

THE RESULTANT DIRECTION AND INCLINATION OF RAINFALL AT ARAHURA, WAIRARAPA, NEW ZEALAND

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ABSTRACT

Resultant directions and inclinations of rainfall have been computed from vectopluiometer data taken at Arahura near Gladstone in the Wairarapa, for the period June 1967 to July 1971. The distribution of resultant direction and inclination of the daily rainfall are discussed along with the relationship between resultant direction and inclination. Monthly and seasonal variation of the resultant direction and inclination of the rainfall are presented.

This study illustrates the marked predominance of southerly rainfall in this part of the Wairarapa and the rarity of northerly or westerly rainfall. Resultant inclinations of the rainfall show that the southerly rainfall is more steeply inclined from the vertical than rainfall from other directions.

INTRODUCTION

To measure rainfall vectors during a study of unstable hill soils, a vectopluiometer was used from June 1967 to July 1971 in the climatological enclosure at Arahura ($41^{\circ} 08' S$, $175^{\circ} 38' E$) near Gladstone in the Wairarapa, New Zealand.

Knowledge of rainfall vectors has many applications, and details of references to rainfall vector measurement and applications are given by Aldridge (1975) along with resultant direction and inclination of rainfall determined from vectopluiometer data at Taita near Wellington.

The predominant direction of driving rain is often different from that of the general prevailing wind (Finkelstein, 1972). Thus vectopluiometer data as well as wind data, could be of assistance when planning farm buildings. Knowledge of the predominant direction and inclination of rainfall would also be of assistance in planning the use of hillsides as water catchment areas.

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In animal health studies, such as the study of iodine deficiency in lambs (Healy *et al.*, 1972), knowledge of the direction of rainfall could be of assistance in determining the sources of a particular element, such as iodine, which may be present in rainfall.

EXPERIMENTAL

Equipment, methods of measurement, and data reduction were described by Aldridge (1975). All rainfall measurements were taken

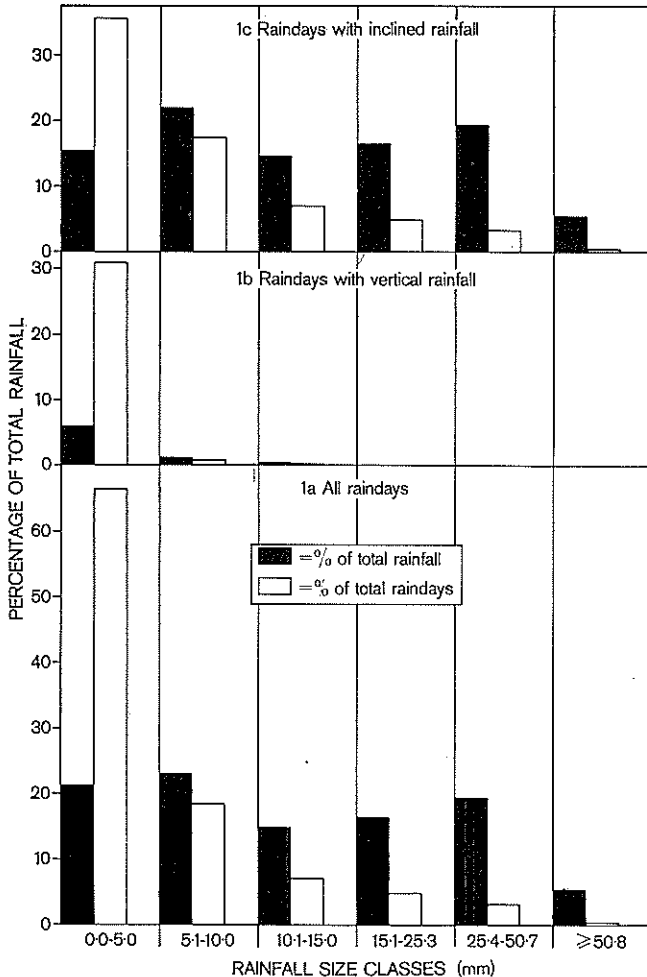


FIG. 1 — Rainfall distribution in selected size classes June 1967 to July 1971.

in inches and in the discussion, figures, and table have been converted to millimetres.

DIRECTION AND INCLINATION OF DAILY RAINFALL

Distribution of Rainfall

Annual rainfall for the three complete calendar years of the study ranged from 721 mm to 970 mm. Summer and spring each received 19 percent of the total rainfall, autumn 32 percent and winter 31 percent. Raindays with 0.1–5.0 mm rainfall accounted for 67 percent of the total raindays (Fig. 1a), but contributed only 21 percent of the total rainfall. The number of raindays, but not the amount of rainfall, in each size class decreased rapidly with increasing rainfall.

Of the 558 raindays with vectopluiometer data available in the period June 1967 to July 1971, 177 were raindays with nil rainfall recorded in any of the four vectopluiometer gauges and are referred to as raindays with vertical rainfall (Fig. 1b). Raindays with vertical rainfall contributed 7 percent of the total rainfall, were predominantly in the 0.1–5.0-mm size class, and would probably be raindays with low daily windrun (Aldridge, 1975). The remaining raindays (Fig. 1c), with rainfall recorded in one or more of the four gauges of the vectopluiometer are referred to as raindays with inclined rainfall. The rainfall distribution in selected size classes for raindays with inclined rainfall was similar to the distribution for all raindays (Fig. 1a).

Resultant Direction of Rainfall

The resultant directions of the daily rainfall (Fig. 2) showed a marked predominance of southerly rainfall. Rainfall with resultant directions of 160° to 200° occurred on 219 or 39 percent of the 558 raindays and contributed 46 percent of the total rainfall. Rainfall from resultant directions between southwest and northnorthwest (220 – 340°) occurred on only nine raindays. There were 73 raindays with easterly resultant directions of rainfall.

This pattern of predominant southerlies was maintained when the raindays were subdivided into selected rainfall size classes (Fig. 3). With increasing daily rainfall the range of resultant directions decreased. The two raindays in the largest size class included an unusually severe southerly storm on 10 April 1968 (Hill, 1970). The rainfall for the 24 hours ending 0900 NZST was 116.8 mm with horizontal components of 2.5 mm from the north, 100.8 mm from

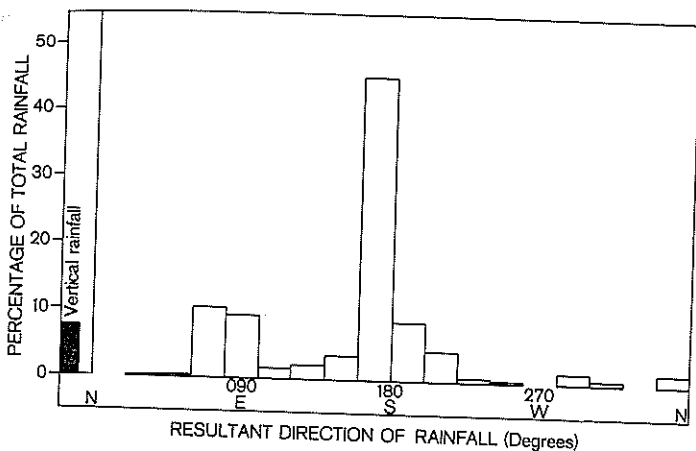


FIG. 2 — The distribution of the resultant direction of rainfall as percentage of total rainfall.

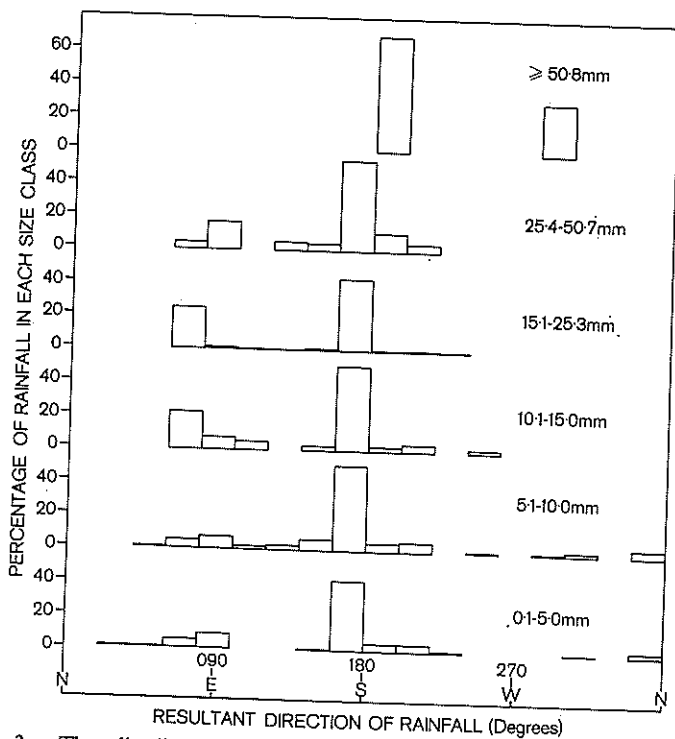


FIG. 3 — The distribution of resultant direction of rainfall in selected rainfall size classes.

TABLE 1 — Total vertical raingauge and vectopluiometer catches.

Vertical gauge catch (mm)	Horizontal gauge catches (mm)			
	North	South	East	West
3112.0	97.0	1141.0	351.0	140.7
Percentage of total horizontal catch :	5.6	66.0	20.3	8.1

the south, 7.4 mm from the east and 33.8 mm from the west, giving a resultant direction of 195°. The other rainday in this class, while having a resultant direction of 292°, also had a southerly component to the rainfall. The daily rainfall was 52.3 mm with horizontal components of 11.2 mm from the north, 7.9 mm from the south, 3.6 mm from the east and 11.7 mm from the west. This rainday was the only rainday in the 50-month period with a large westerly component.

Over the whole period northerly and westerly components of the rainfall were the smallest (Table 1), while the southern component was 66 percent of the total vectopluiometer catch.

Resultant Inclination of Rainfall

The distribution of the total daily rainfall into 5° classes of resultant inclination (Fig. 4) showed that 23 percent of the total rainfall fell at resultant inclinations up to 10° from the vertical and 47 percent at up to 20°. Very little rainfall was inclined at greater than 45°.

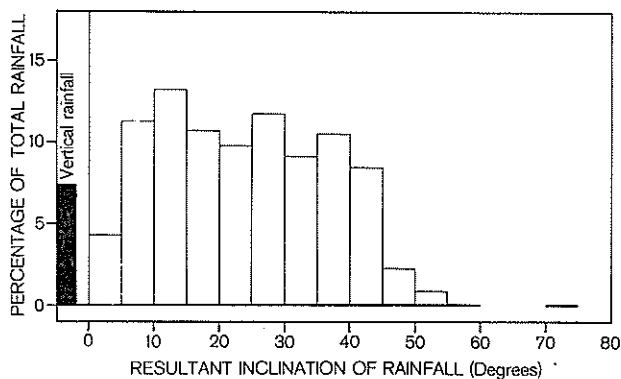


FIG. 4 — The distribution of resultant inclination of rainfall as percentage of total rainfall.

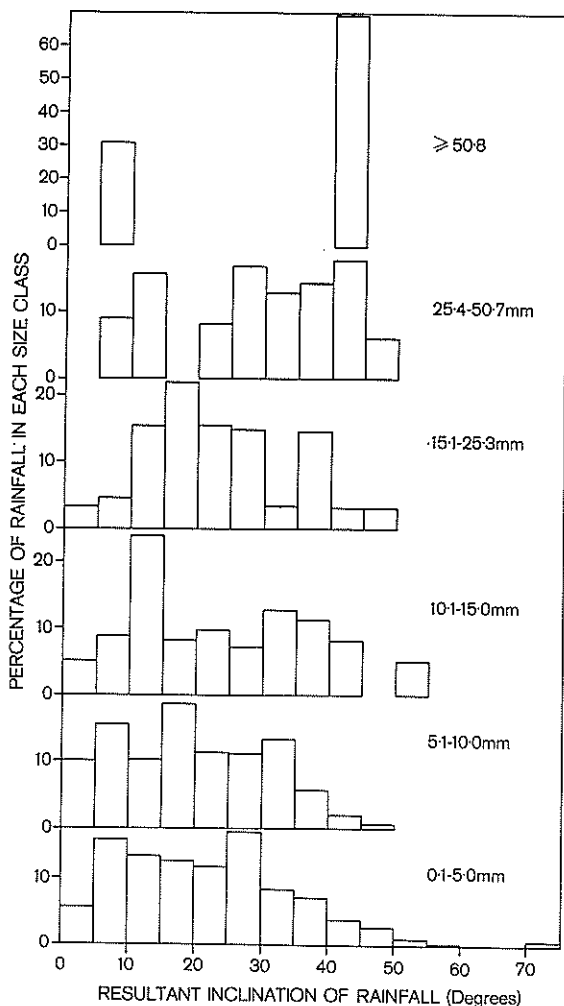


FIG. 5 — The distribution of resultant inclination of rainfall in selected rainfall size classes.

The distribution of inclination classes in relation to rainfall size classes (Fig. 5) showed that there was a shift from low resultant inclinations to higher inclinations with increasing rainfall. Resultant inclinations of rainfall between 1° and 10° decreased from 21.5 percent of the rainfall in the 0.1–5.0-mm class to 9.1 percent of the rainfall in the 25.4–50.7-mm class, while resultant inclinations greater than 20° increased from 52.3 per cent of the rainfall to

75.3 percent. However, the maximum resultant inclinations were recorded in the 0.1–5.0-mm class. There were 16 raindays in the whole period with resultant inclinations greater than 45° from the vertical, 11 of these in the 0.1–5.0-mm class. The largest daily rainfall of the period (recorded on 10 April 1968) was inclined 41° from the vertical.

To examine resultant inclinations of rainfall in relation to resultant directions, the resultant directions of rainfall were grouped into northerlies ($340\text{--}040^\circ$), easterlies ($040\text{--}140^\circ$), southerlies ($140\text{--}240^\circ$) and westerlies ($240\text{--}340^\circ$). The largest resultant direction group were the southerlies which were inclined predominantly at greater than 20° from the vertical (66 percent of total southerly rainfall). The second largest group were easterly, of which 62 percent gave resultant inclinations up to 20° . Northerly rainfalls were of low inclination, 79 percent falling at resultant inclinations up to 10° from the vertical. Westerly rainfalls, the smallest group, were made up of 36 percent at up to 10° and 59 percent up to 20° .

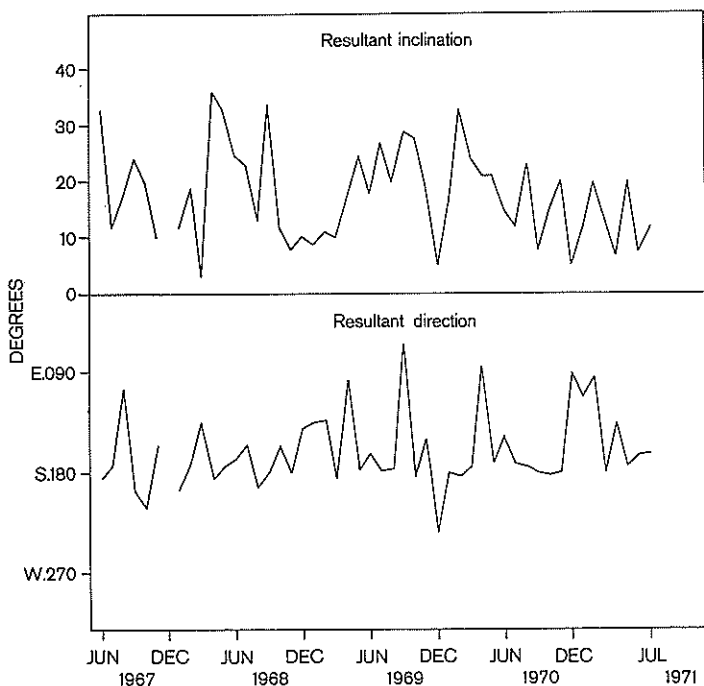


FIG. 6 — Monthly resultant inclination and direction of rainfall June 1967 to July 1971.

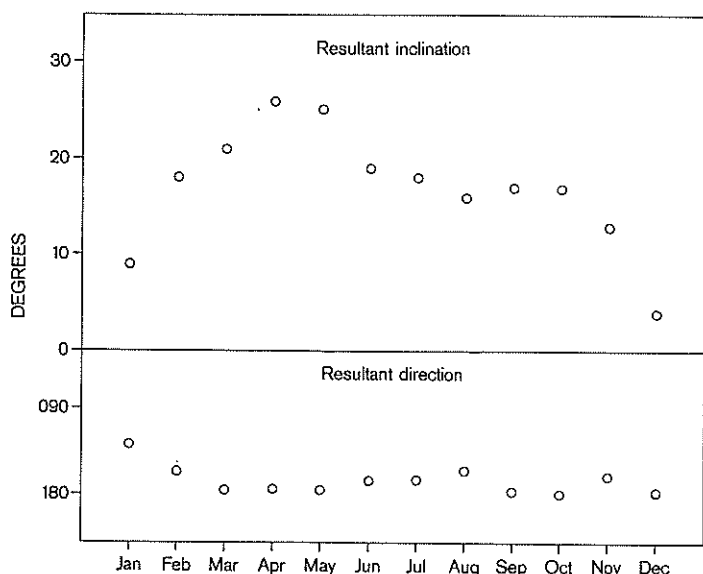


FIG. 7—Resultant monthly inclination and direction of rainfall June 1967 to July 1971.

MONTHLY PATTERN OF RESULTANT INCLINATION AND DIRECTION

Resultant inclinations and directions of the rainfall for each month are plotted in Fig. 6. Over the 50-month period monthly resultant inclinations were variable, although summer gave the lowest resultant inclinations, and autumn generally the highest. Generally, summer resultant directions were more easterly than other seasons.

Resultant monthly inclinations and directions for the 12 calendar months are presented in Fig. 7. These were computed by summing the catch of each of the four gauges of the vectopluviometer for each calendar month from January through to December for the whole period, and computing the resultant inclinations and directions in the usual manner (Jackson and Aldridge, 1972). Resultant inclinations of rainfall were lowest in December and January and highest in April and May. The resultant direction for January was more easterly (139°) than those for the other months, which varied between southeast (150°) and south (180°).

CONCLUSIONS

This study has shown that at Arahura in the Wairarapa in the period June 1967 to July 1971, 7.4 percent of the total rainfall was

vertical, i.e. there was no measurable rainfall in the vectopluiometer, and the remainder predominantly from the south and east with very little rain from westerly or northerly directions.

Generally about 45–50 percent of the total rainfall fell at inclinations up to 20° from the vertical, but southerly rainfall was predominantly inclined greater than 20° and easterly rainfall less than 20°.

Lowest inclinations were found to occur in the summer months when resultant directions of rainfall were more easterly than in other seasons. Highest inclinations occurred during autumn.

ACKNOWLEDGMENTS

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