut temporarily evacuated 2 buildings temporarily evacuated 1 lane closed	
HK 6/3	Shum Wan Road, Aberdeen	6/6	BOO	6/6 (11 am)	Retaining wall	Minor	Squatters	8 huts permanently evacuated	Wall failure caused ground subsidence
HK 6/4	Ngar Choi Hang Village above Cloud View Road, North Point	6/6	DO	6/6 (11 am)	Soil cut slope	Minor	Squatters	1 hut permanently evacuated	

Table A1 (Cont.) - List of Incidents in Hong Kong Island Reported to GCO in 1986 (Sheet 2 of 5)

Incident No.	Location	Call Received		Failure			Area Affected	Consequence	Remarks
		Date	From	Date (Time)	Type	Scale			
HK 6/5	Tsin Tsui Ma Tau Village, Shaukeiwan	6/6	HyD	6/6	Boulder	Minor	Squatters, footpath, access	3 huts temporarily evacuated, footpath closed, access closed	Boulder on the bank of a stream course dislodged
HK 6/6	Mt. Parker Road near King's Road	6/6	HyD	6/6 (4 pm)	Soil cut slope	Minor	Footpath	Footpath blocked	
HK 6/7	Bowen Road, Happy Valley	7/6	HyD	6/6	Boulder	Minor	Road	Road blocked	
HK 6/8	Mt. Parker Road near King's Road	6/6	HyD	6/6 (4 pm)	Fallen tree	Minor	Footpath	Footpath blocked	
HK 6/9	Ngoi Man Street, Shaukeiwan	7/6	DO	6/6 (am)	Subsidence	Minor	Squatters	5 huts permanently evacuated	
HK 6/10	Yau Sheung Village, Nam Fung Road, Wong Chuk Hang	27/6	DO	27/6 (3 pm)	Subsidence	Minor	Squatters	1 hut permanently evacuated	
HK 6/11	Lung Wah Street, Kennedy Town	27/6	Police	NK	Soil cut slope	Minor	Squatters	An area fenced off	
HK 7/1	27 Blue Pool Road, Happy Valley	30/6	HyD	NK	Natural slope	Minor	Building lot		Long-term erosion problem
HK 7/2	Pokfulam Plant Nursery	5/7	ASD	4/7 (am)	Retaining wall	Minor	Plant nursery		
HK 7/3	Kennedy Road near Wah Yan College	9/7	Public	NK	Soil cut slope	Minor	Building, road		Chunam crack and slope surface erosion
HK 7/4	Shui Choi Tin Village, Wan Fu	12/7	DO	12/7 (7 am)	Soil cut slope	Minor	Squatters	1 hut permanently evacuated 1 hut temporarily evacuated	
HK 7/5	Queen's Road East near Junction with Stubbs Road	12/7	HyD	12/7 (10 am)	Natural slope	Minor	Road	2 lanes closed	Affected one road above and one below the failure
HK 7/6	17, Magazine Gap Road	12/7	HyD	12/7 (am)	Soil/rock cut slope	Minor	Road	1 lane blocked	
HK 7/7	Hornsey Road near Chater Hall	12/7	HyD	12/7 (am)	Soil/rock cut slope	Minor	Road	1 lane blocked	

Table A1 (Cont.) - List of Incidents in Hong Kong Island Reported to GCO in 1986 (Sheet 3 of 5)

Incident No.	Location	Call Received		Failure			Area Affected	Consequence	Remarks
		Date	From	Date (Time)	Type	Scale			
HK 7/8	Lee Kwok Yin Building, Hong Kong University	12/7	BOO	12/7 (3 pm)	Soil/rock cut slope	Minor	Building lot		
HK 7/9	Mt. Kellett Road opposite Matilda Hospital	12/7	H/HK	12/7 (pm)	Soil/rock cut slope	Minor	Road	1 lane blocked	
HK 7/10	Shui Choi Tin Village, Wah Fu	12/7	DO	12/7 (am)	Soil cut slope	Minor	Squatters	2 huts temporarily evacuated	
HK 7/11	Shum Wan Road Village, Aberdeen	13/7	H/HK	12/7	Retaining wall	Minor	Squatters	8 huts permanently evacuated	
HK 7/12	Choi Sheung Village, Nam Fung Road, Wong Chuk Hang	12/7	BOO	12/7 (7 pm)	Soil cut slope	Minor	Squatters	1 hut temporarily evacuated	
HK 7/13	Maryknoll Sisters School, Blue Pool Road	14/7	BOO	12/7 (pm)	Boulder	Minor	Buildings	An area fenced off	
HK 7/14	Tsin Shui Ma Tau Village, Shaukeiwan	14/7	HyD	12/7 (8 am)	Soil cut slope	Minor	Squatters	4 huts temporarily evacuated	
HK 7/15	Holy Cross Path Village, Shaukeiwan	14/7	HyD	13/7 (6 am)	Retaining wall	Minor	Access		
HK 7/16	Kennedy Town Police Quarters, Ka Wai Man Road	14/7	Police	14/7 (6 pm)	Boulder	Minor	Car park	1 car destroyed car park closed	
HK 7/17	27 Lugard Road, the Peak	15/7	HyD	12/7 (pm)	Soil/rock cut slope	Minor	Access	1 lane blocked	
HK 7/18	Tai Hang Old Village, Tai Hang	28/7	HyD	NK	Boulder	Minor	Squatters	1 hut permanently evacuated	
HK 7/19	Yee King Road, North Point	28/7	HyD	NK	Boulder	Minor	Footpath		Complaint only, no movement
HK 7/20	Ma Shan Village above Yee King Road, North Point	28/7	HyD	NK	Boulder	Minor	Squatters		Complaint only, no movement
HK 8/1	St. Stephen's Girls School Lyttelton Road, Mid-Levels	11/8	H & S Consult	11/8	Retaining wall	Minor	Road, building	1 lane closed	Soil washed out due to a burst water-main
HK 8/2	6 Broadwood Road, Happy Valley	15/8	BOO	14/8	Soil cut slope	Minor	Building lot, construction site	An area fenced off	

Table A1 (Cont.) - List of Incidents in Hong Kong Island Reported to GCO in 1986 (Sheet 4 of 5)

Incident No.	Location	Call Received		Failure			Area Affected	Consequence	Remarks
		Date	From	Date (Time)	Type	Scale			
HK 8/3	St. Stephen's Girl's College, Lyttelton Road, Mid-Levels	20/8	H & S Consult	20/8	Subsidence	Minor	Road, building	1 lane closed	Soil washed out due to water-main and sewer leakage
HK 8/4	Tsin Shui Ma Tau Village, Shaukeiwan	21/8	HyD	21/8 (2 pm)	Soil cut slope	Minor	Squatters	3 huts permanently evacuated	
HK 8/5	Tsin Shui Ma Tau Village, Shaukeiwan	21/8	HyD	21/8 (11 am)	Subsidence	Minor	Squatters	3 huts temporarily evacuated	At the same site as Incident HK 6/5
HK 8/6	Tsin Shui Ma Tau Village, Shaukeiwan	22/8	HyD	NK	Soil cut slope	Minor	Squatters	3 huts permanently evacuated	Complaint of potential failure
HK 8/7	Tsin Shui Ma Tau Village, Shaukeiwan	22/8	HyD	NK	Soil cut slope	Minor	Squatters	1 hut permanently evacuated	Complaint of potential failure
HK 8/8	Aldrich Village, Shaukeiwan	22/8	HyD	NK	Soil cut slope	Minor	Squatters	1 hut permanently evacuated	Complaint of potential failure
HK 8/9	Victoria Road, Pokfulam	27/8	HyD	24/8	Boulder	Minor	Road		
HK 8/10	Nam Long Shan Road Village, Aberdeen	26/8	HyD	18/8	Subsidence	Minor	Squatters	1 hut permanently evacuated	
HK 9/1	Mary New Village, Stanley	6/9	HyD	5/9 (5 pm)	Fill slope	Minor	Squatters	2 huts permanently evacuated	
HK 9/2	Sham Kap Village, Shek Pai Wan Road, Aberdeen	8/9	HyD	7/9	Fill slope	Minor	Squatters	A storage area closed	
HK 9/3	Holy Cross Path Village	8/9	HyD	7/9 (8 pm)	Soil cut slope	Minor	Squatters	1 hut permanently evacuated	
HK 9/4	40 Cloud View Road, North Point	10/9	BOO	8/9 (6 am)	Rock cut slope	Minor	Road	Footpath closed	
HK 9/5	Nam Long Shan Road Village, Aberdeen	10/9	HyD	4/9 (10 am)	Fill slope	Minor	Squatters		
HK 9/6	Tai Hang Old Village, Tai Hang	5/9	HyD	NK	Boulder	Minor	Squatters		Complaint only, no movement
HK 9/7	Black's Link, Mt. Cameron	22/9	HyD	NK	Soil cut slope	Minor	Road		
HK 10/1	90 Shan Pin Terrace, A Kunz Ngam	2/10	HyD	11/7	Soil cut slope	Minor	Squatters	1 hut permanently evacuated	

Table A1 (Cont.) -- List of Incidents in Hong Kong Island Reported to GCO in 1986 (Sheet 5 of 5)

Incident No.	Location	Call Received		Failure			Area Affected	Consequence	Remarks
		Date	From	Date (Time)	Type	Scale			
HK 10/2	Nam Long Shan Road Village, Aberdeen	10/10	HyD	NK	Subsidence	Minor	Squatters		
HK 10/3	Nam Long Shan Road Village, Aberdeen	18/10	Police	18/10 (am)	Fill slope	Minor	Squatters	2 huts temporarily evacuated	
HK 11/1	Holy Cross Path Village	11/11	HyD	7/11	Boulder	Minor	Squatters		
HK 11/2	O Pui Lung Village, Shaukeiwan	20/11	HyD	15/11 (6 am)	Soil cut slope	Minor	Squatters	1 hut permanently evacuated	
HK 11/3	Aldrich Bay Village, Shaukeiwan	13/11 (noon)	HyD	NK	Boulder	Minor	Squatters		Complaint only, no movement
HK 12/1	Sir Cecil's Ride, Wong Nei Chung	20/12	HyD	19/12	Natural slope	Major	Country park trail	Footpath (trail) closed	
HK 12/2	Holy Cross Path Village, Shaukeiwan	31/12	HyD	NK	Retaining wall	Minor	Squatters		Signs of distress observed
Legend : NK Not known									

Table A2 - List of Incidents in Kowloon Reported to GCO in 1986 (Sheet 1 of 6)

Incident No.	Location	Call Received		Failure			Area Affected	Consequence	Remarks
		Date	From	Date (Time)	Type	Scale			
K 1/1	Man Kuk Village, KC	20/1	HyD	12/1	Soil cut slope	Minor	Squatters		
K 2/1	Ngau Chi Wan Village, KC	18/2	HyD	18/2 (9 am)	Retaining wall	Minor	Squatters	1 hut permanently evacuated	
K 2/2	Cheung Lung Tin Village, KE	21/2	HyD	20/2 (10 pm)	Retaining wall	Minor	Squatters	1 hut permanently evacuated 2 huts temporarily evacuated	
K 2/3	Ling Nam San Tsuen, KE	24/2	HyD	24/2 (1 pm)	Subsidence	Minor	Squatters	1 hut temporarily evacuated	
K 3/1	Cheung Lung Tin Village, KE	14/3	HyD	13/3 (6 pm)	Subsidence	Minor	Squatters		
K 3/2	Bishop Ford Memorial School, Lok Fu, Kowloon City	19/3	HyD	30/1	Soil cut slope	Minor	Footpath, school	Footpath blocked	
K 3/3	Cheung Lung Tin Village, KE	24/3	HyD	NK	Subsidence	Minor	Squatters	1 hut temporarily evacuated	
K 4/1	Hammer Hill Road, KC	8/4	HyD	NK	Subsidence	Minor	Squatters		
K 4/2	Butterfly Valley Road, KW	21/4	HyD	21/4	Boulder	Minor	Road	1 lane closed, footpath closed	
K 4/3	Argyle Street, below 16 Kadoorie Avenue, Ho Man Tin	22/4	HyD	21/4 (6 pm)	Boulder	Minor	Footpath	Footpath closed	
K 5/1	Block 7, Lok Fu Estate (11NW-B/C170)	12/5	GCO	11/5 (5 pm)	Soil/rock cut slope	Minor	Building		Soil wash out, LPM works in progress
K 5/2	Kwong Lee Road Bus Terminus, So Uk	11/5	BOG	11/5 (10 pm)	Soil cut slope	Minor	Bus terminus		Near default works in progress
K 5/3	Ling Nam San Tsuen, KE	12/5	HyD	12/5 (2 am)	Boulder	Minor	Squatters	1 hut permanently evacuated	
K 5/4	Ling Nam San Tsuen, KE	12/5	HyD	12/5	Hut collapse	Minor	Squatters		Not a geotechnical problem
K 5/5	Cheung Lung Tin Village, KE	12/5	HyD	11/5 (pm)	Soil cut slope	Minor	Squatters	1 hut permanently evacuated	
K 5/6	Clear Water Bay Road below Lee On Flyover	12/5	HyD	11/5	Soil cut slope	Minor	Footpath	Footpath closed	

Table A2 (Cont.) - List of Incidents in Kowloon Reported to GCO in 1986 (Sheet 2 of 6)

Incident No.	Location	Call Received		Failure			Area Affected	Consequence	Remarks
		Date	From	Date (Time)	Type	Scale			
K 5/7	Tai Koon New Village, KW	12/5	HyD	11/5 (6 pm)	Soil cut slope	Minor	Squatters	1 hut temporarily evacuated	
K 5/8	Lee On Road, opposite Lee Hang House, KC	12/5	HyD	11/5	Soil cut slope	Minor	Footpath		
K 5/9	Lam Tin 3rd Village, KE	13/5	HyD	12/5	Soil cut slope	Minor	Footpath	Footpath blocked	
K 5/10	Cheung Lung Tin Village, KE	20/5	HyD	19/5	Retaining wall	Minor	Squatters	3 huts permanently evacuated	
K 5/11	Sze Shun Street, CL-KX910, KE	20/5	HyD	12/5	Soil cut slope	Minor	Footpath	Footpath blocked	
K 5/12	Ngau Chi Wan, East Village, KC	22/5	HyD	22/5 (1 am)	Subsidence	Minor	Squatters	2 huts permanently evacuated	
K 6/1	Tai Shin Village, Sau Mau Ping, KC	2/6	HyD	31/5	Soil cut slope	Minor	Squatters	2 huts permanently evacuated	
K 6/2	Diamond Hill, Ha Yuen Ling, KC	3/6	BOO	3/6 (3 am)	Hut collapse	Minor	Squatters		Not a geotechnical problem
K 6/3	Man Kuk New Village, KC	5/6	HyD	4/6 (2 pm)	Subsidence	Minor	Squatters	1 hut permanently evacuated	
K 6/4	Martha Boss Community Centre, Chung Hau Street, Ho Man Tin	6/6	Public	6/6 (8 am)	Soil cut slope	Minor	School playground	An area fenced off	File No. BDD (B) 6/4163/81
K 6/5	Sau Ming Village, KE	6/6	Public	6/6 (am)	Natural slope	Major	Squatters	An area fenced off	
K 6/6	King's Park (11NW-D/F97)	6/6	CEO	6/6	Fill slope	Minor	Road	1 lane blocked (water & mud)	LPM works in progress
K 6/7	Chung Luen Village, Tai Po Road, KW	6/6	HyD	6/6 (8 am)	Retaining wall	Minor	Squatters	1 hut permanently evacuated	
K 6/8	Ling Nam San Tsuen, KE	6/6	HyD	6/6 (am)	Hut collapse	-	Squatters		Not a geotechnical problem
K 6/9	Lei Yue Mun Village, Chuen Yuen Road, KE	6/6	HyD	6/6 (am)	Hut collapse	-	Squatters		Not a geotechnical problem
K 6/10	Tai Luk San Tsuen, Cha Kwo Ling Road, KE	6/6	HyD	6/6 (am)	Boulder	Minor	Squatters	1 hut permanently evacuated	

Table A2 (Cont.) - List of Incidents in Kowloon Reported to GCO in 1986 (Sheet 3 of 6)

Incident No.	Location	Call Received		Failure			Area Affected	Consequence	Remarks
		Date	From	Date (Time)	Type	Scale			
K 6/11	Fuk Tak New Village, Jordan Valley, KE	6/6	HyD	6/6 (10 am)	Soil cut slope	Minor	Squatters	1 hut permanently evacuated	Not a geotechnical problem
K 6/12	Cheung Lung Tin Village, KE	6/6	HyD	6/6 (am)	Soil cut slope	Minor	Squatters	6 huts permanently evacuated	
K 6/13	Clear Water Bay Road near Tak Mon Village	6/6	HyD	NK	Subsidence	Minor	Road		
K 6/14	Ngau Chi Wan East Village, KC	6/6	HyD	6/6 (10 am)	Soil cut slope	Minor	Squatters	1 hut permanently evacuated	
K 6/15	Ngau Chi Wan East Village, KC	6/6	HyD	6/6 (10 am)	Hut collapse	Minor	Squatters	1 hut temporarily evacuated	
K 6/16	Ngau Chi Wan East Village, KC	6/6	HyD	6/6 (8 am)	Soil cut slope	Minor	Squatters	1 hut temporarily evacuated 1 hut permanently evacuated	
K 6/17	Ngau Chi Wan West Village, KC	6/6	HyD	6/6 (10 am)	Fill slope	Minor	Squatters	5 huts temporarily evacuated	
K 6/18	Sau Ming Village, KE	6/6	HyD	6/6 (am)	Retaining wall	Minor	Squatters	1 hut permanently evacuated	
K 6/19	Sau On Village, Sau Mau Ping	6/6	DO	6/6 (am)	Subsidence	Minor	Squatters		
K 6/20	Linx Nam San Tsuen, KE	9/6	HyD	6/6 (am)	Soil cut slope	Minor	Road, footpath	Footpath blocked	
K 6/21	Cheung Lung Tin Village, KE	9/6	HyD	6/6 (am)	Subsidence	Minor	Squatters		
K 6/22	Kam Shek Village, KE	9/6	HyD	8/6	Soil cut slope	Minor	Squatters	1 hut permanently evacuated	
K 6/23	Ngau Chi Wan East Village, KC	9/6	HyD	6/6 (pm)	Subsidence	Minor	Squatters	3 huts temporarily evacuated	
K 6/24	Ngau Chi Wan East Village, KC	9/6	HyD	6/6 (9 pm)	Soil cut slope	Minor	Squatters		
K 6/25	Ngau Chi Wan West Village, KC	9/6	HyD	6/6 (pm)	Retaining wall	Minor	Squatters	1 hut permanently evacuated	

Table A2 (Cont.) - List of Incidents in Kowloon Reported to GCO in 1986 (Sheet 4 of 6)

Incident No.	Location	Call Received		Failure			Area Affected	Consequence	Remarks
		Date	From	Date (Time)	Type	Scale			
K 6/26	Ngau Chi Wan West Village, KC	9/6	HyD	6/6 (pm)	Boulder	-	Squatters		No movement, complaint only
K 6/27	Ngau Chi Wan West Village, KC	9/6	HyD	6/6	Flooding	Minor	Squatters		
K 6/28	Fung Wong High Level-Service Reservoir, Sha Tin Pass Road	10/6	HyD	6/6 (11 am)	Natural slope	Minor	Footpath	Footpath blocked	
K 6/29	Sha Tin Pass Road, Area A & B	10/6	HyD	6/6 (am)	Soil cut slope	Minor	Road		
K 6/30	Kung Lok Road, Jordan Valley	10/6	HyD	6/6 (am)	Rock cut slope	Minor	Footpath	Footpath blocked	
K 6/31	Hip Wo Street, Kwun Tong	13/6	HyD	NK	Rock cut slope	Minor	Road	Footpath blocked	
K 6/32	USD Temporary Parking Lot, Ho Man Tin	10/6	USD	NK	Soil cut slope	Minor	Parking lot		Surface erosion only
K 6/33	Lion Rock Village, KC	27/6	HyD	NK	Boulder	-	Squatters		No movement, complaint only
K 7/1	Lion Rock Village (Lower), KC	4/7	DO	4/7 (9 am)	Soil cut slope	Minor	Squatters		
K 7/2	Kam Shek Village, KE	4/7	HyD	NK	Soil cut slope	Minor	Squatters	1 hut permanently evacuated	
K 7/3	Ngau Chi Wan East Village, KC	4/7	HyD	4/7	Hut collapse	Minor	Squatters	2 huts temporarily evacuated	
K 7/4	Nodel Village, Kowloon Tong	8/7	Police	8/7 (10 am)	Soil cut slope	Minor	Squatters	1 hut permanently evacuated	
K 7/5	Tai Hang Tung, Tung Hang Lane	14/7	HyD	12/7	Soil cut slope	Minor	Squatters		
K 7/6	Tai Hang Tung, Tung Hang Lane	14/7	HyD	12/7 (5 pm)	Retaining wall	Minor	Squatters		
K 7/7	Tak Wo Street, Sau Mau Ping	14/7	HyD	14/7	Subsidence	Minor	Road	1 lane closed	
K 7/8	Tai Shing Village, Sau Mau Ping	12/7	BOO	12/7 (pm)	Soil cut slope	Minor	Squatters	4 huts permanently evacuated	
K 7/9	Ngau Chi Wan West Village, KC	14/7	HyD	12/7 (8 am)	Soil cut slope	Minor	Squatters		Arch SD(M) slope work in progress

Table A2 (Cont.) - List of Incidents in Kowloon Reported to GCO in 1986 (Sheet 5 of 6)

Incident No.	Location	Call Received		Failure			Area Affected	Consequence	Remarks
		Date	From	Date (Time)	Type	Scale			
K 7/10	Ngau Chi Wan West Village, KC	14/7	HyD	13/7 (2 pm)	Subsidence	Minor	Squatters		
K 7/11	Ngau Chi Wan East Village, KC	14/7	HyD	12/7 (11 am)	Soil cut slope	Minor	Squatters	1 hut permanently evacuated	
K 7/12	Ma Wan Village, Lei Yue Mun	12/7	DO	12/7 (7 am)	Soil/rock cut slope	Major	Squatters	1 person injured, 6 huts permanently evacuated	
K 7/13	Cheung Lung Tin Village, KE	15/7	HyD	13/7	Fill slope	Minor	Squatters	1 hut permanently evacuated	
K 7/14	Fuk Tak New Village, Jordan Valley	18/7	DO	13/7 (am)	Soil cut slope	Minor	Squatters	Footpath blocked	
K 7/15	Ling Nam New Village, KE	19/7	DO	18/7 (pm)	Subsidence	Minor	Squatters		
K 7/16	Ngau Chi Wan East Village, KC	21/7	Police	21/7 (9 am)	Soil cut slope	Minor	Squatters	1 hut permanently evacuated	
K 7/17	Tai Koon New Village, KW	30/7	DO	NK	Subsidence	Minor	Squatters		
K 7/18	Tai Koon/Man Kuk Village, KW	30/7	DO	NK	Soil cut slope	Minor	Squatters		
K 8/1	Lung Yiu Hang Village, KC	4/8	BOO	1/8	Soil cut slope	Minor	Squatters	3 huts permanently evacuated	
K 8/2	Butterfly Valley Road	11/8	HyD	11/8	Rock cut slope	Minor	Road	Footpath closed	
K 8/3	Ngau Chi Wan East Village, KC	11/8	FSD	11/8 (pm)	Subsidence	Minor	Squatters	2 huts permanently evacuated	
K 8/4	Ma Wan Village, Lei Yue Mun	12/8	HyD	11/8 (3 pm)	Soil/rock cut slope	Minor	Squatters	13 huts permanently evacuated	
K 8/5	Lam Tin 3rd Village, KE	12/8	DO	11/8 (pm)	Soil cut slope	Minor	Footpath		
K 8/6	Junction between Lei Yue Mun Road and Rehab Path, KE	8/8	Police	NK	Boulder	Minor	Road		
K 8/7	Stonecutter Island behind Dupont W/G Factory	25/7	ASD	12/7	Natural slope	Minor	Factory lot		

Table A2 (Cont.) - List of Incidents in Kowloon Reported to GCO in 1986 (Sheet 6 of 6)

Incident No.	Location	Call Received		Failure			Area Affected	Consequence	Remarks	
		Date	From	Date (Time)	Type	Scale				
K 8/8	72-74 Tai Po Road (11NW-B/CR46)	20/8	GCO	12/7	Soil cut slope	Minor	Car park	Footpath closed	Rupture of water- main	
K 8/9	Kam Mun Village, Tai Wo Ping	25/8	BOO	23/8 (3 pm)	Fill slope	Minor	Squatters			
K 9/1	Hiu Ming Street Playground, KE	8/9	ASD	3/9 (8 am)	Rock fall	Minor	Building lot			
K 9/2	Hiu Ming Street opposite Holm Glad College, KE	17/9	HyD	17/9 (am)	Rock fall	Minor	Footpath			
K 9/3	On Lok Village, Sau Mau Ping	18/9	HyD	18/9 (am)	Subsidence	Minor	Squatters			
K 9/4	Diamond Hill Cemetery	25/9	ASD	NK	Soil cut slope	Minor	Cemetery	1 lane closed		
K 10/1	Cheung Lung Tin Village, KE	2/10	DO	NK	Soil cut slope	Minor	Squatters			
K 10/2	Tsz Wan Shan Road (11NE-A/F12)	3/10	HyD	3/10 (11 am)	Fill slope	Minor	Road, building			
K 11/1	Tsz Mei Village, KC	10/11	HD	9/11 (7 pm)	Subsidence	Minor	Squatters			

Legend :

NK Not known

Table A3 - List of Incidents in Eastern New Territories Reported to GCO in 1986 (Sheet 1 of 3)

Incident No.	Location	Call Received		Failure			Area Affected	Consequence	Remarks
		Date	From	Date (Time)	Type	Scale			
ME 2/1	26 Second St, Heung Fan Lui, Shatin	21/2	DLO	19/2 (7 am)	Soil cut slope	Minor	Squatters		
ME 2/2	55 Pai Tau Village, Sha Tin	24/2	DLO	NK	Soil cut slope	Minor	Building		
ME 3/1	Ngau Liu, Ho Chung, Sai Kung	11/4	HyD	28/3 (5 pm)	Soil cut slope	Minor	Village house		
ME 4/1	Bride's Pool Road, Tai Po	23/4	HyD	20/4	Rock fall	Minor	Road		
ME 4/2	Cut slope at Bride's Pool Road between MS 8 & MS 9, Tai Po	23/4	HyD	20/4	Rock fall	Minor	Road		
ME 5/1	Clear Water Bay Golf and Country Club, Sai Kung	11/5	BOG	11/5 (6 pm)	Soil cut slope	Minor	Road	1 lane blocked	
ME 5/2	Ko Lau Wan School, Sai Kung	12/5	DLO	11/5 (6 pm)	Retaining wall	Minor	Footpath, building	Footpath closed	
ME 5/3	Tai Po Kau, Tai Po	13/5	DLO	NK	Soil cut slope	Minor	Village house		
ME 5/4	7 Tai Om Village, Tai Po	13/5	DLO	NK	Soil cut slope	Minor	Building		
ME 5/5	9 Tai Om Village, Tai Po	13/5	DLO	NK	Soil cut slope	Minor	Building		
ME 6/1	Toi Hoi Village, Lot 291, Sai Kung	6/6	BOG	6/6 (am)	Retaining wall	Minor	Building		
ME 6/2	Ma Yau Tong Village, Lot 35-38, SD 9, Sai Kung	6/6	DLO	6/6 (8 am)	Retaining wall	Major	Access	An area fenced off	
ME 7/1	To Fung Shan Road, Sha Tin	4/7	DLO	4/7	Soil cut slope	Minor	Footpath		
ME 7/2	Fu Yui Ha Village, Sai Kung	9/7	DLO	4/7 (am)	Soil cut slope	Minor	Footpath	Footpath blocked	
ME 7/3	Tam Cheung Lot 783 RP in DD 215, Sai Kung	12/7	HyD	11/7 (12 pm)	Soil cut slope	Minor	Building	1 building temporarily evacuated	
ME 7/4	MS 15 Tai Po Road, near Lai Chi Hang, Tai Po Kau, Tai Po	11/7	HyD	11/7 (7 pm)	Fill slope	Major	Road	1 lane closed	
ME 7/5	Tai Po Road, Tai Po Kau Tai Po	12/7	HyD	12/7 (am)	Soil/rock cut slope	Minor	Road	1 lane blocked	

Table A3 (Cont.) - List of Incidents in Eastern New Territories Reported to GCO in 1986 (Sheet 2 of 3)

Incident No.	Location	Call Received		Failure			Area Affected	Consequence	Remarks
		Date	From	Date (Time)	Type	Scale			
ME 7/6	MS 5½ Tai Po Road, Sha Tin	12/7	Police	12/7 (8 am)	Soil cut slope	Minor	Road	1 lane blocked	Not a geotechnical problem
ME 7/7	79B 1st District, Pak Tin Village, Sha Tin	12/7	HyD	12/7 (am)	Retaining wall	Minor	Squatters	1 hut temporarily evacuated	
ME 7/8	77 4th District, Pak Tin Village, Sha Tin	14/7	DLO	12/7 (7 am)	Fill slope	Major	Squatters, road	1 hut permanently evacuated 1 lane blocked	
ME 7/9	59C 1st District, Pak Tin Village, Sha Tin	14/7	HD	12/7 (am)	Soil cut slope	Minor	Squatters		
ME 7/10	Kenz Hau Road, Sha Tin	14/7	HyD	14/7	Retaining wall	Minor	Building lot	An area fenced off	
ME 7/11	36 Yau Oi Village, Sha Tin	15/7	DLO	12/7 (am)	Natural slope	Minor	Squatters	1 hut permanently evacuated	
ME 7/12	293 Tin Liu Village, Sha Tin	15/7	DLO	NK	Fallen tree	-	Squatters		
ME 7/13	4th District, Pak Tin Village, Sha Tin	16/7	DLO	12/7 (6 am)	Soil cut slope	Minor	Squatters	3 huts permanently evacuated	
ME 7/14	266 Ha Wo Che Village, Sha Tin	13/7	Public	12/7 (8 am)	Fill slope	Minor	Squatters	2 huts permanently evacuated	
ME 7/15	CLL 7431, Yau Oi Village, Sha Tin	16/7	DLO	12/7 (am)	Boulder	Minor	Building lot		
ME 7/16	Fung Hang Village, Sha Tau Kok, DD 50 Lot 346, North	12/7	DO	12/7	Boulder	Minor	Building lot		
ME 7/17	48 Sam Mun Tsai New Village, Tai Po	18/8	DO	NK	Soil cut slope	Minor	Building		
ME 7/18	Wu Kau Tang access road, Tai Po	12/8	HyD	10/8	Soil cut slope	Minor	Road		
ME 7/19	Lung Ha Wan Road, Tai Hang Hau, Sai Kung	22/8	DO	22/7	Soil cut slope	Minor	Road	1 lane blocked	
ME 8/1	6½ MS, Tai Po Road, Sha Tin	11/8	HyD	11/8 (8 am)	Soil/rock cut slope	Minor	Road	1 lane closed	
ME 8/2	Wo Lai Hang Village, Sha Tin	2/9	DLO	NK	Retaining wall	Minor	Access	Access blocked	

Table A3 (Cont.) - List of Incidents in Eastern New Territories Reported to GCO in 1986 (Sheet 3 of 3)

Incident No.	Location	Call Received		Failure			Area Affected	Consequence	Remarks
		Date	From	Date (Time)	Type	Scale			
ME 8/3	Bride's Pool Road, near Chung Mei, Tai Po	10/9	RyD	13/8	Soil cut slope	Minor	Road		
ME 8/4	153 Oi Tak San Tsuen, Tai Po	17/9	RyD	21/8	Soil cut slope	Minor	Building lot		
ME 12/1	160, 4th Street, Heung Fan Liu, Sha Tin	9/12	HD	NK	Fill slope	Minor	Squatters		
Legend : NK Not known									

Table A4 - List of Incidents in Western New Territories Reported to GCO in 1986 (Sheet 1 of 3)

Incident No.	Location	Call Received		Failure			Area Affected	Consequence	Remarks
		Date	From	Date (Time)	Type	Scale			
MW 1/1	Shek Lei Hang Village, Tsuen Wan	27/1	HyD	26/1	Subsidence	Minor	Squatters	1 hut permanently evacuated	
MW 3/1	Kwai Shing Circuit, Tsuen Wan (7SW-C/FR63)	4/3	HyD	3/3 (4 pm)	Fill slope	Major	Road	1 lane closed	File No. GCMd 2/D4/40
MW 3/2	DD 434 Ko Tan, Tsing Yi (10NE-B/W5)	7/3	HyD	NK	Soil cut slope	Major	Squatters		File No. GCMd 2/E2/86-3
MW 4/1	Kwong Pan Tin Tsuen, Route Twisk, Tsuen Wan	21/4	HD	21/4 (5 am)	Soil cut slope	Minor	Squatters	2 huts permanently evacuated	
MW 4/2	6½ MS Castle Peak Road, Tsuen Wan	22/4	HyD	21/4	Soil cut slope	Minor	Squatters		
MW 4/3	6½ MS Castle Peak Road, Tsuen Wan	23/4	GCO	21/4	Soil cut slope	Minor	Squatters		
MW 5/1	7 MS Castle Peak Road, Tsuen Wan	12/5	HyD	12/5 (10 am)	Soil cut slope	Minor	Footpath	Footpath blocked	
MW 5/2	MS 13, Route Twisk	12/5	HyD	12/5 (am)	Boulder	Minor	Road		
MW 5/3	Kau Wa Keng Village, Tsuen Wan	14/5	HyD	14/5	Soil cut slope	Minor	Squatters		
MW 5/4	DD 387 Lot 103 Castle Peak Road, Tsuen Wan	16/5	GCO	11/5	Soil cut slope	Minor	Road	Private access blocked	File No. DH/14B/82/C
MW 5/5	Siu Lam Hospital, Tuen Mun	19/5	ASD	12/5	Soil cut slope	Minor	Building lot		File No. DH/4B/82/K
MW 5/6	Lamma Island Lot No. 1888	27/5	DLO	23/5	Soil cut slope	Minor	Footpath		
MW 6/1	Tuen Mun Highway, Tine Kau, Tsuen Wan. (6SE-C/P9)	21/5	GCO	NK	Fill slope	Minor	Road		
MW 6/2	DD 387 Lot 103 Castle Peak Road, Tsuen Wan	19/5	GCO	18/6 (9 pm)	Fill slope	Minor	Road		
MW 6/3	Lot 1461 Lung Tsai Tsuen, Cheung Chau	26/6	DLO	19/6	Soil cut slope	Minor	Footpath	Footpath partly blocked	
MW 6/4	Tsing Yi North Bridge (11NW-A/C155)	23/6	HyD	NK	Soil/rock cut slope	Minor	Road	Footpath partly blocked	

Table A4 (Cont.) - List of Incidents in Western New Territories Reported to GCO in 1986 (Sheet 2 of 3)

Incident No.	Location	Call Received		Failure			Area Affected	Consequence	Remarks
		Date	From	Date (Time)	Type	Scale			
NW 7/1	MS 13 Route Twisk (6NE-D/C21)	12/7	HyD	12/7 (10 am)	Soil cut slope	Major	Road	All two lanes blocked	File No. GCMd 2/E2/86-7
NW 7/2	Junction of Kwai Shing Circuit and Tai Wo Hau Road	12/7	Police	12/7	Fill slope	Minor	Footpath	Footpath, bus stop blocked	
NW 7/3	30 Kung Yip Street, Tuen Wan (7SW-C/C208)	12/7	Public	12/7 (9 am)	Soil cut slope	Major	Building		
NW 7/4	Lai King Hill Road near Princess Margaret Hospital	12/7	Police	12/7	Soil/rock out slope	Minor	Road	1 lane blocked	
NW 7/5	23 Wu Lei Hang Village, Tuen Wan	12/7	Police	12/7 (am)	Soil cut slope	Minor	Squatters	1 hut permanently evacuated	
NW 7/6	33 Wu Lei Hang Village, Tuen Wan	12/7	Police	12/7 (am)	Natural slope	Minor	Squatters	2 huts permanently evacuated	
NW 7/7	15 Shek Lei Hang Village, Tuen Wan	12/7	Police	12/7 (am)	Soil cut slope	Minor	Squatters	1 hut permanently evacuated	
NW 7/8	Tso Kung Tam Village, Tuen Wan	14/7	HyD	12/7 (10 am)	Soil cut slope	Minor	Squatters	1 hut temporarily evacuated	
NW 7/9	Da Chuen Ping Village, Tuen Wan	12/7	HyD	12/7 (am)	Soil cut slope	Minor	Building		
NW 7/10	13½ MS Route Twisk	15/7	HyD	12/7	Rock fall	Minor	Road		Fissured dike
NW 7/11	13½ MS Route Twisk	15/7	HyD	12/7	Rock fall	Minor	Road		
NW 7/12	Tseng Tau Chung Tsuen, Tuen Mun	12/7	DO	12/7 (12 am)	Retaining wall	Minor	Squatters	2 huts temporarily evacuated	
NW 7/13	31 Tung Wan Tau, Mui Wo, Lantau	17/7	GCO	12/7	Retaining wall	Minor	Licensed lot (pavty)		
NW 7/14	Lot 387 DD 302, Shek Tsai Po, Tai O, Lantau (9SW-C/C1)	1/8	GCO	NK	Soil cut slope	Major	Open space		
NW 7/15	Road D4 South Area 17, Tuen Mun	24/7	PM/TM	12/7	Soil cut slope	Minor	Squatters	9 huts permanently evacuated	File No. GCMd 2/E2/86-5
NW 7/16	Wo Yi Hop Road, Tuen Wan	16/7	Public	12/7 (7 am)	Boulder	Minor	Construction site	1 car destroyed	

Table A4 (Cont.) - List of Incidents in Western New Territories Reported to GCO in 1986 (Sheet 3 of 3)

Incident No.	Location	Call Received		Failure			Area Affected	Consequence	Remarks
		Date	From	Date (Time)	Type	Scale			
MW 8/1	Tiger's Head Village, Tsing Yi	8/8	DLO	6/8 (4 pm)	Retaining wall	Minor	Footpath	Footpath closed	Trench excavation at toe by CLP
MW 8/2	Pok Wai Village, Yuen Long	12/8	ASD	NK	Natural slope	Minor	Building		
MW 8/3	Autau Government Quarters, Yuen Long (6NE-A/C2)	13/8	ASD	NK	Soil/rock cut slope	Minor	Building		Erosion of chunam cover
MW 9/1	MS 13 $\frac{1}{2}$ Route Trisk	5/9	HyD	5/9	Soil/rock cut slope	Minor	Road	1 lane blocked	Adjacent to incident MW 7/10
MW 9/2	DD 453, Tai Wo Tsuen, Fu Yung Shan, Tsuen Wan	2/9	HyD	NK	Soil cut slope	Minor	Squatters	1 hut permanently evacuated	
MW 9/3	Wo Yi Hop Village, Tsuen Wan	27/8	HyD	NK	Subsidence	Minor	Squatters		
MW 9/4	Shing Mun Road, Wo Yi Hop, Tsuen Wan	10/9	HyD	NK	Retaining wall	Minor	Road		
MW 11/1	Pak She Cheung Lee Park, Cheung Chau	3/11	DLO	NK	Soil cut slope	Minor	Footpath	Footpath closed	
MW 12/1	14 Yung Shue Long, Lamma	2/12	BOC	29/11	Boulder	Minor	Building		
MW 12/2	Siu Lam Centre for Women, Yuen Long (6SW-D/CR29)	5/12	ASD	4/12 (8 am)	Soil/rock cut slope	Major	Construction site, building	1 building temporarily evacuated	Unsupported excavation File No. GCMd 3/1/461
Legend : NK Not known									

APPENDIX B
RECORDS FROM GCO RAINGAUGES

APPENDIX B

LIST OF FIGURES

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B3	Histograms of Hourly Rainfall Recorded by GCO Raingauges on 4th July 1986	99
B4	Histograms of Hourly Rainfall Recorded by GCO Raingauges on 12th July 1986	104
B5	Histograms of Hourly Rainfall Recorded by GCO Raingauges on 11th August 1986	109

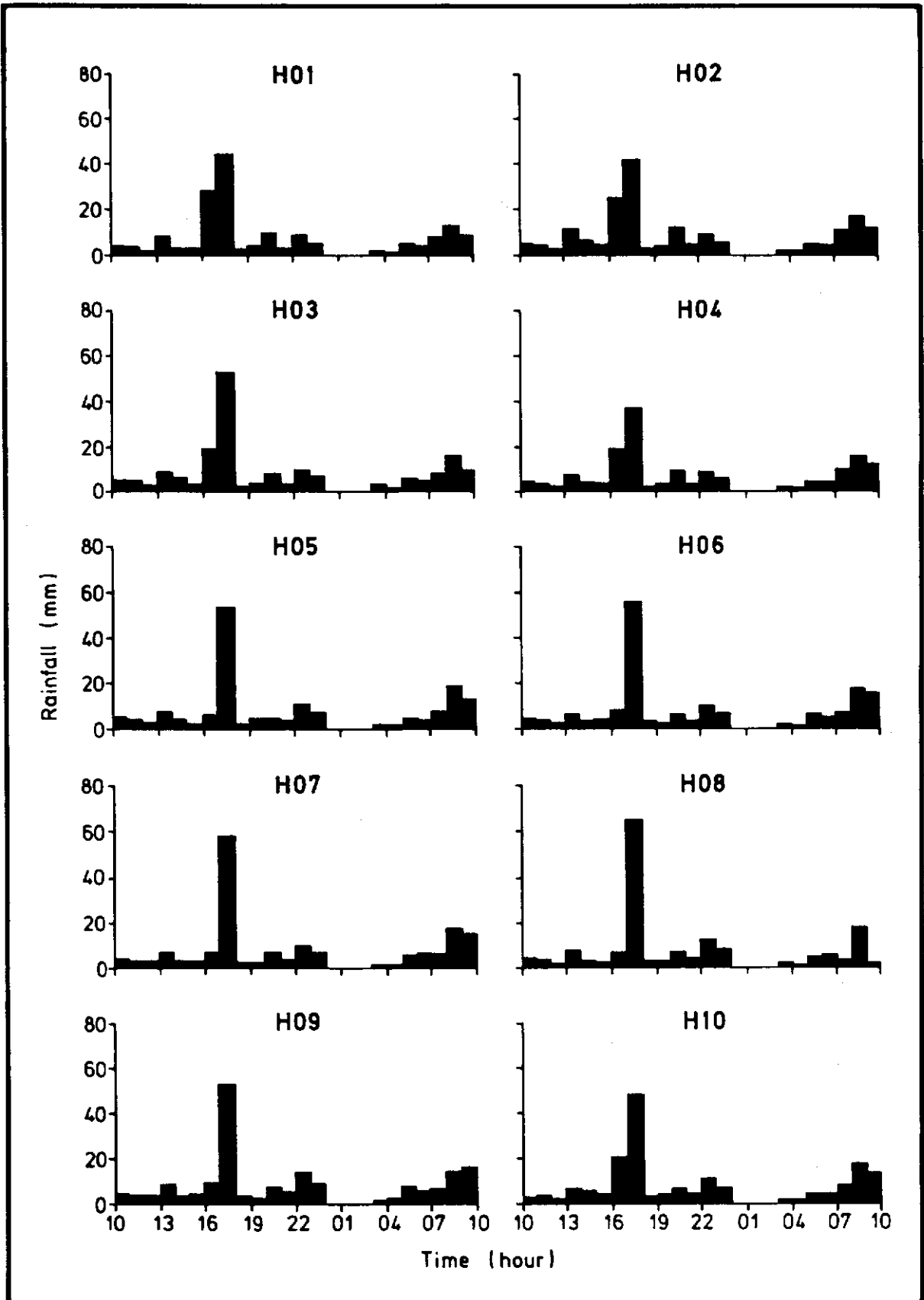


Figure B1 - Histograms of Hourly Rainfall Recorded by GCO
Rain gauges on 11th to 12th May 1986 (Sheet 1 of 5)

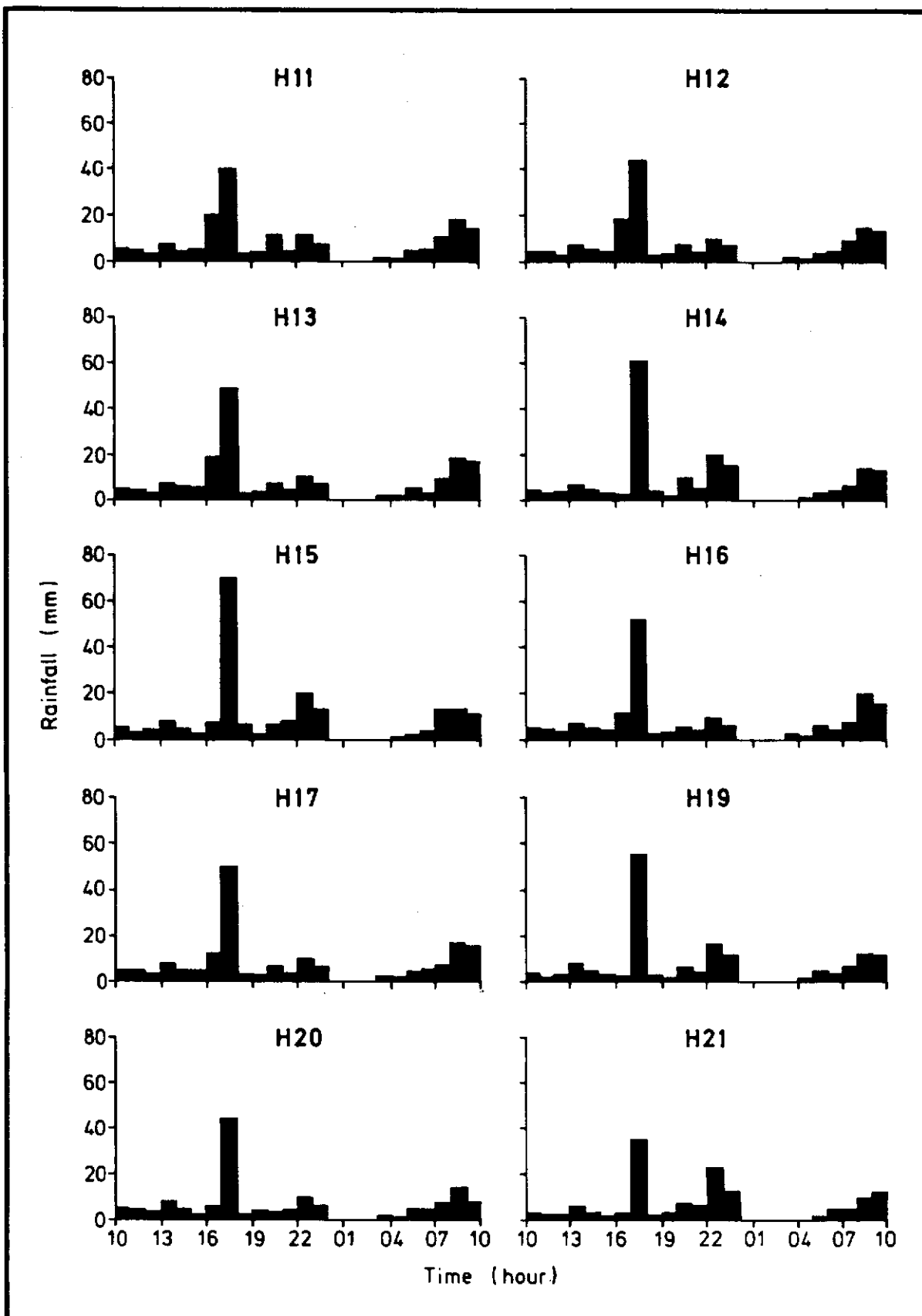


Figure B1 (Cont.) - Histograms of Hourly Rainfall Recorded by GCO
Raingauges on 11th to 12th May 1986 (Sheet 2 of 5)

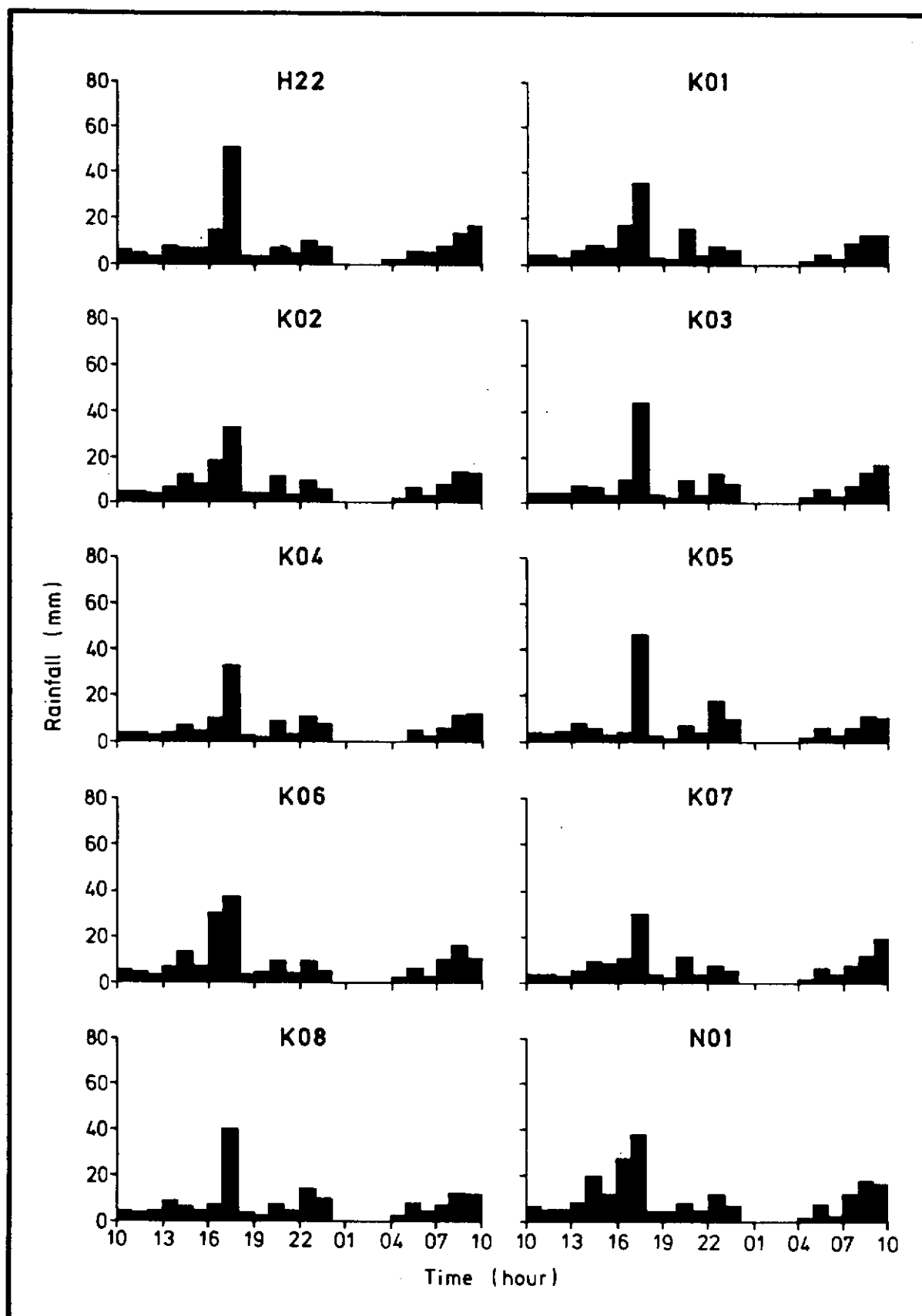


Figure B1 (Cont.) - Histograms of Hourly Rainfall Recorded by 700 Raingauges on 11th to 12th May 1986 (Sheet 3 of 5)

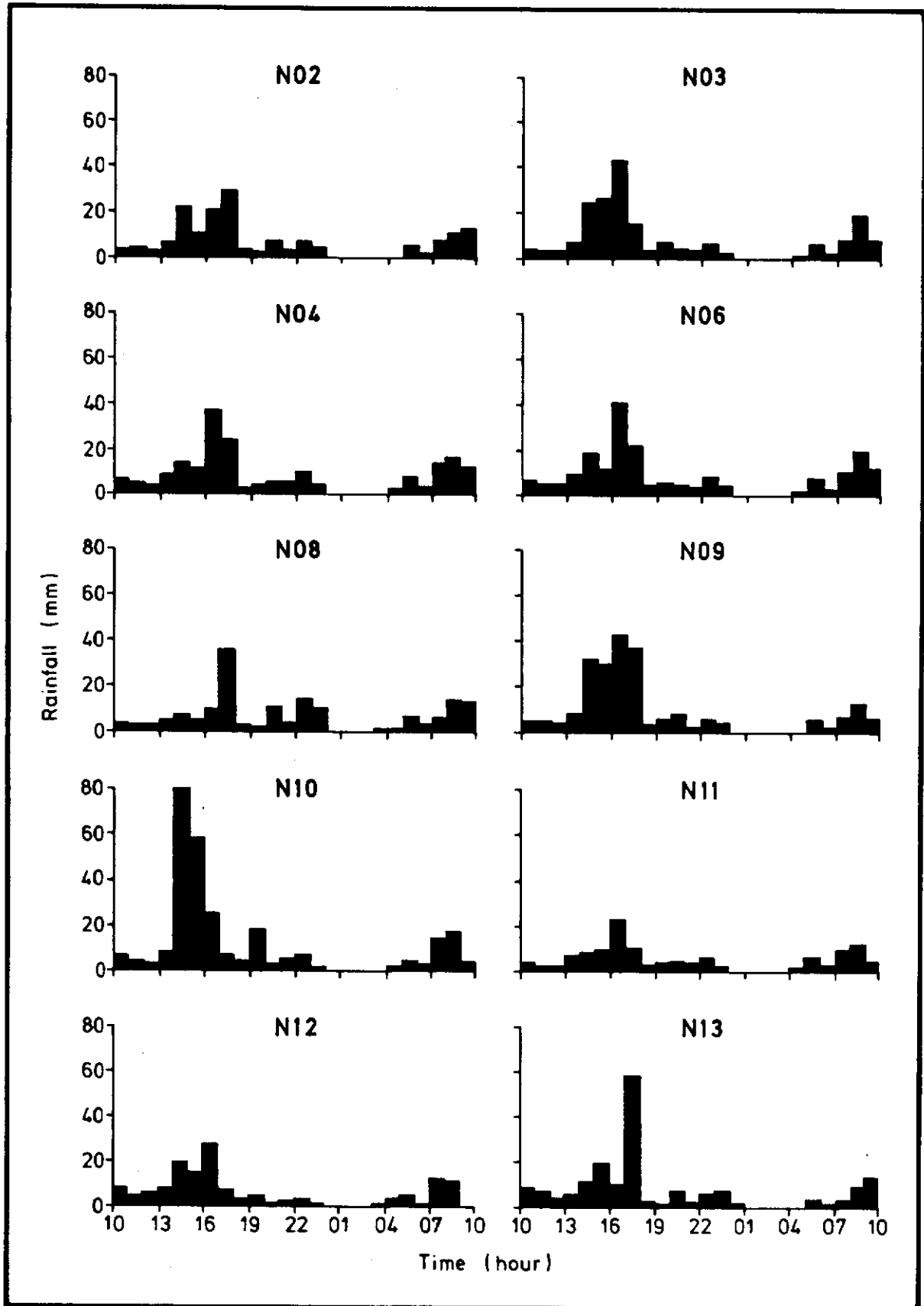


Figure B1 (Cont.) - Histograms of Hourly Rainfall Recorded by GCO
Raingauges on 11th to 12th May 1986 (Sheet 4 of 5)

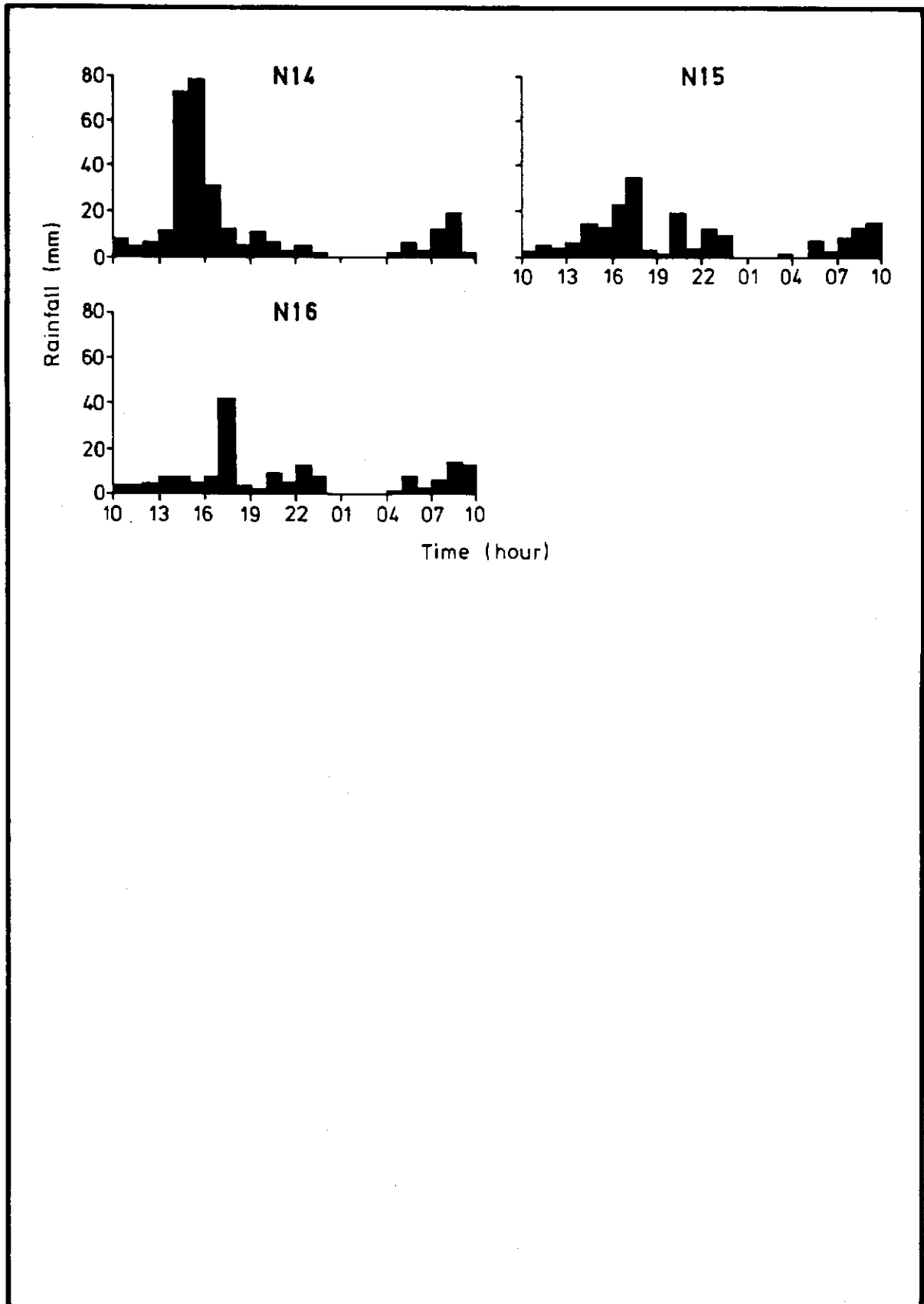


Figure B1 (Cont.) - Histograms of Hourly Rainfall Recorded by GCO
Rain gauges on 11th to 12th May 1986 (Sheet 5 of 5)

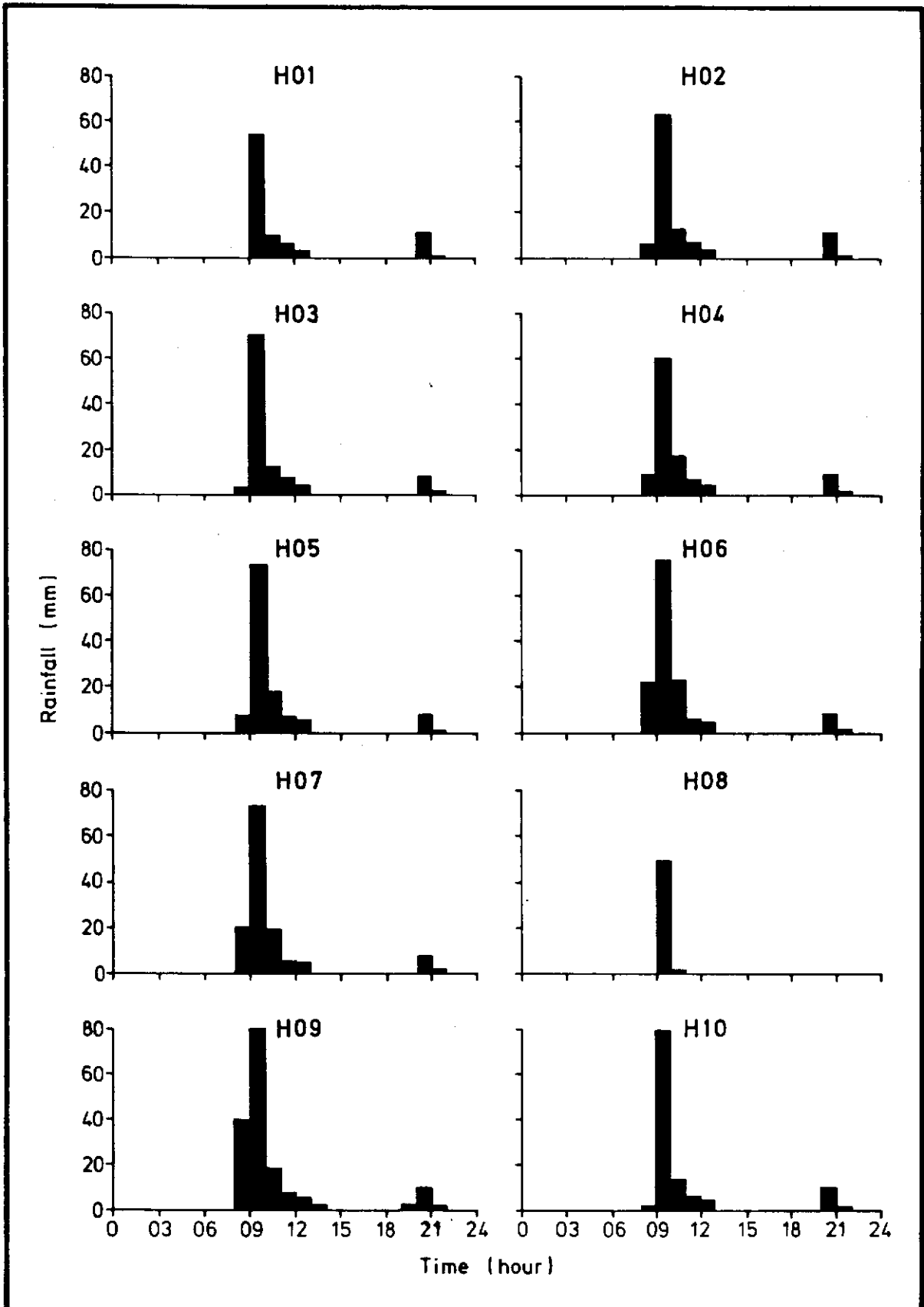


Figure B2 - Histograms of Hourly Rainfall Recorded by GCO Raingauges on 6th June 1986 (Sheet 1 of 5)

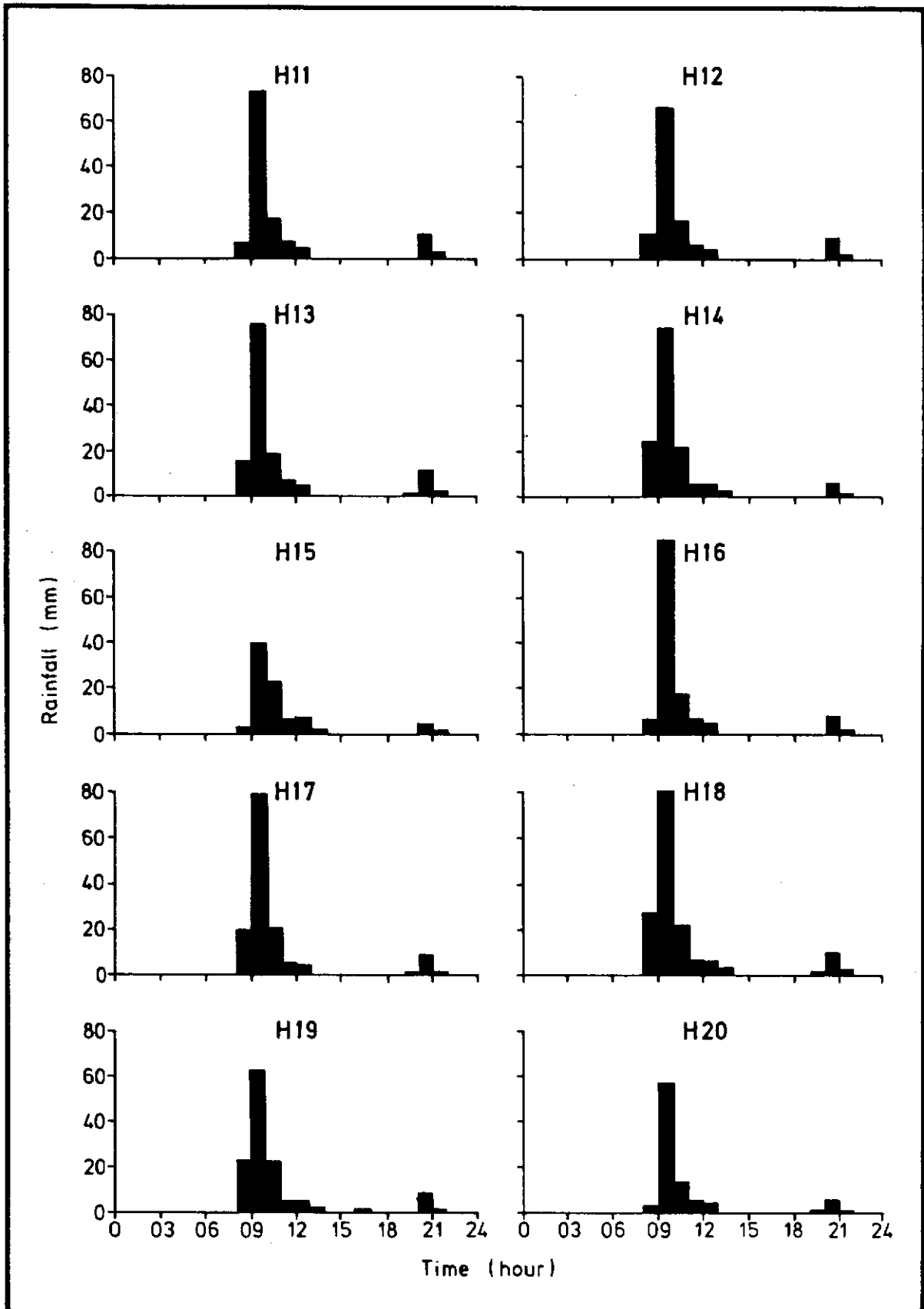


Figure B2 (Cont.) - Histograms of Hourly Rainfall Recorded by GCO Raingauges on 6th June 1986 (Sheet 2 of 5)

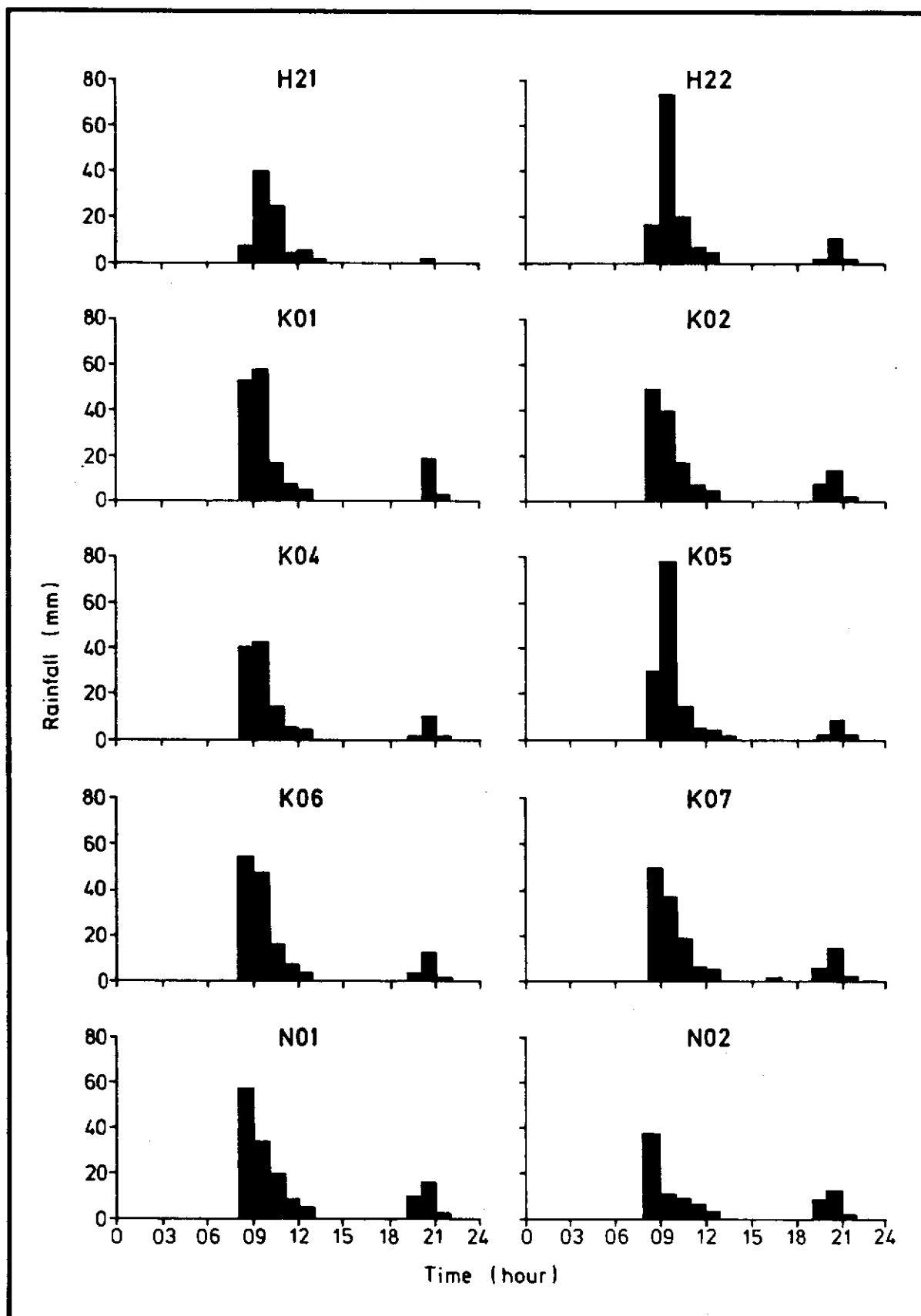


Figure B2 (Cont.) - Histograms of Hourly Rainfall Recorded by GCO Raingauges on 6th June 1986 (Sheet 3 of 5)

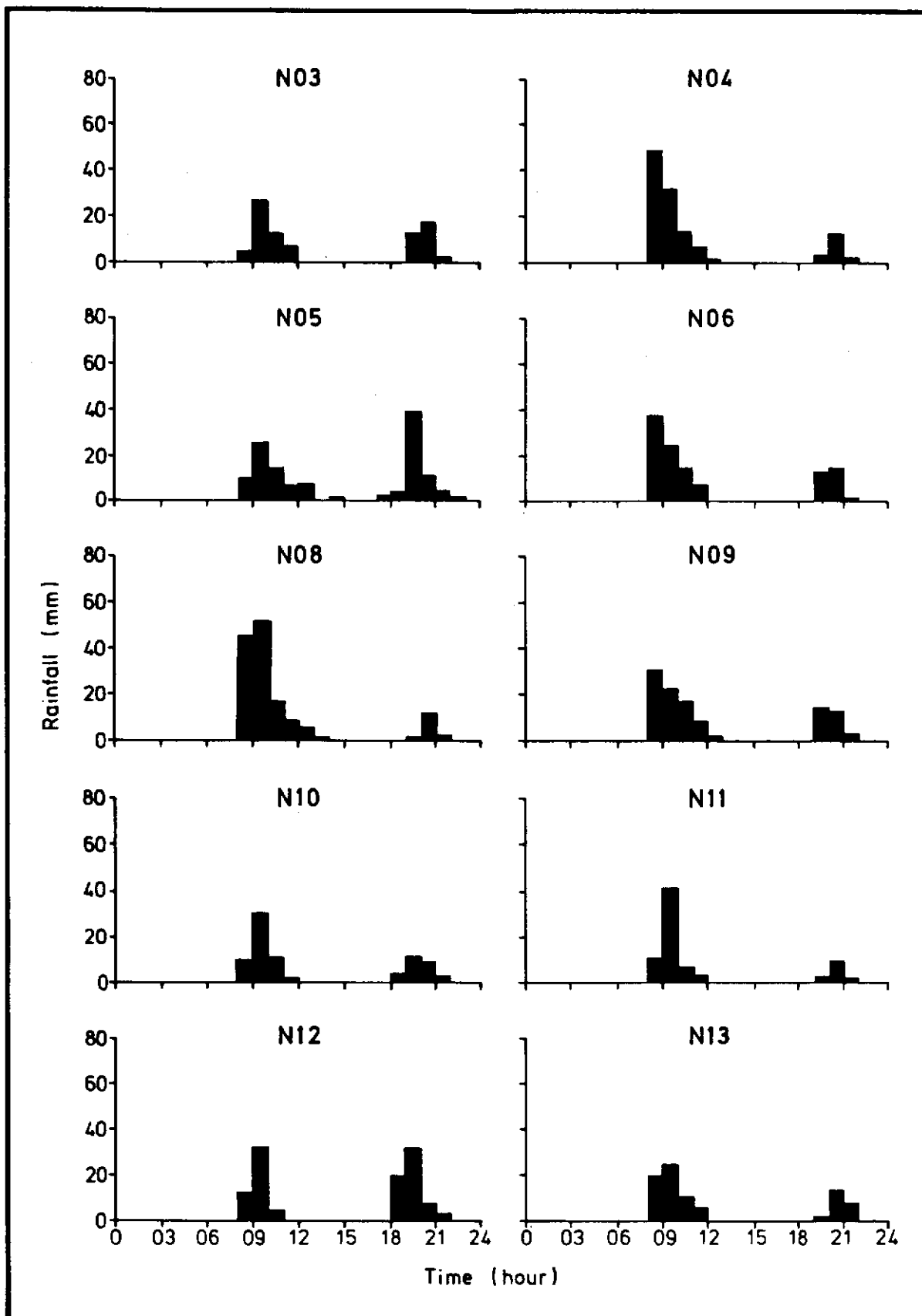


Figure B2 (Cont.) - Histograms of Hourly Rainfall Recorded by GCO Raingauges on 6th June 1986 (Sheet 4 of 5)

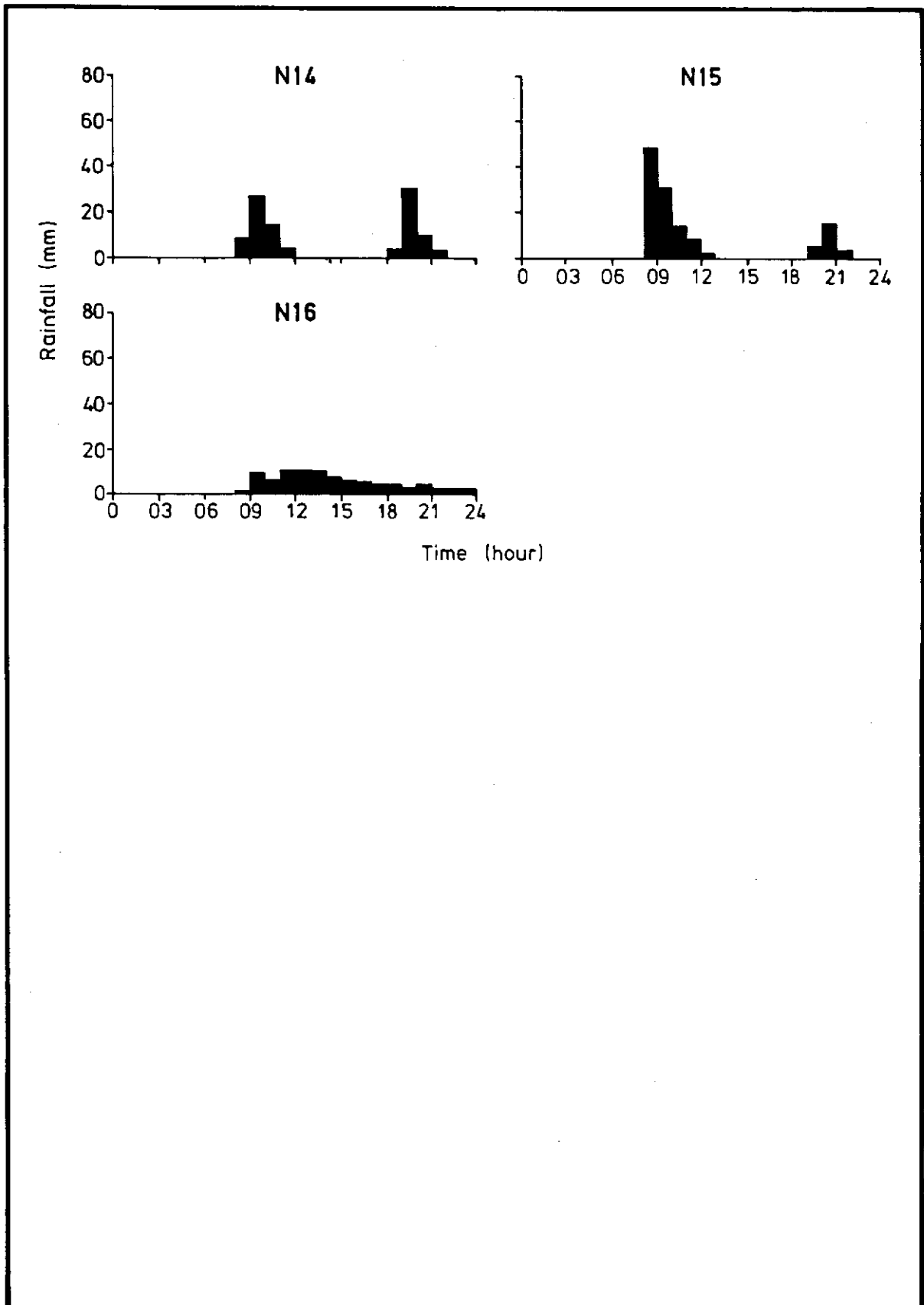


Figure B2 (Cont.) - Histograms of Hourly Rainfall Recorded by GCO Raingauges on 6th June 1986 (Sheet 5 of 5)

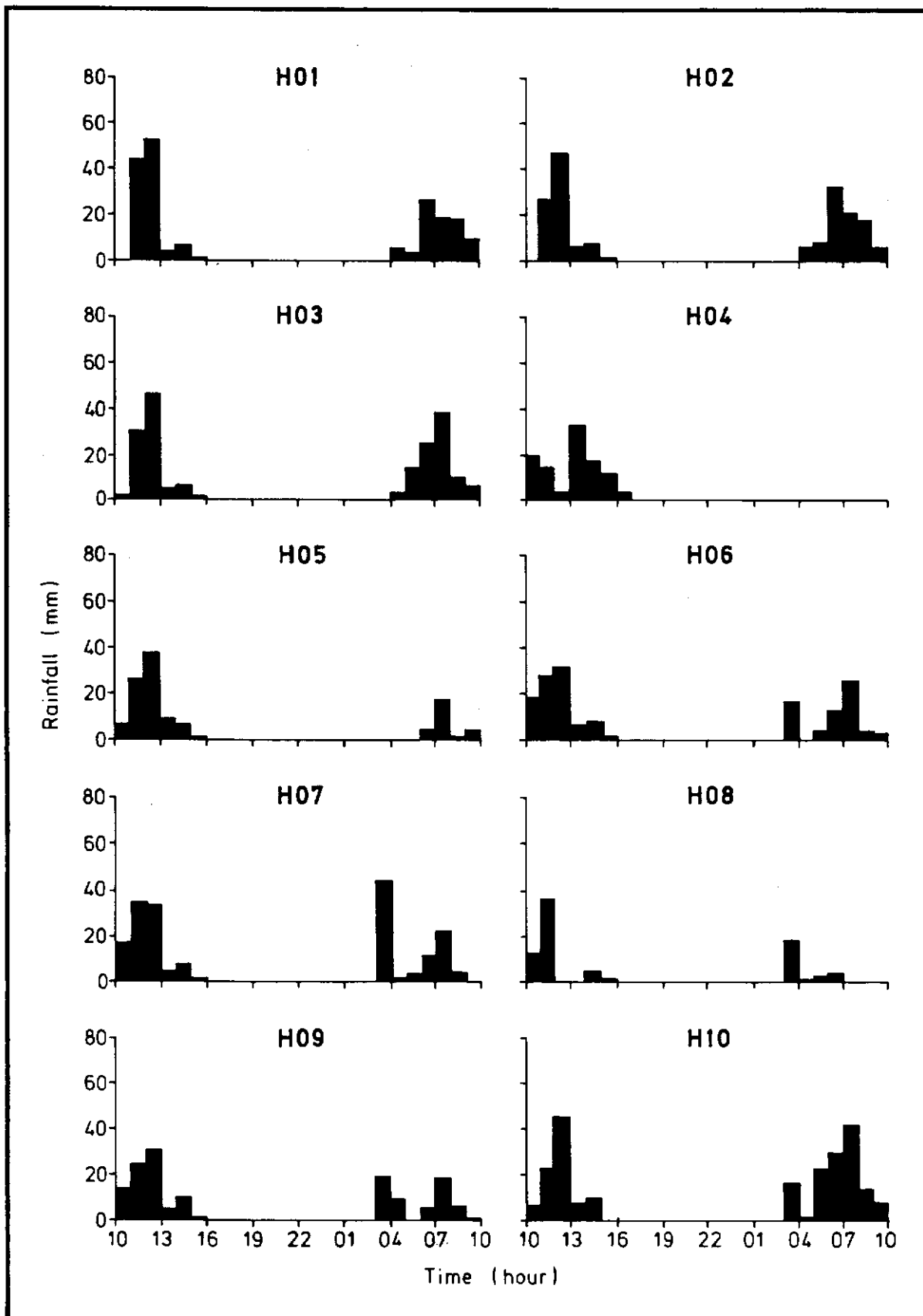


Figure B3 - Histograms of Hourly Rainfall Recorded by GOC Raingauges on 3rd to 4th July 1986 (Sheet 1 of 5)

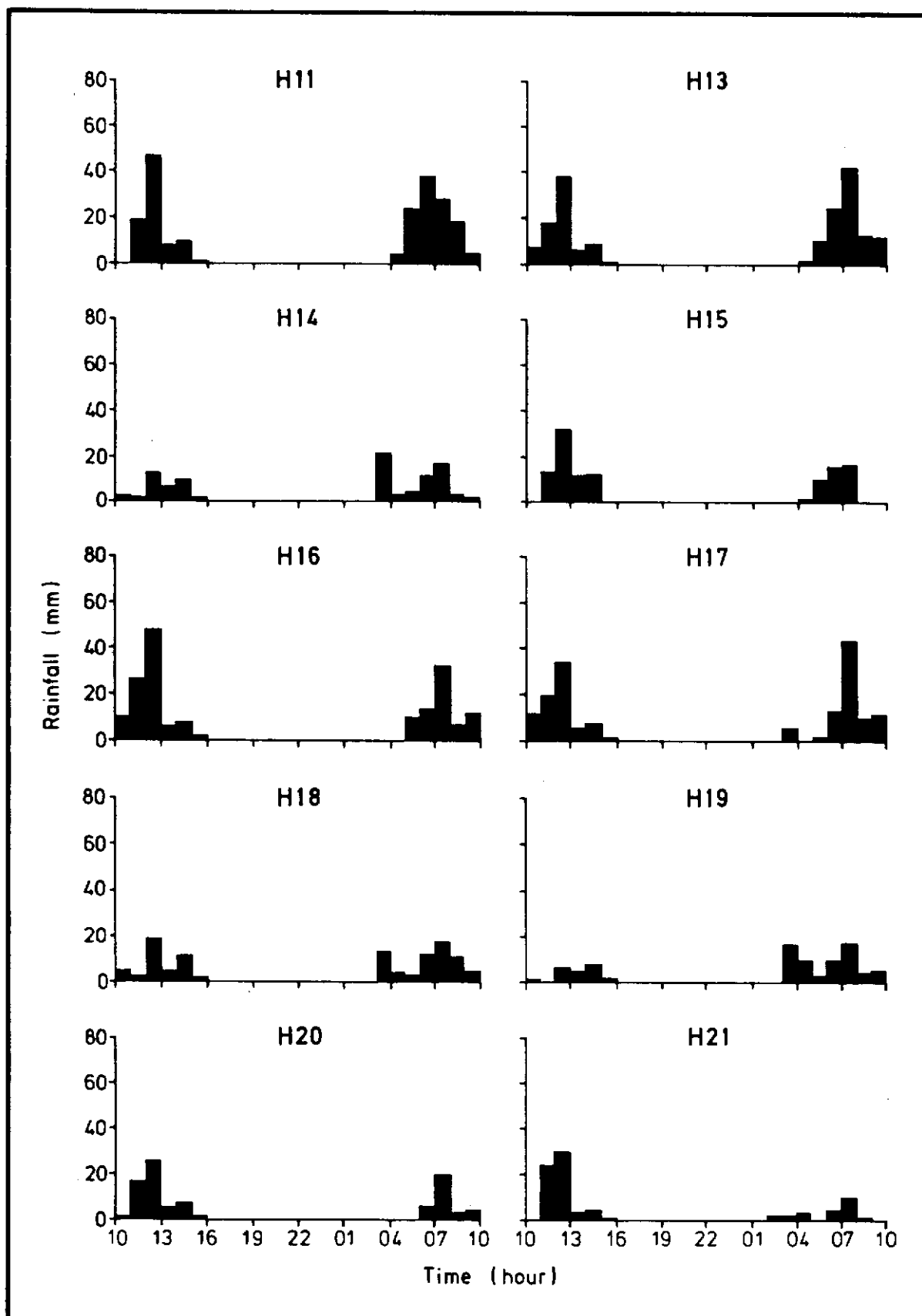


Figure B3 (Cont.) - Histograms of Hourly Rainfall Recorded by GCO
Raingauges on 3rd to 4th July 1986 (Sheet 2 of 5)

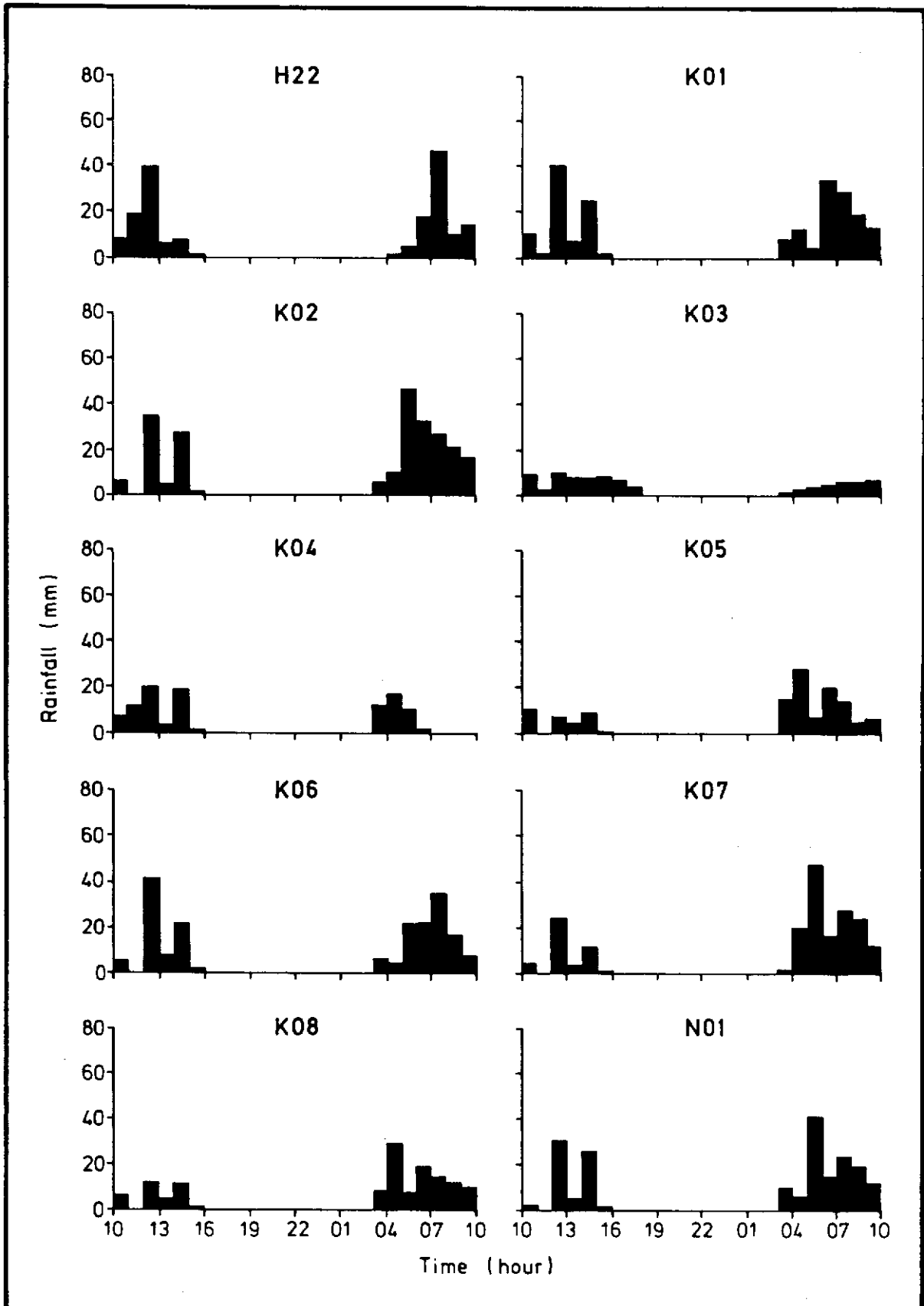


Figure B3 (Cont.) - Histograms of Hourly Rainfall Recorded by GCO Raingauges on 3rd to 4th July 1986 (Sheet 3 of 5)

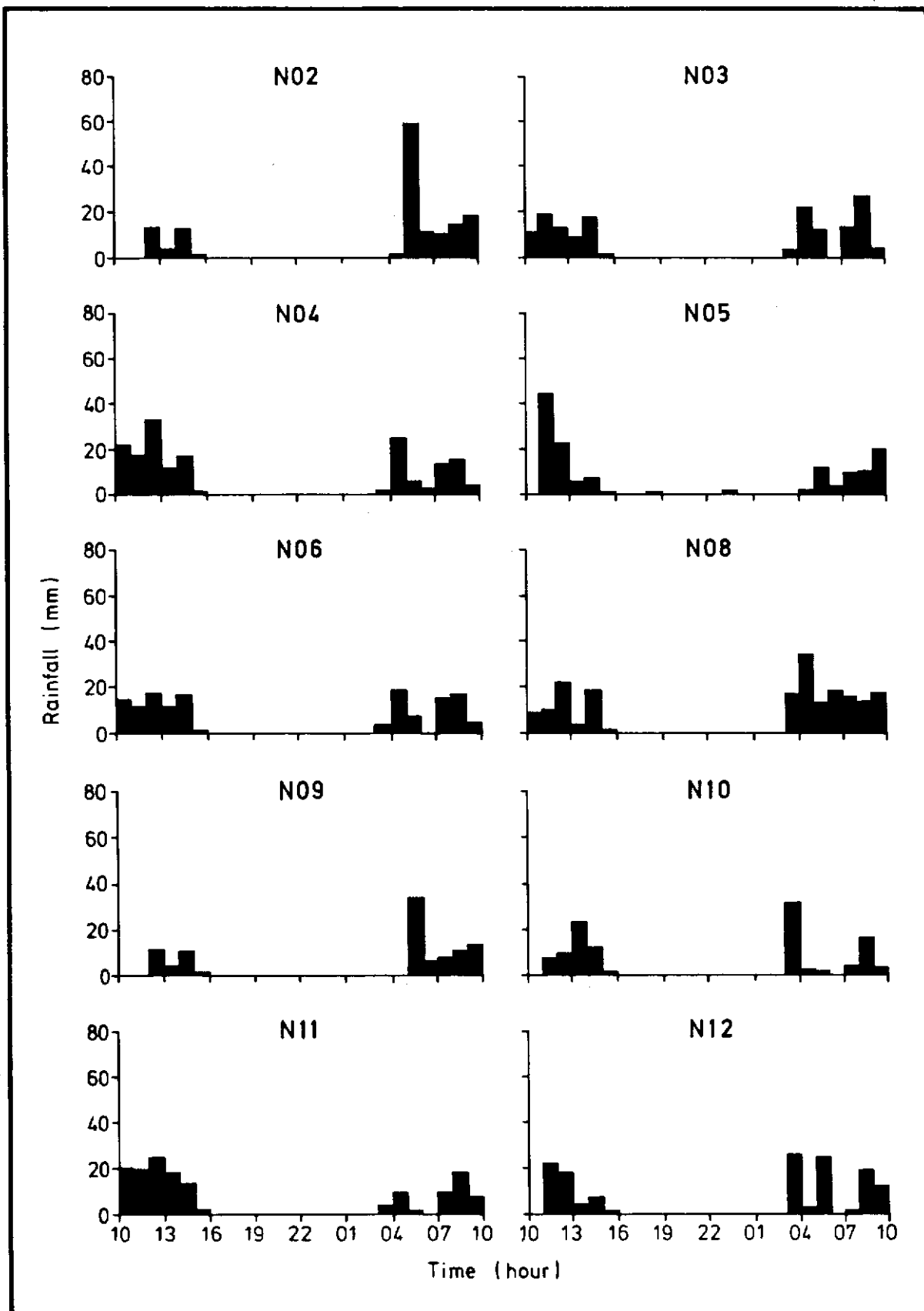


Figure B3 (Cont.) - Histograms of Hourly Rainfall Recorded by GCO Raingauges on 3rd to 4th July 1986 (Sheet 4 of 5)

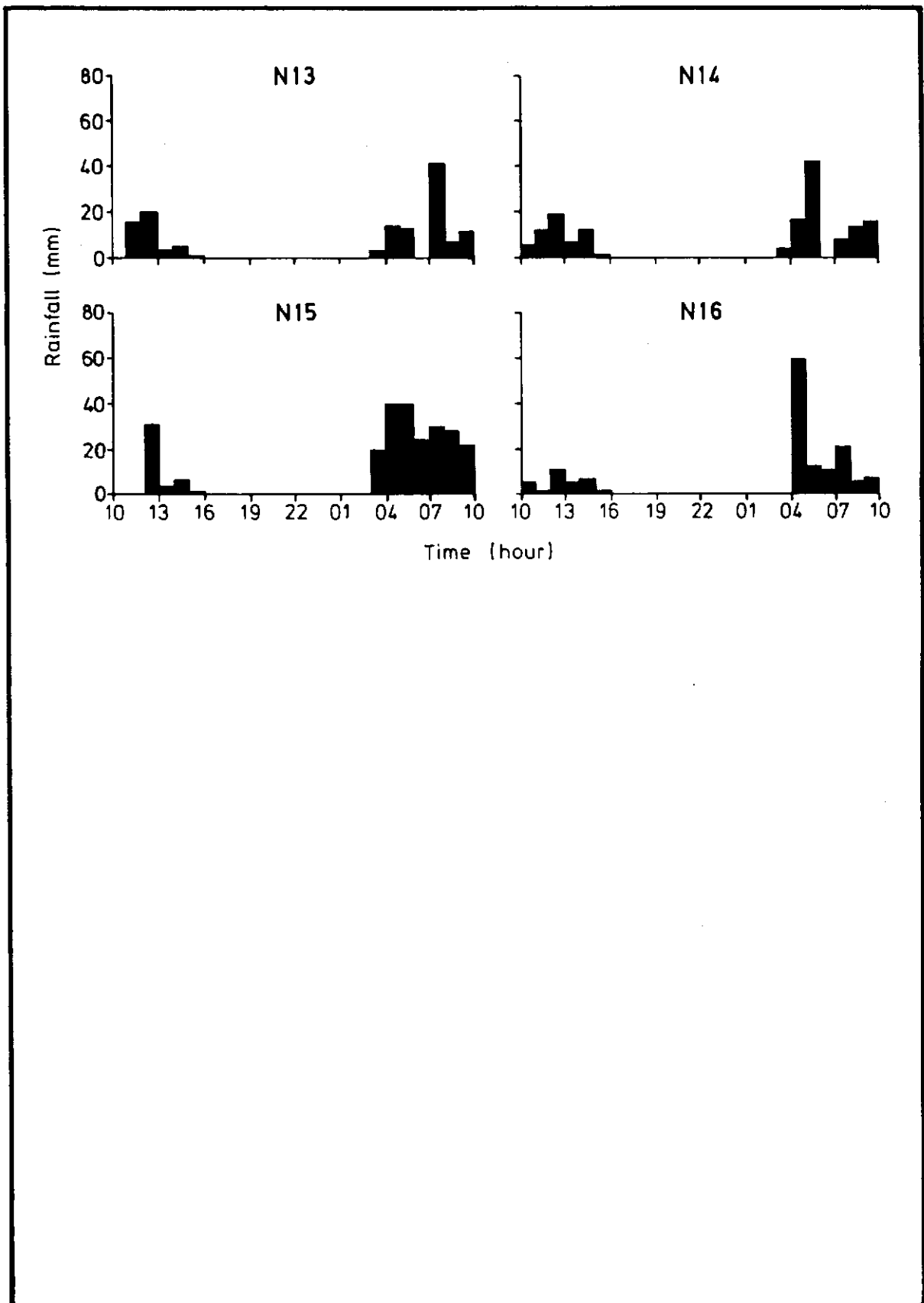


Figure B3 (Cont.) - Histograms of Hourly Rainfall Recorded by 700 Rain gauges on 3rd to 4th July 1986 (Sheet 5 of 5)

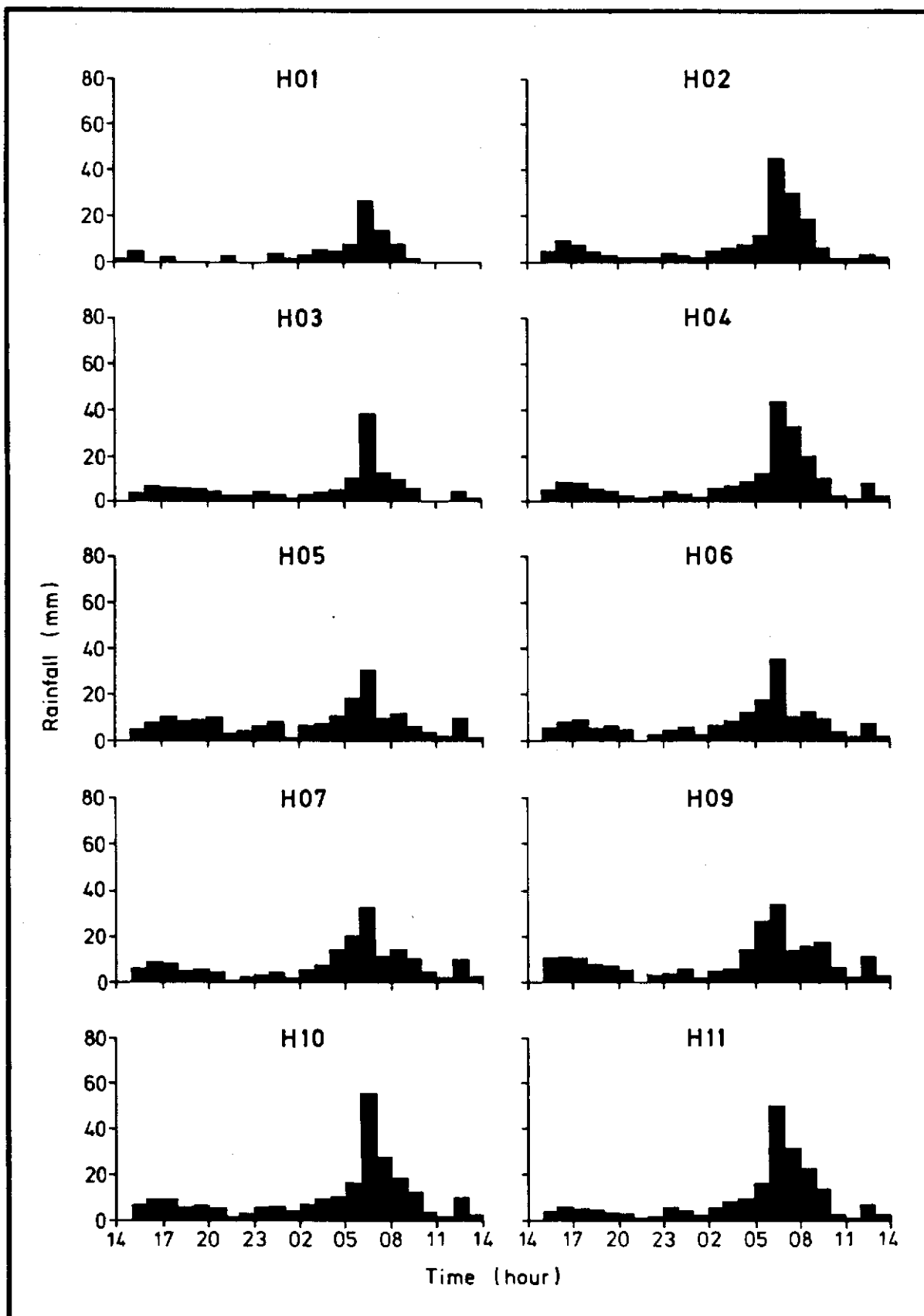


Figure B4 - Histograms of Hourly Rainfall Recorded by GCO Raingauges on 11th to 12th July 1986 (Sheet 1 of 5)

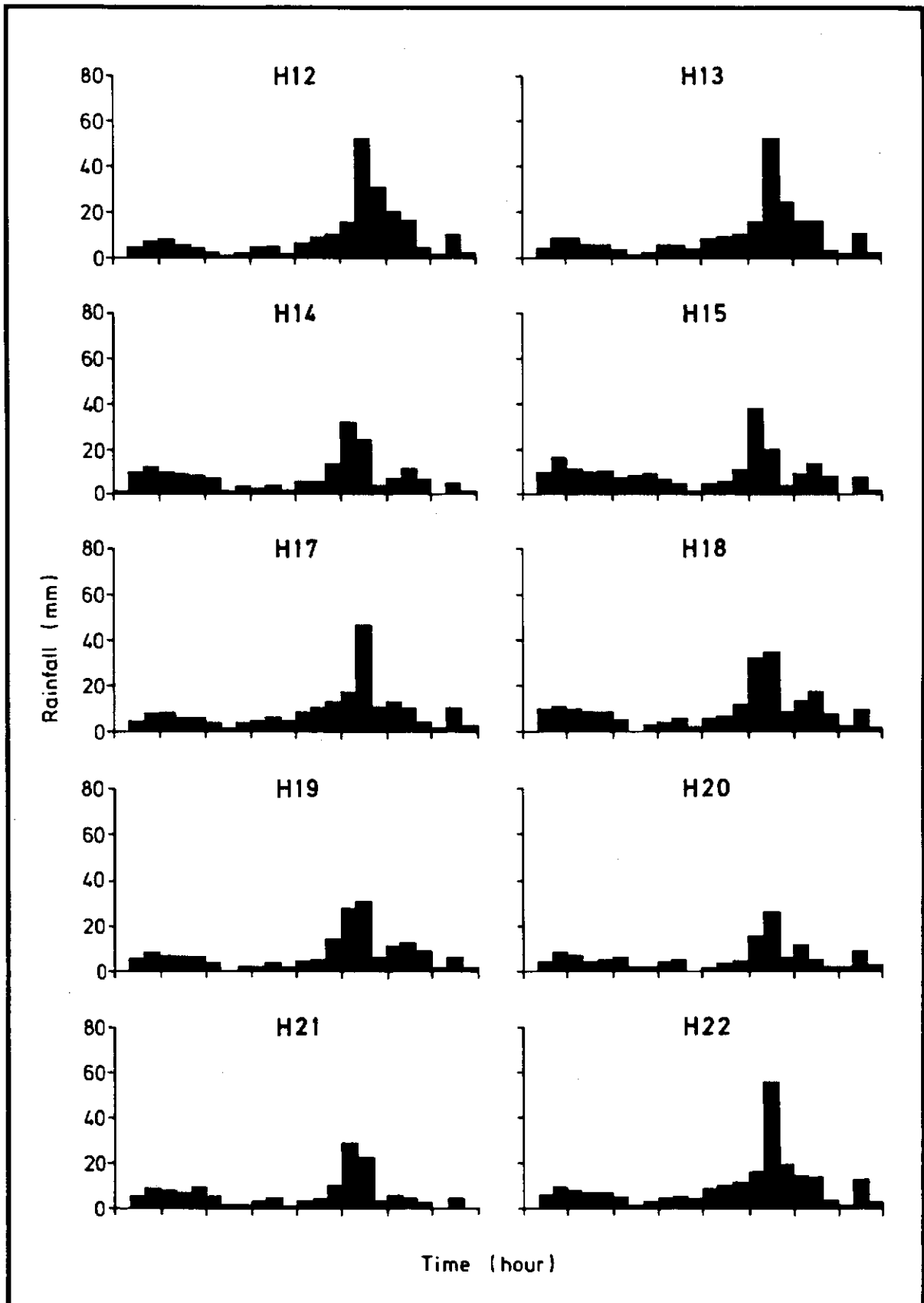


Figure B4 (Cont.) - Histograms of Hourly Rainfall Recorded by 700
Raingauges on 11th to 12th July 1986 (Sheet 2 of 5)

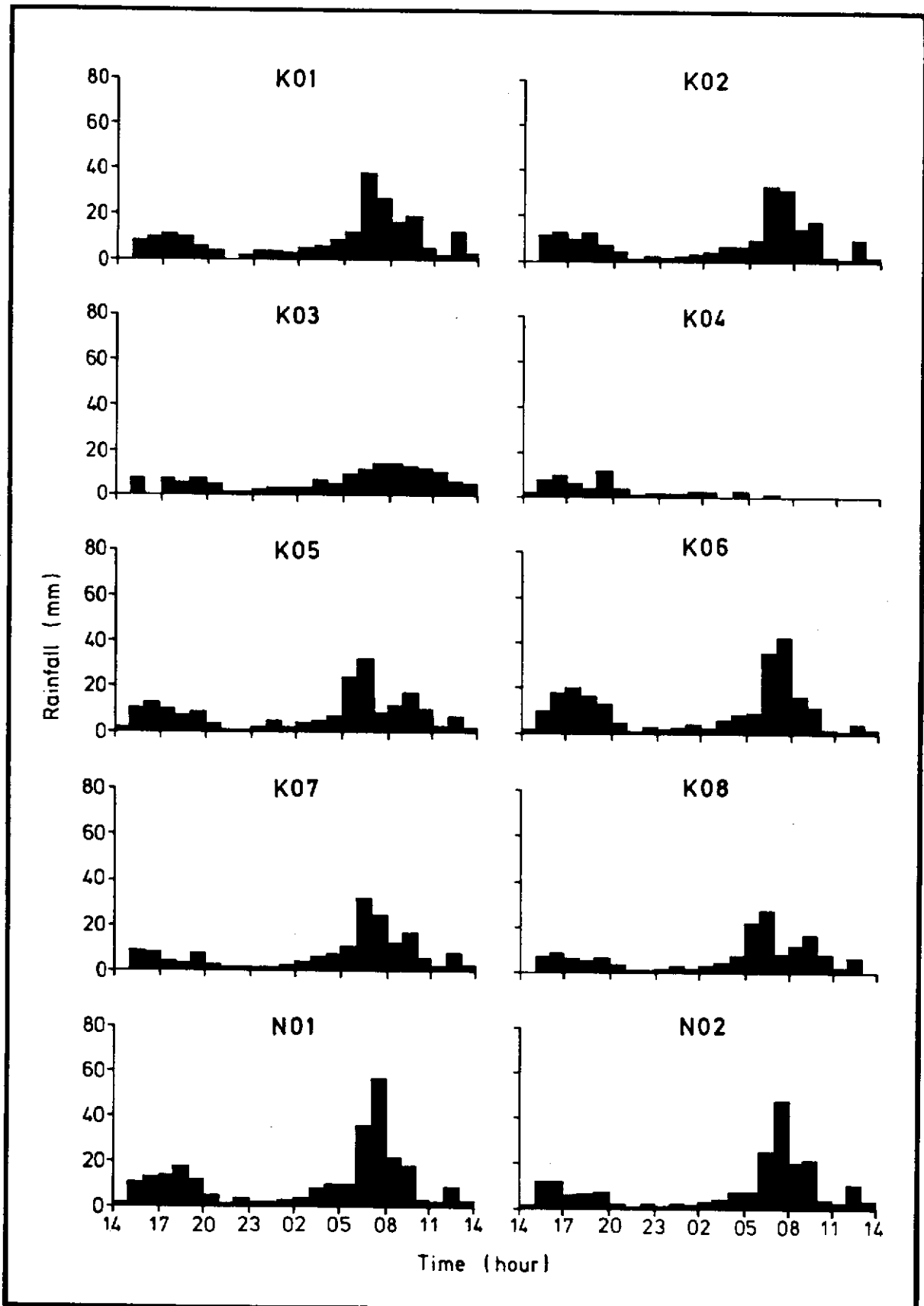


Figure B4 (Cont.) - Histograms of Hourly Rainfall Recorded by GCO Rain gauges on 11th to 12th July 1986 (Sheet 3 of 5)

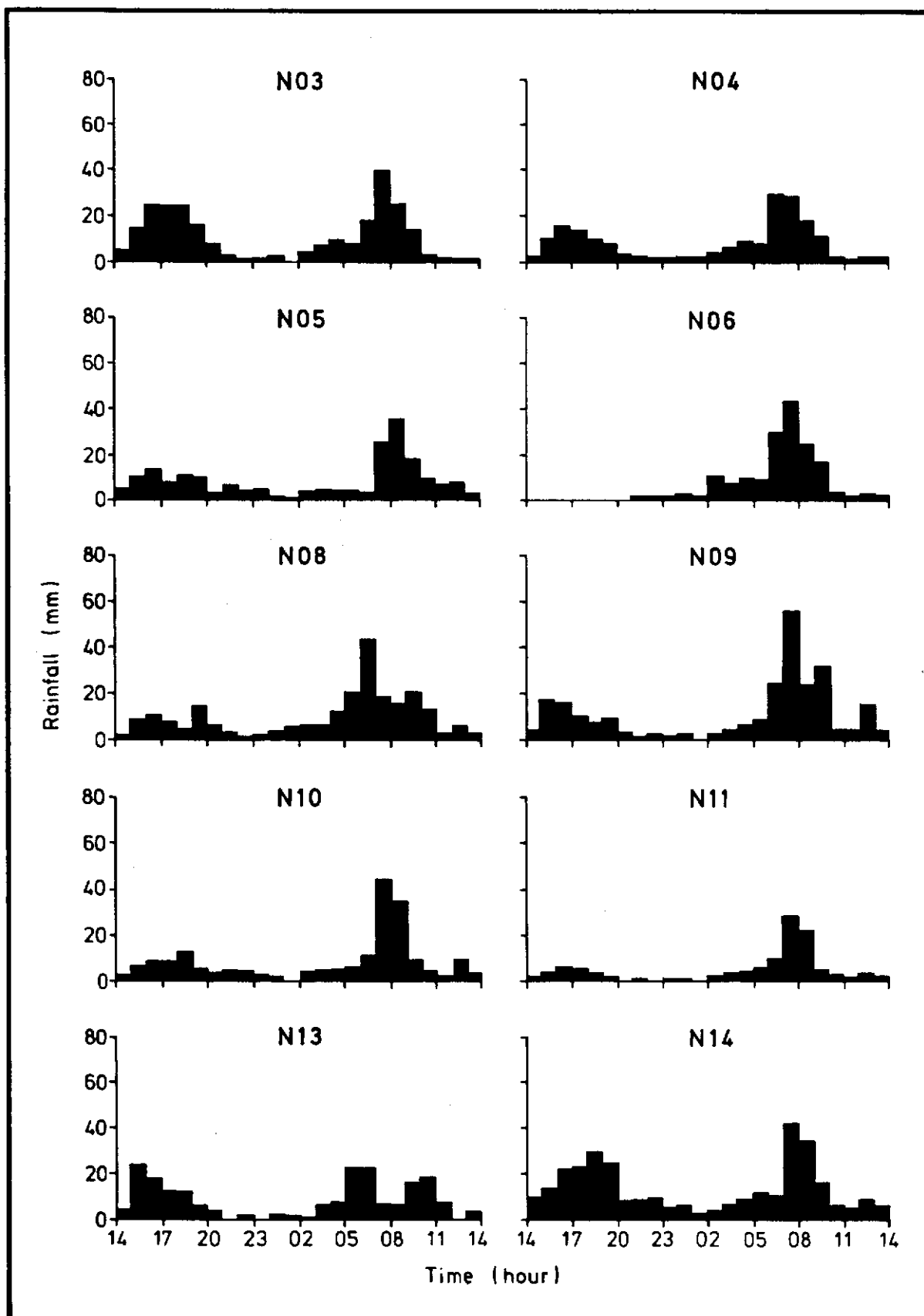


Figure B4 (Cont.) - Histograms of Hourly Rainfall Recorded by GCO
Raingauges on 11th to 12th July 1986 (Sheet 4 of 5)

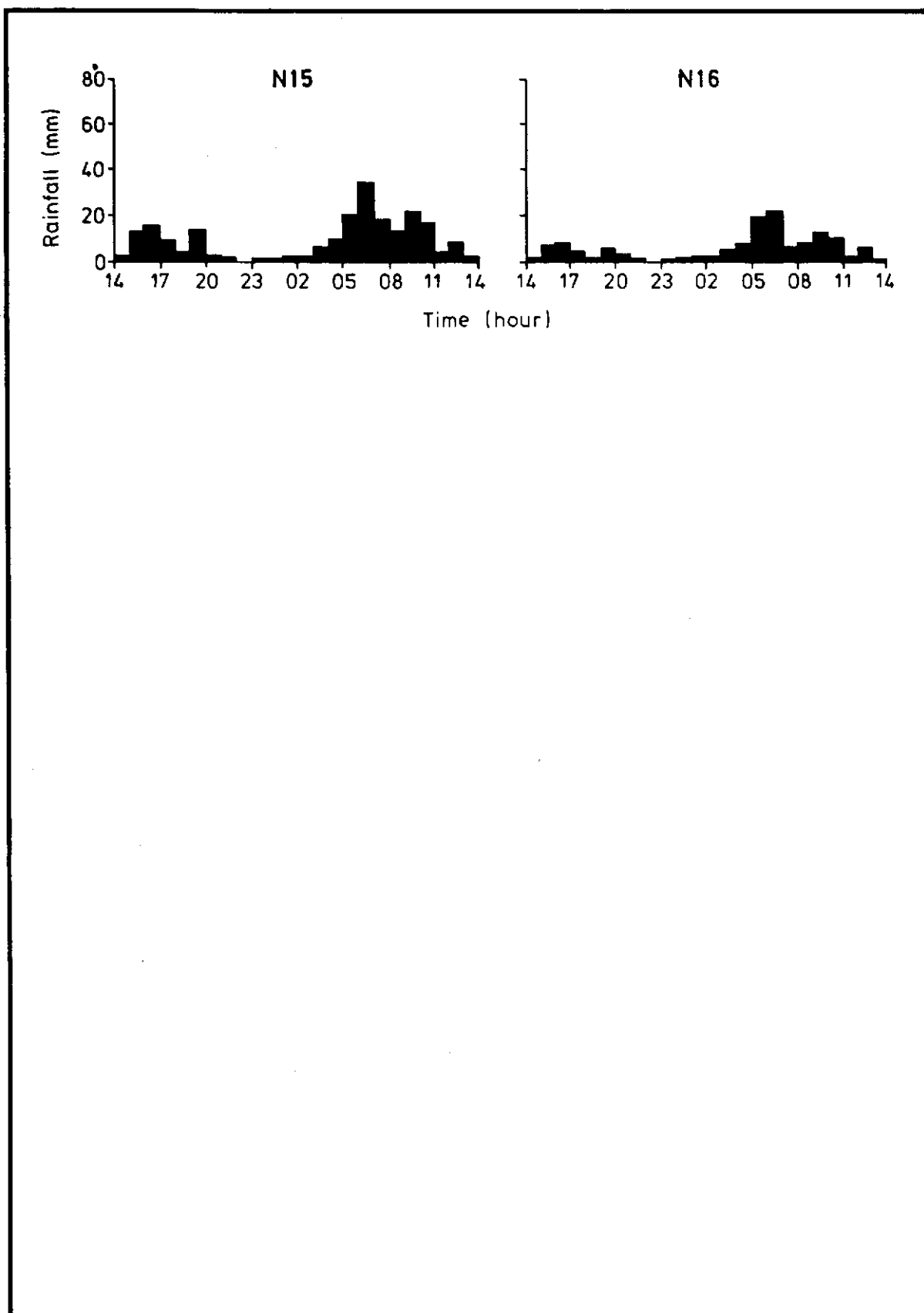


Figure B4 (Cont.) - Histograms of Hourly Rainfall Recorded by GCO
Raingauges on 11th to 12th July 1986 (Sheet 5 of 5)

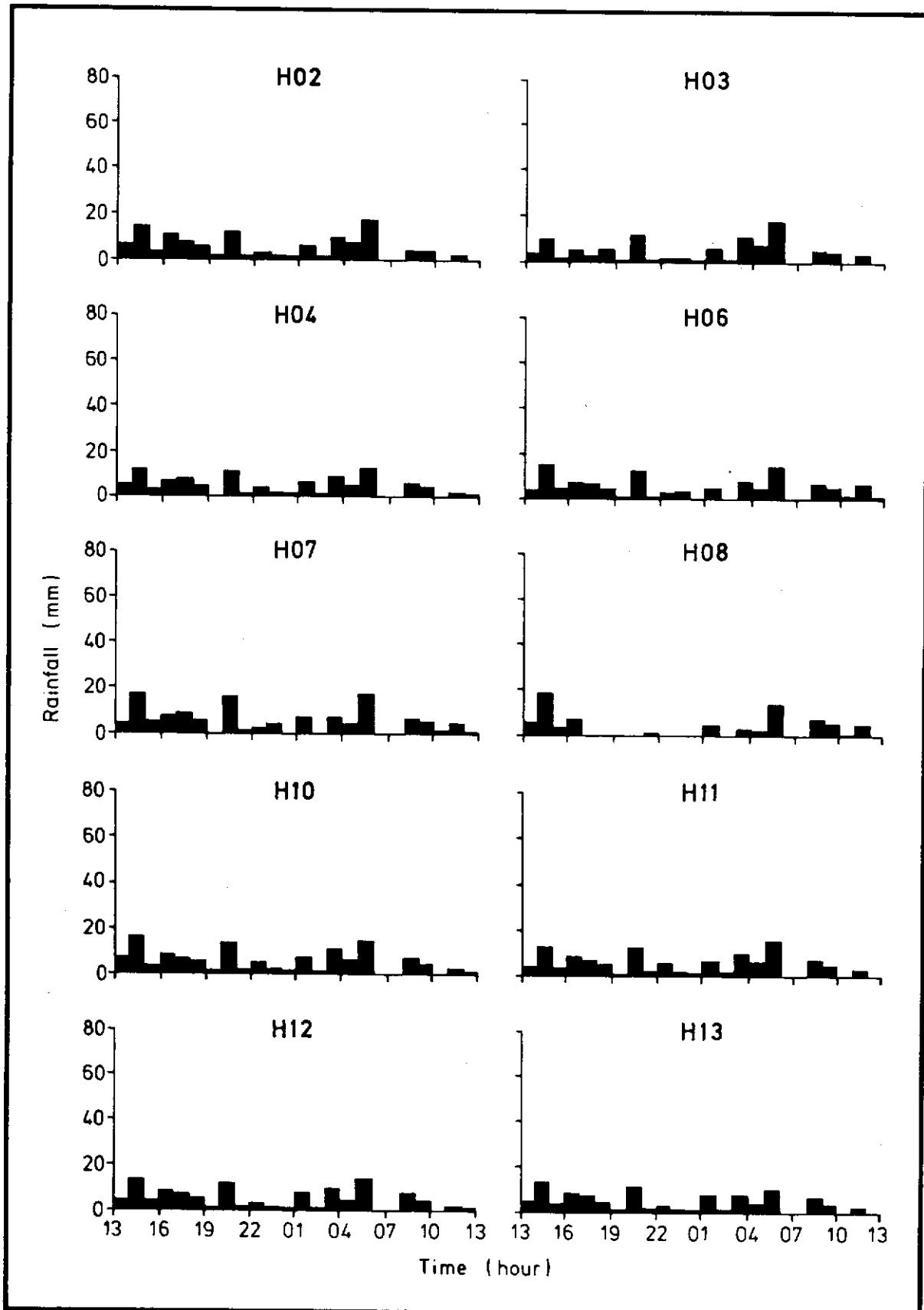


Figure B5 - Histograms of Hourly Rainfall Recorded by TCO
Raingauges on 10th to 11th August 1986 (Sheet 1 of 4)

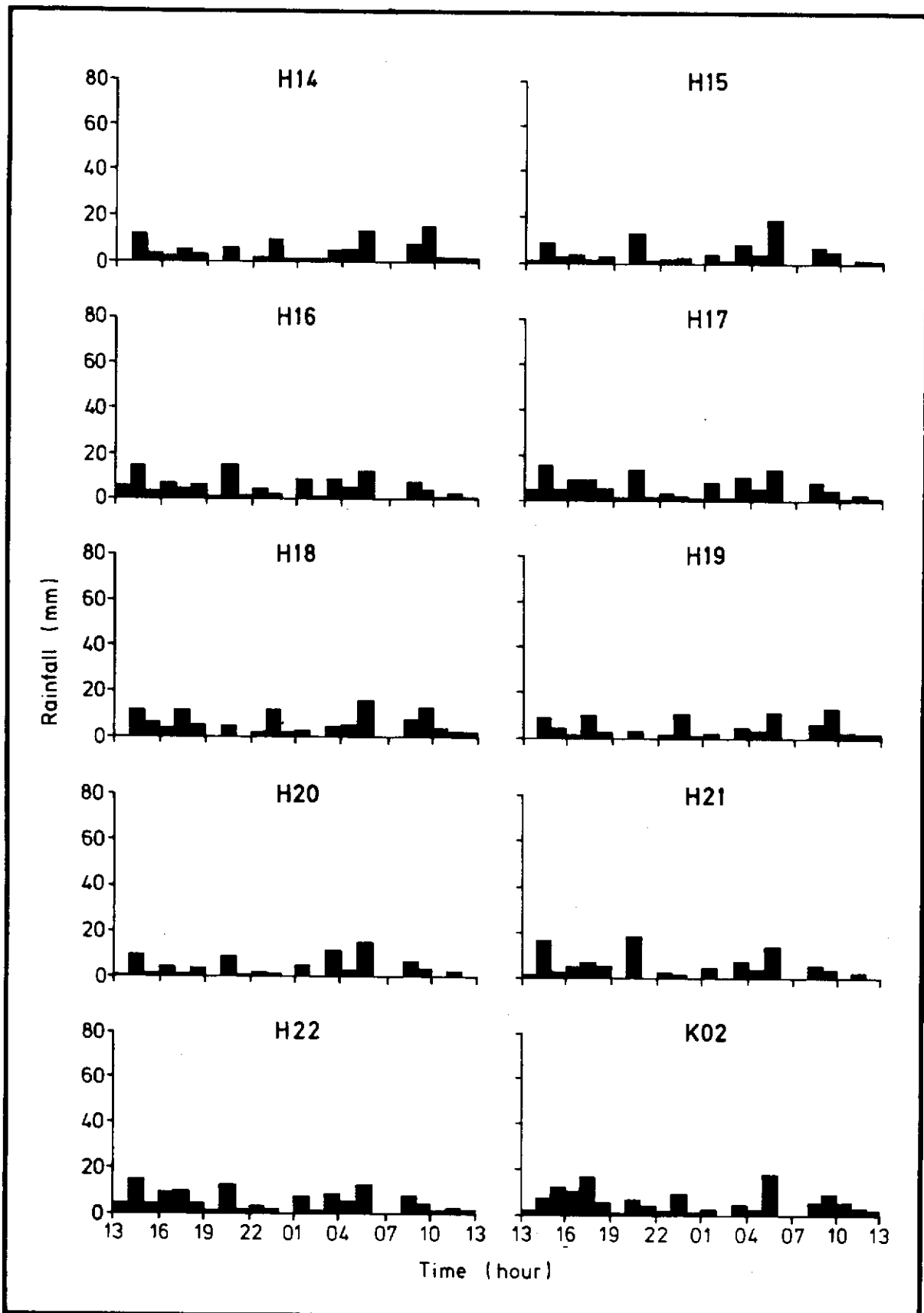


Figure B5 (Cont.) - Histograms of Hourly Rainfall Recorded by 300 Raingauges on 10th to 11th August 1986 (Sheet 2 of 4)

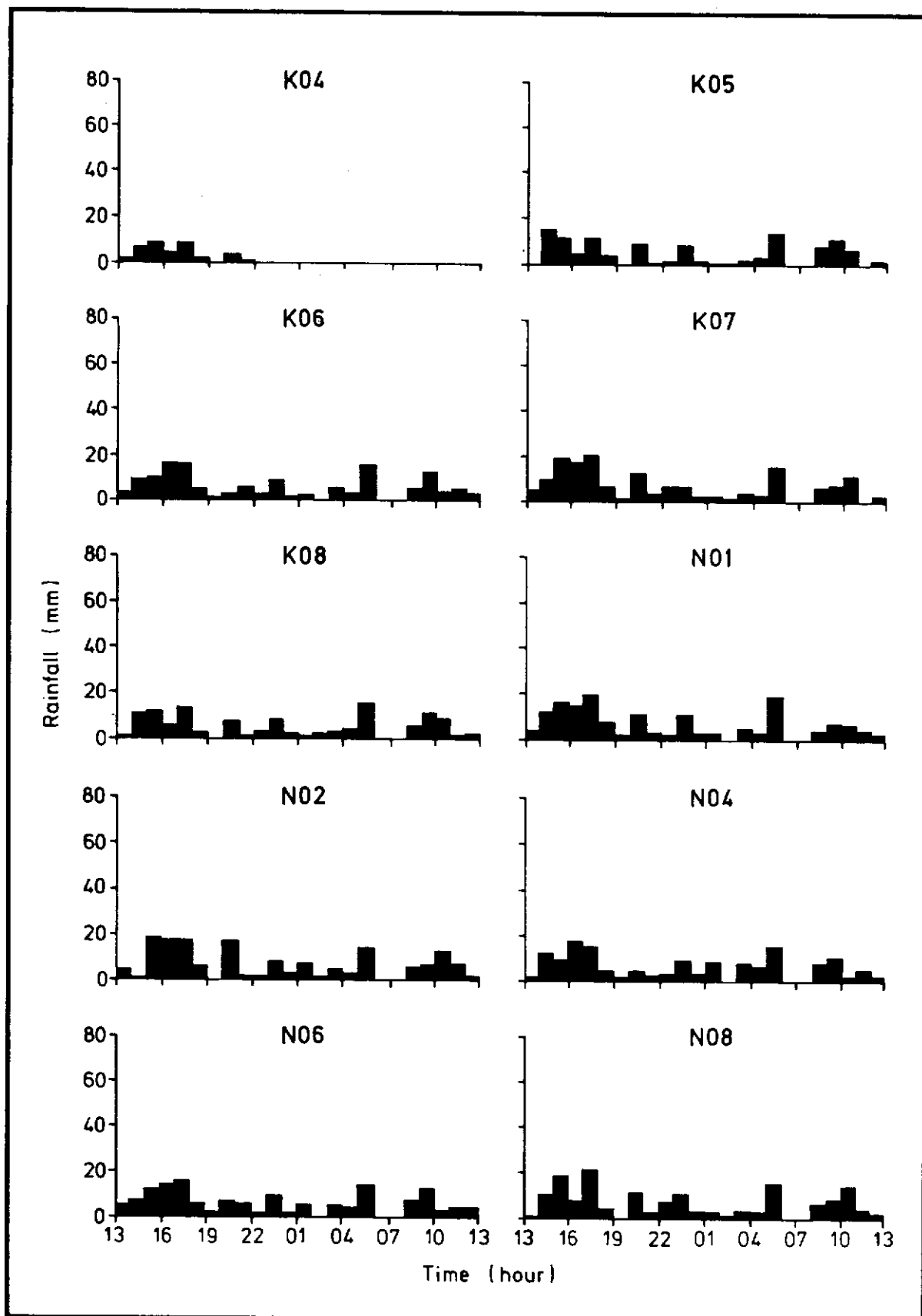


Figure B5 (Cont.) - Histograms of Hourly Rainfall Recorded by GCO
Raingauges on 10th to 11th August 1986 (Sheet 3 of 4)

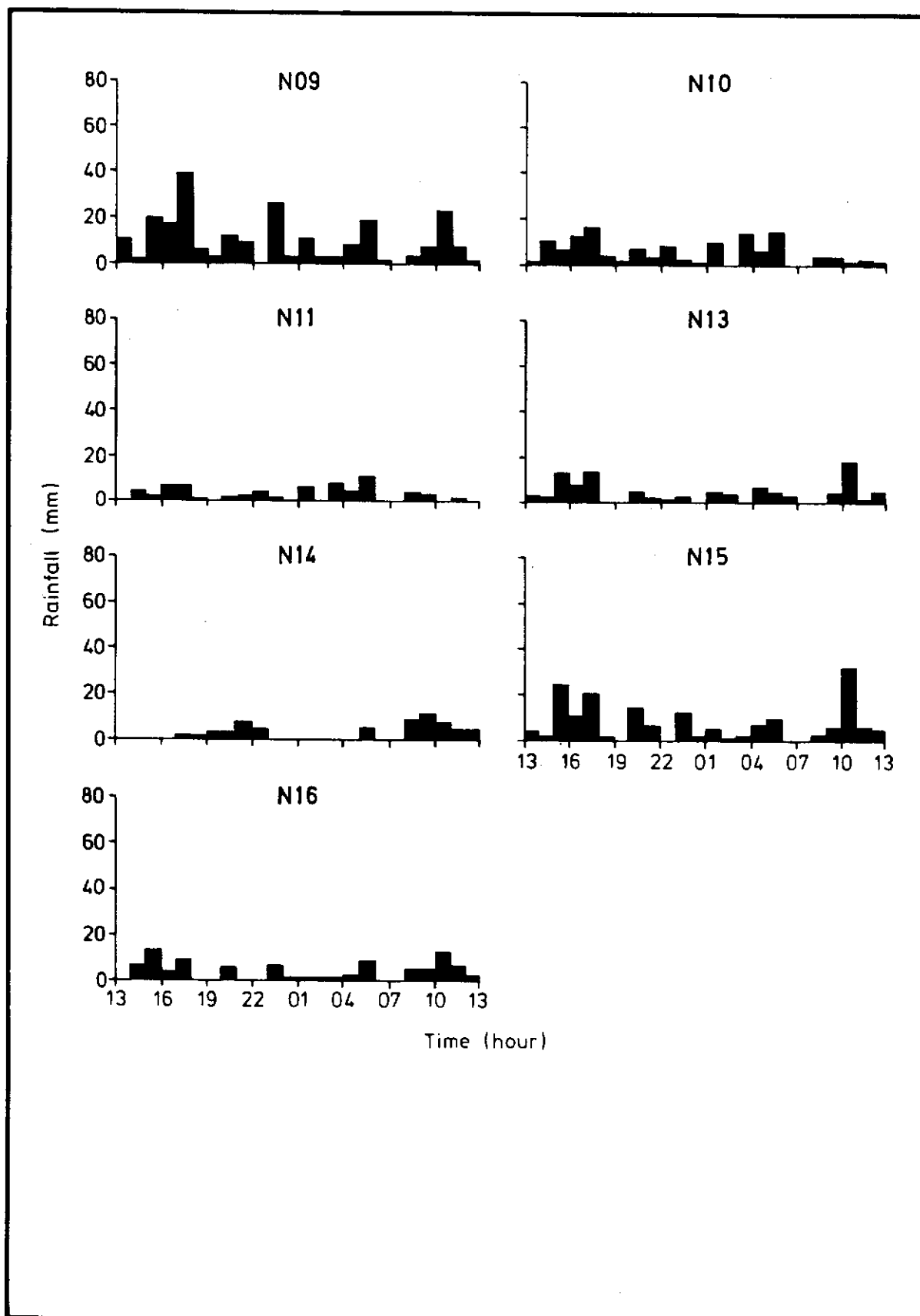


Figure B5 (Cont.) - Histograms of Hourly Rainfall Recorded by GCO
Rain gauges on 10th to 11th August 1986 (Sheet 4 of 4)

LIST OF DRAWING

Drawing
No.

GCSP 8/3

Location Map of Landslides and Related
Incidents in 1986