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THE SOUTHLAND FLOOD OF JANUARY 1984 (NOTE)

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ABSTRACT

The floods of January 1984 in Southland had return periods ranging from 3½ to 1,000 years and caused more than $50m worth of damage. Nine automatic raingauges and more than 110 manual gauges gave an excellent record of the storm rainfall, and river flows and lake levels were recorded at 17 sites. The storm lasted 18 hours, with heavy rainfall associated with fronts in an extremely deep and humid northwesterly airflow. The estimated probable maximum flood for the Waihopai River which flows through Invercargill is twice the size of the January 1984 flood which reached 112 times mean flow.

INTRODUCTION

On 26–27 January 1984 heavy rain fell in Fiordland and southern Southland; 134 mm of rainfall was recorded at Invercargill airport in the 24 hours to 9.00 a.m. on the 27th; nearly twice the previous high (73 mm) of January 1980. Severe flooding occurred in the lower Waiau, Aparima, Makarewa and Waihopai rivers, and in several smaller streams which drain through Invercargill city. The townships of Tuatapere, Otautau, and parts of Invercargill city were inundated. Damage to houses, bridges and roads was widespread in Southland, and insurance claims amounted to more than $50m, making the January 1984 flood the costliest natural disaster in New Zealand since the 1931 Napier earthquake.

METEOROLOGICAL SITUATION

On the 26th of January a relatively deep (980 mb) depression lay far to the southwest of New Zealand and a large anticyclone (1,020 mb) was centred on the north of the North Island (Fig. 1). In the pressure gradient between these features a strong north westerly airflow developed onto southern New Zealand. As the depression moved eastwards, a shallow frontal zone associated with it moved onto the southern South Island. A small, developing wave depression moved east-south-eastwards along the sea-level trough, further strengthening the low-level northwesterly flow of warm moist air into the frontal system.

While the synoptic situation that gave rise to the January storm was typical of those which produce heavy rainfall in New Zealand., it was unusual in that the air mass was extremely humid and deep for such a southern latitude.

A detailed account of the meteorology associated with the storm is given in Hill and Quayle (1984).

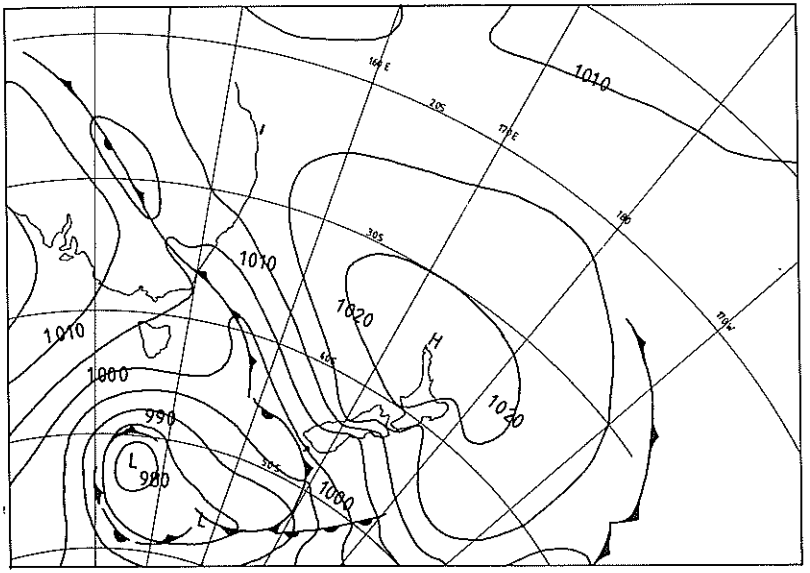

FIG. 1: Meteorological situation at midday (NZDT) 26th January 1984. (Courtesy N.Z. Meteorological Service).

RAINFALL

The distribution of storm rainfall was monitored by nine automatic gauges (Fig. 2) operated by the Southland Catchment Board.

Rain began falling in the south and west early on the morning of 26th January, but ceased by mid-afternoon, with up to 20 mm having been recorded in coastal and north-western Southland. About 4 to 5 p.m. on the 26th heavy rain started falling across all of Southland, apart from the headwaters of the Mataura and Oreti catchments where is began to rain at about midnight.

The rain reached a maximum intensity across the province between 1.00 a.m. and 4.00 a.m. on the 27th January, before easing and eventually ceasing almost simultaneously across Southland between 11.00 a.m. and 12.00 noon on the 27th (Fig. 3). The storm was of short duration, ranging from about 12 hours in the upper Mataura catchment to 18 hours in coastal and western Southland.

Total rainfalls for the 48 hours from 26th January were measured at more than 120 Southland Catchment Board, Meteorological Service and private observer raingauges. Isohyets have been fitted to these point data (Fig. 4). Highest rainfalls were in the area of L. Manapouri and Takitimu mountains, at West Arm, Manapouri, 335 mm was recorded. East of Invercargill a smaller centre of heavy rain occurred, with falls of 150–160 mm.

Heavy rain in Fiordland is common, but the short duration and high intensity in this event were unusual for the latitude.

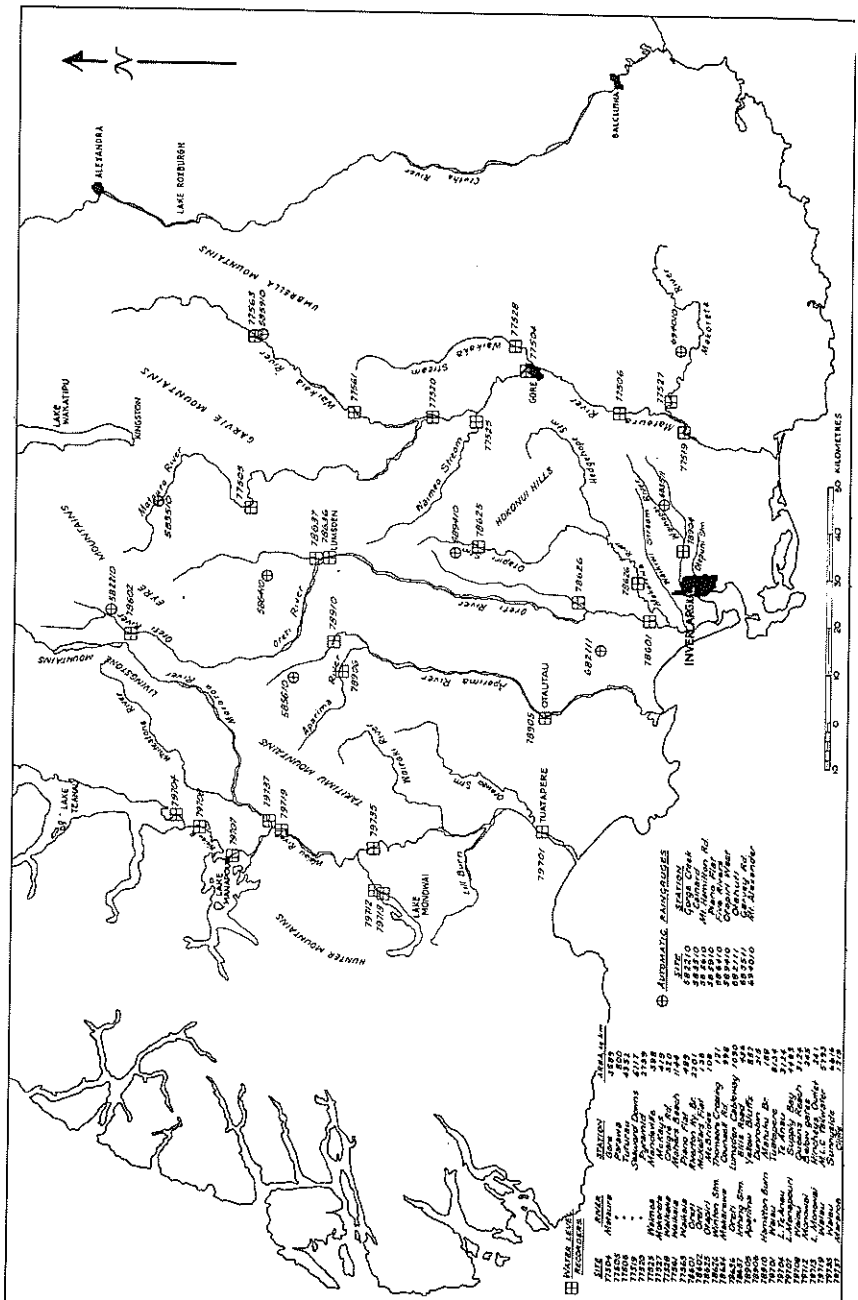

FIG. 2: Locations of automatic raingauges and water level recorders.

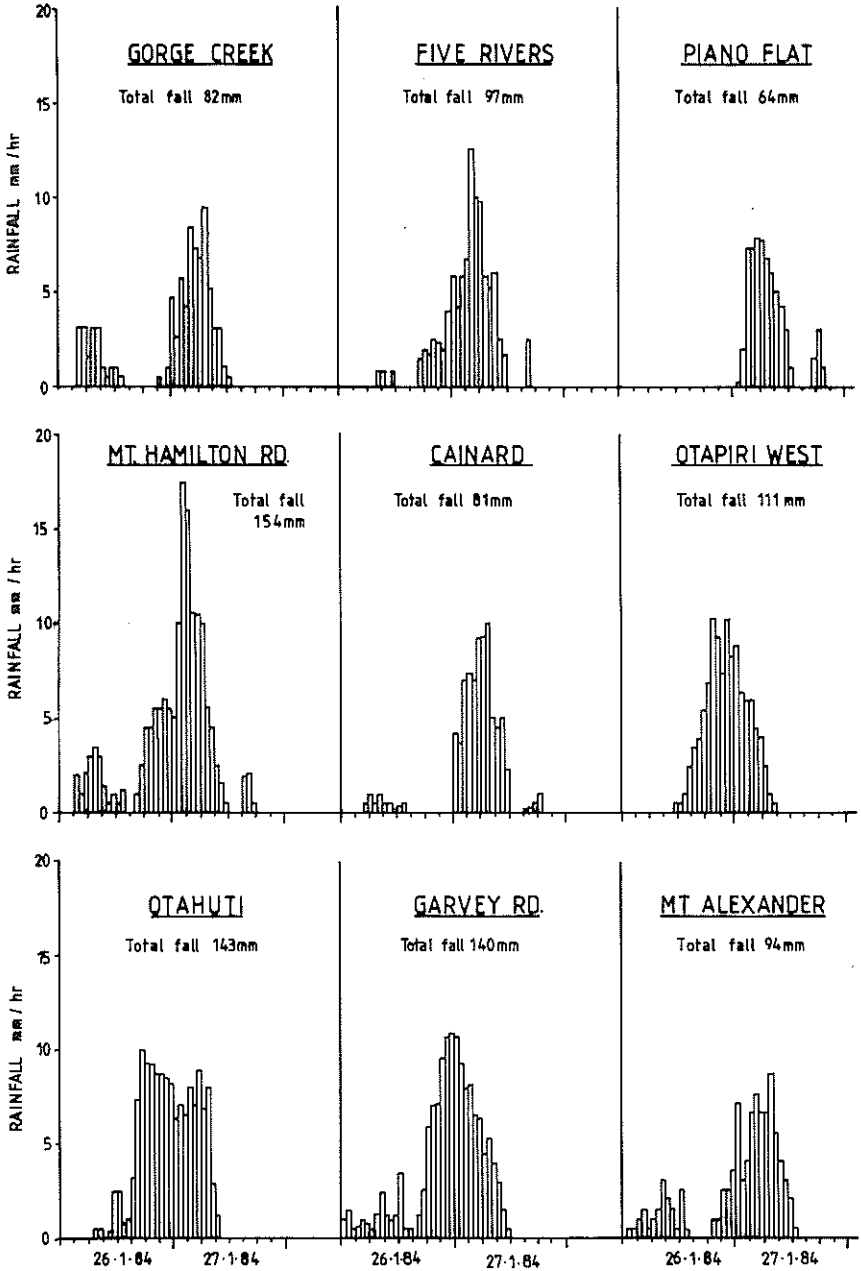

FIG. 3: Storm rainfall intensities recorded by automatic gauges.

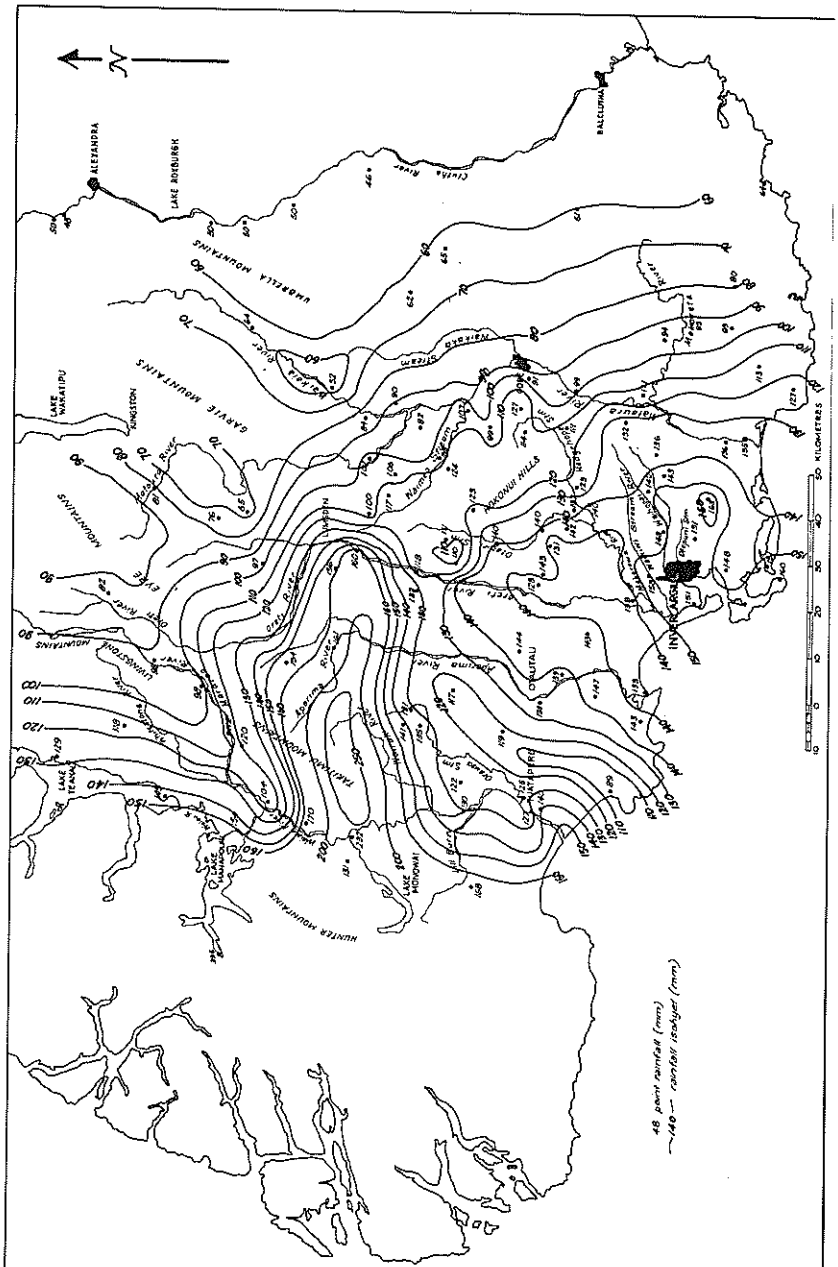

FIG. 4: Storm rainfall isohyets. Point rainfalls derived from Southland Catchment Board, N.Z. Meteorological Service, and private observer raingauges.

Frequency Analyses

The annual maximum daily rainfalls from the 44 years of record at Invercargill airport fit a Gumbel distribution except for two outliers — the January 1980 and 1984 rainfalls (Fig. 5). A Gumbel distribution fitted by least squares to the values (excepting the outliers) suggests a return period of about 1,000 years for the rainfall of 134 mm which occurred in the 24 hours to 9.00 a.m. on 27th January 1984. A similar analysis of the 34 year Otautau record from 1951 to 1984 showed 3 outliers — 1984, 1977, and 1980 (Fig. 5). Fitting a Gumbel distribution by least squares to the data other than these three suggested a return period greater than 1,000 years for the January 1984 one-day rainfall of 128 mm. The four largest one-day rainfalls at Otautau have occurred since 1977 and five of the six largest one-day rainfalls recorded at Invercargill have been since 1978 (the exception being that of 1958).

FLOWS

All rivers in Southland began rising sharply with the heavy rain, and smaller rivers peaked early on the morning of the 27th. All flood hydrographs were single peaked, with the exception of that for Seaward Downs on the lower Mataura River, which peaked late on the 27th with runoff from the lower catchment, and maintained a high flow due to the later contribution of water from the upper catchment.

Most damage to property was in North Invercargill caused by floodwaters from the Waihopai river which was estimated to have peaked at about 280 m^3/s (112 × mean flow), four to five times higher than any flood previously known.

Analysis of 24 years of record to 1984 suggested a 1% probability flood in the Waihopai of 96 m^3/s (cf. the 1950's estimate of 112 m^3/s) and gave the January 1984 flood an annual probability of occurrence less than 0.1%, similar to that of the rainfall over the area.

Flood frequency estimates for other rivers in the Southland region are presented in Table 1.

STORM RAINFALL AND RUNOFF

Average storm rainfalls for several catchments were derived from an isohyetal map (Fig. 4), and compared with their volumes of direct storm runoff estimated from the flood hydrographs (Fig. 6). The curvilinear relationship, tending towards a 1:1 ratio at higher rainfalls and runoffs, is similar to that normally found for a single catchment.

Data for the Waihopai, Yellow Bluffs, and Wyndham catchments do not appear to fit this curvilinear relationship; either the rainfalls or runoffs for these catchments may have been wrongly estimated.

PROBABLE MAXIMUM PRECIPITATION AND FLOOD

Being far larger than any other storm experienced in recent times, the January 1984 storm provided an opportunity for assessing the likely probable maximum precipitation for the Invercargill region and particularly for the

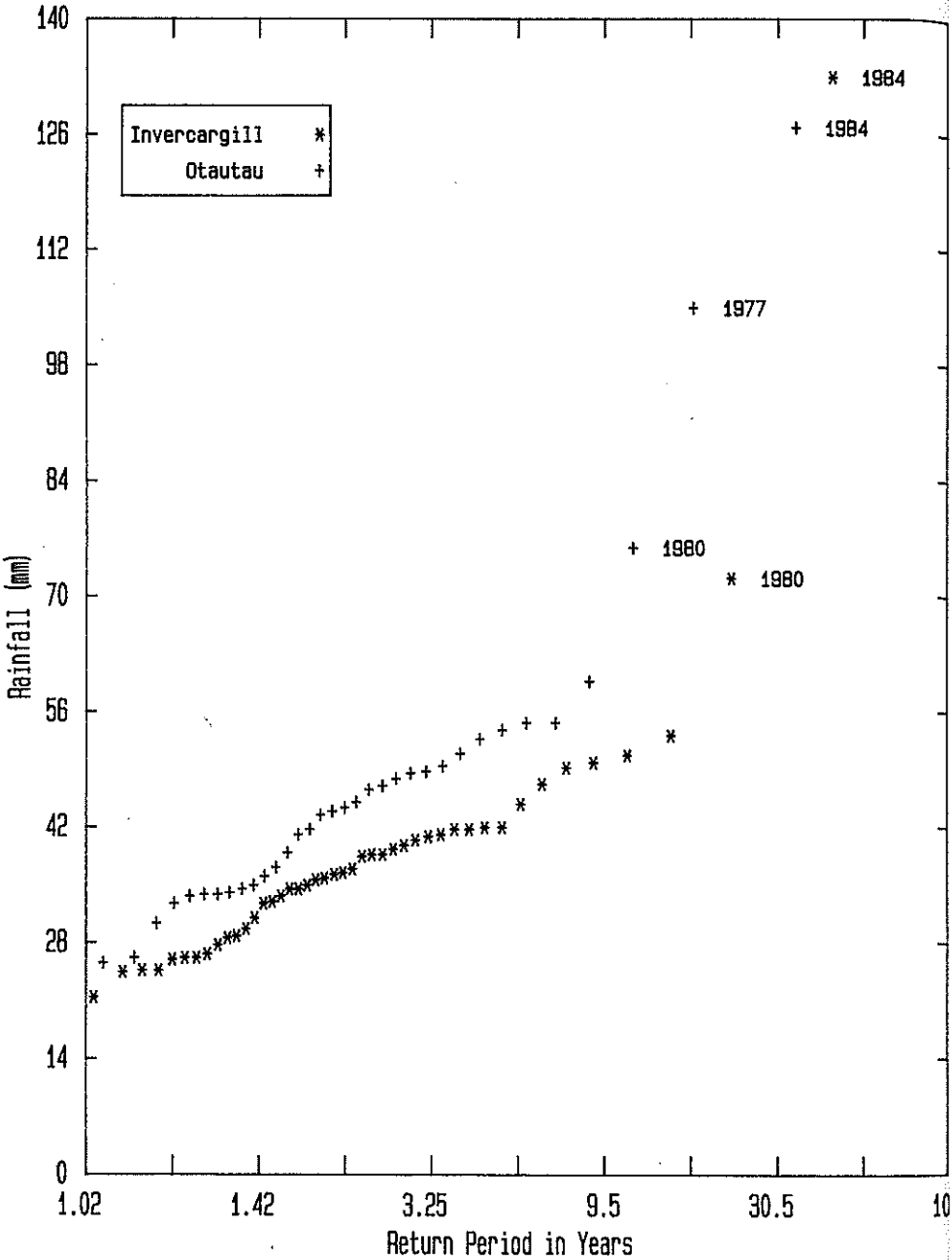

FIG. 5: Invercargill and Otautau 1-day annual maximum rainfalls.

Waihopai River catchment.

Dew-point temperature measured at Invercargill airport during the storm was 13.5°C; the maximum persisting dew point temperature that is likely to occur at Invercargill in the month of January is 19°C (Riddell and Pannell, 1984).

The moisture maximisation factor calculated for the January storm was 1.64. For the Waihopai catchment this would result in a probable maximum precipitation of 235 mm.

Effective (runoff-producing) duration of the January storm was about 12 hours, and the resultant flood in the Waihopai River had a direct runoff

TABLE 1: Summary of flood frequencies*

River	Site	Catchment Area km²	January 1984 Peak m³/s	January 1984 Return Period Years	Previous Highest Recorded Peak m³/s	Previous Highest Recorded Year	100 Year Flood m³/s	Years of Record
Waihopai	Above Scour	157	280	1,000	67	1980	96	26
Makarewa	Counsell Rd.	998	725	350	505	1978	607	28
Otapiri	McBrides	108	150	32	120	1980	184	22
Oreti	Lumsden	1,160	1,110	48	1,171	1978	1,250	25
Oreti	Riverton S.H.	2,201	1,290	33	1,369	1980	1,467	8
Aparima	Dunrobin	215	690	1,000	534	1978	360	22
Aparima	Yellow Bluffs	857	1,098	214	730	1978	1,000	7
Hamiltonburn	Matuku Br.	188	227	83	199	1978	232	9
Mataura	Parawa	800	292	7	590	1978	560	29
Mataura	Gore	3,589	788	3½	2,297	1978	2,120	27
Mataura	Seaward Downs	5,117	1,171	5	2,476	1978	2,430	11
Waimea	Mandeville	398	290	30	200	1978	350	10
Waiau	Tuatapere	8,134	3,000	85	1,887	1983	3,090	24
Mararoa	Cliffs	1,219	811	8	948	1980	1,570	16
L. Manapouri daily mean outflow			1,305	20	1,370	1983	1,610	52
L. Manapouri daily mean inflow			3,240	280	2,279	1957	2,890	52
L. Te Anau daily mean inflow			4,646	37	4,839	1978	5,330	58

* Estimated from Gumbel distributions fitted by least squares

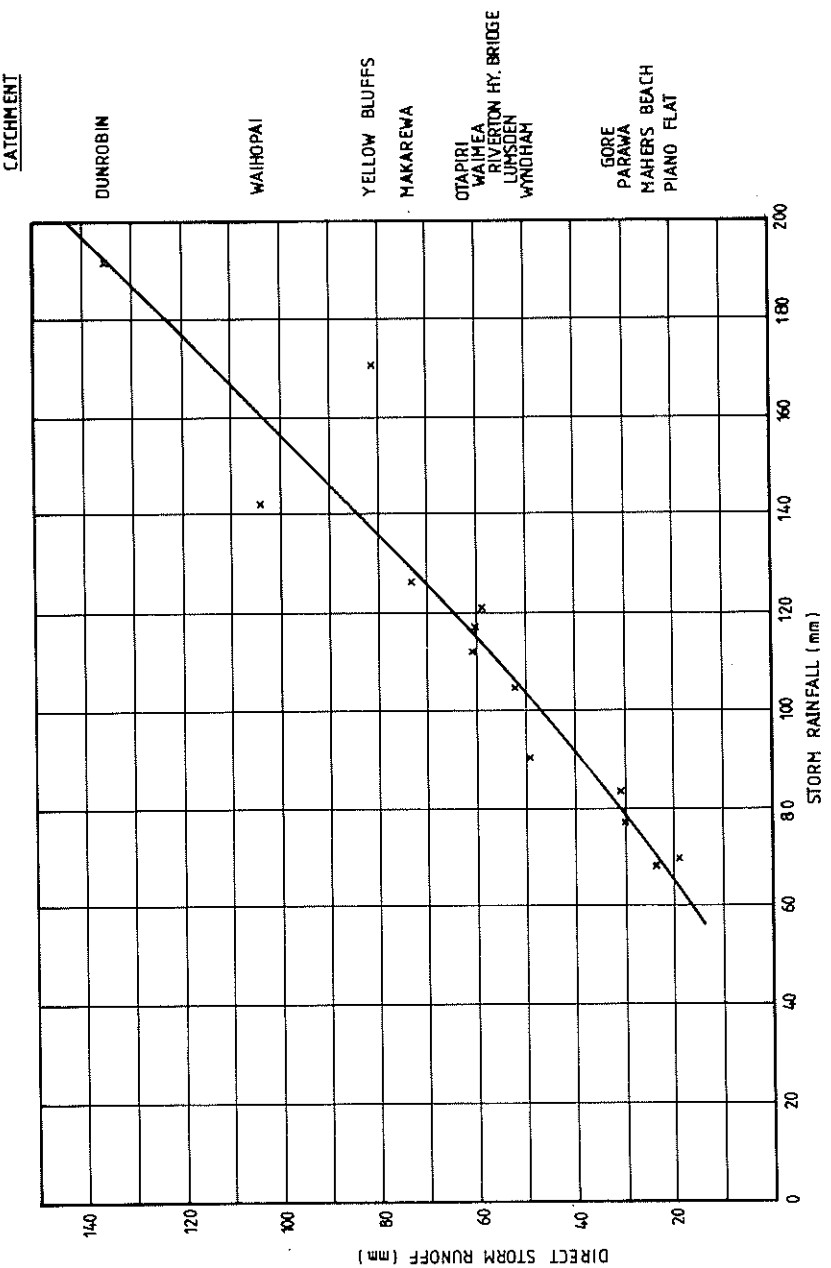

FIG. 6: Storm rainfall/runoff relationships for selected catchments.

component of about 100 mm. After subtraction of baseflow the flood hydrograph could be regarded as a 12 hour — 100 mm unit hydrograph.

Temporal distribution of the January 1984 storm rainfall was similar to that normally assumed for the probable maximum precipitation (Riddell, 1980), so a probable maximum flood hydrograph for the Waihopai River was derived by scaling the ordinates of the January flood hydrograph (minus baseflow) by the ratio of the probable maximum direct runoff to the January runoff. If 10% of the probable maximum precipitation were retained in storage (e.g. ponding), a direct runoff of 211 mm would be expected. This is twice the January 1984 flood runoff.

With baseflow this would result in a probable maximum peak flow of 580 m^3/s in the Waihopai River, a specific discharge of 3.6 cumecs per square kilometre.

ACKNOWLEDGEMENTS

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REFERENCES

Hill, H. W.; Quayle, A. M. 1984: The Southland Flood of January 1984. *N.Z. Meteorological Service Technical Information Circular 1984*, 29 p.

Riddell, D. C. 1980: Flood Hydrology of the Motu River. *Journal of Hydrology (N.Z.). Vol. 19(1)*:35-48.

Riddell, D. C.; Pannell, G. R. 1984: Hydrological Analysis of the January 1984 Southland Floods. *Southland Catchment Board Internal Report*. 21 p.