1983

Precipitation regimes of the Illawarra coast and adjacent highlands

P. F. Cox
University of Wollongong

Publication Details

This report was originally published as Cox, PF, Precipitation regimes of the Illawarra and adjacent highlands, Wollongong Studies in Geography No.12, Department of Geography, University of Wollongong, 1980, 4p.

Precipitation regimes of the Illawarra coast and adjacent highlands

Abstract

The South Coast and Highlands area of the IIlawarra has a temperate marine climate which fits within Koppen's classification of climatic regimes as the type Cfb. As far as precipitation is concerned, Koppen's f modifier denotes a region with a moist climate and no dry season; that is, rainfall is well distributed across the seasons of the year. While these characteristics apply to the IIlawarra region as a whole (and in fact to most of south-eastern New South Wales and eastern Victoria), there are important variations in precipitation within the region, and in addition there are quite marked variations in precipitation on a year-by-year basis. This paper examines the factors which produce these variations in space and time.

Publication Details

This report was originally published as Cox, PF, Precipitation regimes of the Illawarra and adjacent highlands, Wollongong Studies in Geography No.12, Department of Geography, University of Wollongong, 1980, 4p.

WOLLONGONG STUDIES IN GEOGRAPHY No. 12
Department of Geography, University of Wollongong.

PRECIPITATION REGIMES OF THE ILLAWARRA COAST AND ADJACENT HIGHLANDS

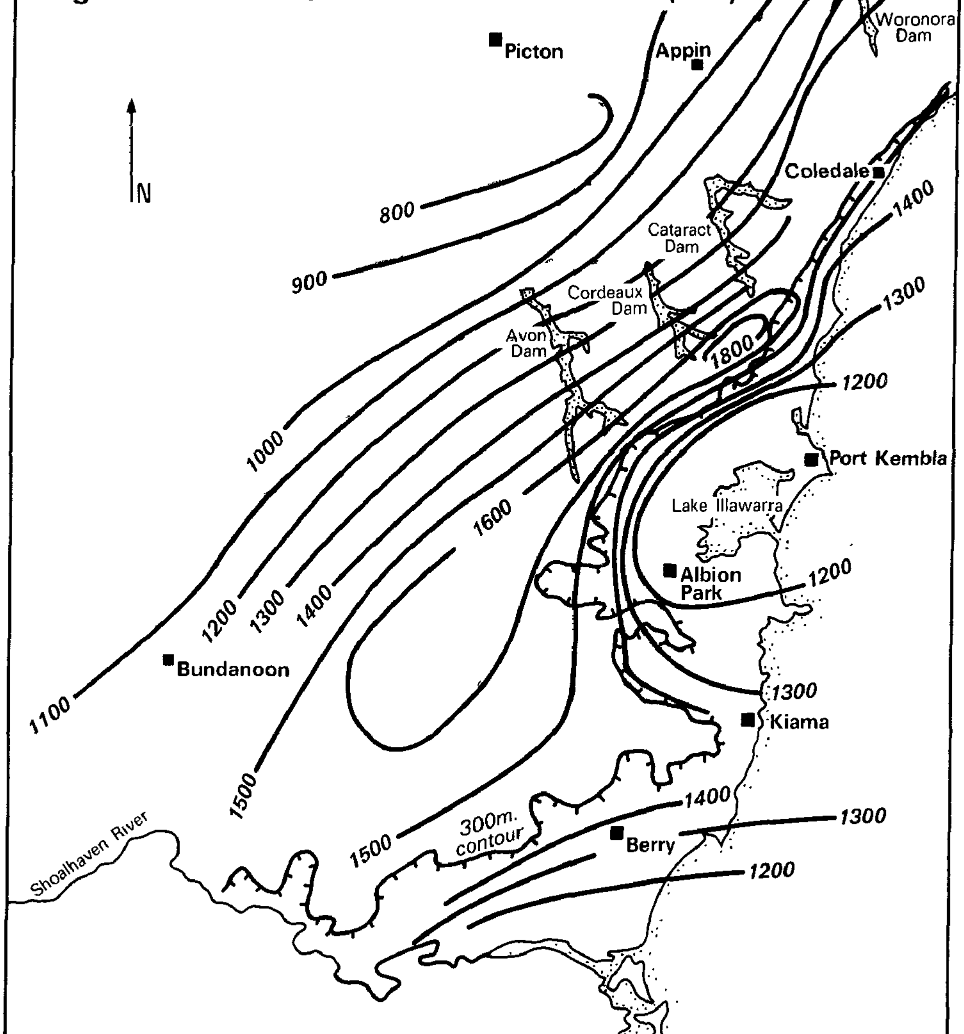
P. F. COX

INTRODUCTION

The South Coast and Highlands area of the Illawarra has a temperate marine climate which fits within Köppen's classification of climatic regimes as the type **Cfb**. As far as precipitation is concerned, Köppen's f modifier denotes a region with a moist climate and no dry season; that is, rainfall is well distributed across the seasons of the year. While these characteristics apply to the Illawarra region as a whole (and in fact to most of south-eastern New South Wales and eastern Victoria), there are important variations in precipitation within the region, and in addition there are quite marked variations in precipitation on a year-by-year basis. This paper examines the factors which produce these variations in space and time.

Two major factors (the topographic structure of the region and the nature of the prevailing air masses) control precipitation in the Illawarra. The seasonal movement of pressure cells - anticyclonic highs and cyclonic lows - determines the types of air that are drawn towards the region. This movement is such that rain-bearing tropical or sub-tropical maritime air masses and polar maritime air masses dominate in summer and winter respectively. These air masses encounter a topography which is dominated by the Illawarra Escarpment, and the alignment of which plays an important role in determining the distribution of rainfall. The escarpment divides the region into two parts. To the west lies a dissected plateau which slopes generally northwards from Macquarie Pass and westward from the scarp itself; to the east is a coastal plain of varying width.

Figure 1: AVERAGE ANNUAL RAINFALL (mm.)



Source: Bureau of Meteorology records

TOPOGRAPHY AND THE DISTRIBUTION OF RAINFALL

Site characteristics are important in determining the actual precipitation which falls at specific locations. For example, both Coledale and Port Kembla are located adjacent to the coast, but Coledale's average annual rainfall is some 200 mm higher than that of Port Kembla. Coledale's closer proximity to the escarpment accounts for this difference. The influence of the scarp can be seen in other ways as well. Albion Park and Berry, for example, are similarly situated in terms of distance from the scarp (and from the sea), yet Albion Park's average yearly precipitation (1123 mm) is only about three quarters that of Berry (1464 mm). In this case the difference arises from the alignment of the escarpment. At Albion Park a rainshadow is produced behind an eastward-swinging arm of the Illawarra Range.

The escarpment plays a dominating role in the patterning of rainfall within the Illawarra region in that average annual precipitation totals increase with altitude (Figure 1), reflecting the existence of a pronounced orographic effect. Air moving in from the sea is forced to rise and cooling is thus induced. Ultimately, if dew point is reached, cloud will form with intense condensation leading to precipitation. The orographic effect is not confined to the seaward side of the scarp's edge, but extends some distance to the west as a result of a 'spill-over' effect (Schermerhorn, 1967) (see Figure 2). The existence of the spill-over is evident in Figure 1, which illustrates that the highest rainfall values occur immediately west of the top of the escarpment. From maximum values in excess of 1800 mm annually, rainfall decreases sharply both to the east and to the west.

The importance of the escarpment is also clearly evident from the alignment of the isohyets which run parallel to it. Where the scarp swings to the south-east from Albion Park towards Kiama, the isohyets follow suit. Precipitation gradients also closely reflect slope: thus the isohyets are close together along the face of the scarp itself but widely spaced in areas of low altitude and undulating topography such as are found between Kiama and central Wollongong.

THE ROLE OF AIR MASSES: WET AND DRY YEARS

While site and topographic characteristics determine the distributional pattern of precipitation, atmospheric conditions control the availability of moisture in the air and thus the actual amount of rain that can fall. In the Illawarra there are pronounced differences in rainfall totals between wet and dry years, but the distributional pattern remains quite stable. In 1950, for example, the region experienced roughly twice its average precipitation without any significant change in pattern (Figure 3). A similar phenomenon can be discerned in unusually dry years such as 1968, when most stations recorded only about half their average annual totals (Figure 4). Thus while drier conditions prevail in the western portion of the region than elsewhere because of the barrier effect produced by the escarpment, such conditions develop throughout the Illawarra when atmospheric conditions (including temperature, humidity, wind direction and wind intensity) are such as to decrease the availability of atmospheric moisture to a significant degree.

Four types of weather pattern account for most of the rainfall in the Illawarra, and logically the frequency with which these patterns occur in a particular year will have much to do with the amount of precipitation which is recorded during that year. These weather patterns are examined in relation to precipitation recorded at the University of Wollongong Climatological Station during 1974 and 1979. Of these years 1974 (with a total of 1998 mm of rainfall recorded) was an unusually wet year, while 1979 (776 mm) was unusually dry.

Firstly, during summer the location of anticyclones south of the Illawarra produces north-easterly trade winds along the coast (Figure 5A). These winds, coming off the warm water of the Tasman Sea, account for more than thirty per cent of the area's precipitation and can generate very heavy rains: on one occasion during 1974, more than 200 mm were recorded at Wollongong during a two-day period in which this particular condition dominated the region. Such high-intensity rainfall is not uncommon in the Illawarra (Young and Johnson, 1977, 45-47), and significant deviations from long-term averages can be produced as a result of short periods of very heavy rain. If the anticyclones fail to move as far south as they did in 1974, the easterlies and south-easterlies that develop affect only the North Coast of New South Wales. This was frequently the case during the summer months of 1979.

A second difference between the two years further explains the difference between them as far as precipitation is concerned. 1974 was a year of repeated autumn upper-atmospheric low pressure generation over New South Wales, with intensification over the warm seas. These systems enhanced south-easterly air flow and produced copious amounts of rain in 1974; however their absence in 1979 contributed to the development of drought conditions. The significance of these low-pressure cells for the Illawarra is accentuated because of the region's topography. The alignment of the escarpment means that south-easterly winds generated by these storms strike the escarpment almost at right angles, inducing both high precipitation and the characteristic north-east/south-west alignment of the isohyets.

Figure 2: THE SPILLOVER EFFECT (OROGRAPHIC RAINFALL

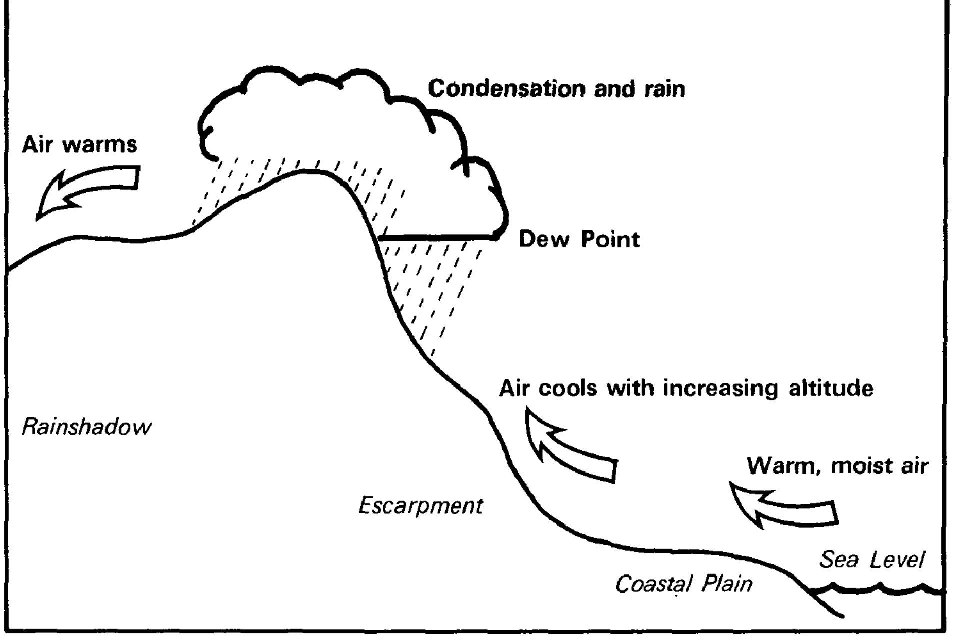
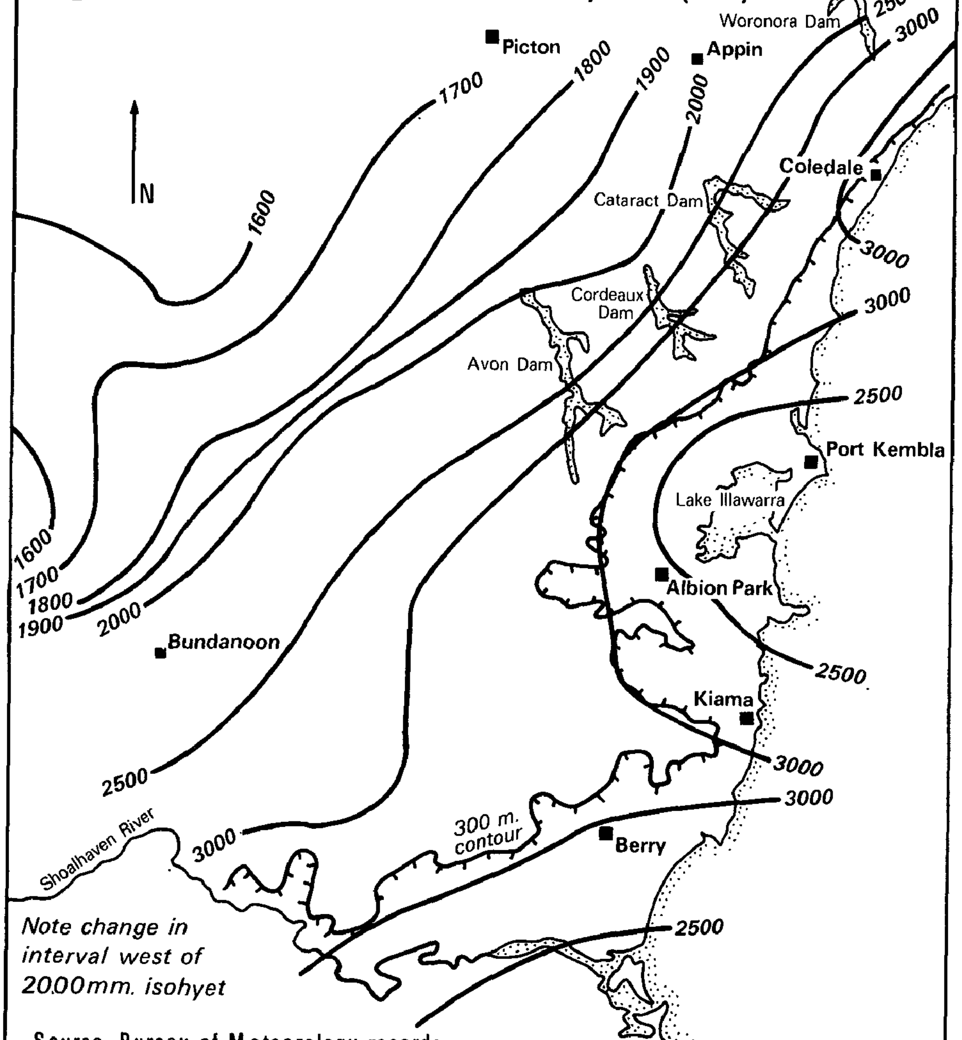


Figure 3: RAINFALL DISTRIBUTION, 1950 (mm.)



Source: Bureau of Meteorology records

The third weather pattern occurs in summer and involves the location of the Inter-Tropical Convergence Zone (I.T.C.Z.) (see Linacre and Hobbs, 1977, 110). During 1974 this zone moved further southward than usual, with the result that moist north-easterly winds associated with Tropical maritime (Tm) air masses brought heavy rains to the Illawarra. Failure of the I.T.C.Z. to move south prohibits the convergence of warm, moist air over New South Wales and low precipitation results.

The fourth rain-bearing pattern occurs during winter. Winds from the south-west accompanying cold fronts bring rain to the Illawarra. These winds pick up moisture as Polar maritime (Pm) air sweeping across to the Southern Ocean (Figure 5B).

SEASONALITY

The previous section illustrates that the predominant rain-bearing winds in the Illawarra come from the north-easterly and south-easterly compass points during summer and autumn and from the south-west during winter. No pronounced seasonality in precipitation results from this difference, however: long-term rainfall records show a fairly even distribution over the seasons (a characteristic of f climates), with only a slight dominance in summer and autumn (Table 1). The dominance of these two seasons may occur simply as a result of the high frequency of very heavy falls at these times of year. Any generalization about an evenness of rainfall distribution across the seasons must be applied with some care, however. For example, while summer rainfall represents, on average, some thirty-one per cent of the annual total, its contribution in individual years can vary between ten and sixty per cent. Likewise the spring months, which on average produce about one fifth of Wollongong's annual rainfall, can produce more than twice this proportion in some years. The general condition of low seasonality can, therefore,

TABLE 1: THE SEASONAL DISTRIBUTION OF RAINFALL AT WOLLONGONG

	Summer	Autumn	Winter	Spring
% of average a .nual rainfall:	31.1	27.4	21.9	19.6
Some individu.. years:				
1953	18.4	58.3	7.8	15.5
1961	17.7	22.7	15.4	44.2
1964	12.0	27.2	47.3	13.5
1971	59.8	22.1	10.3	7.8

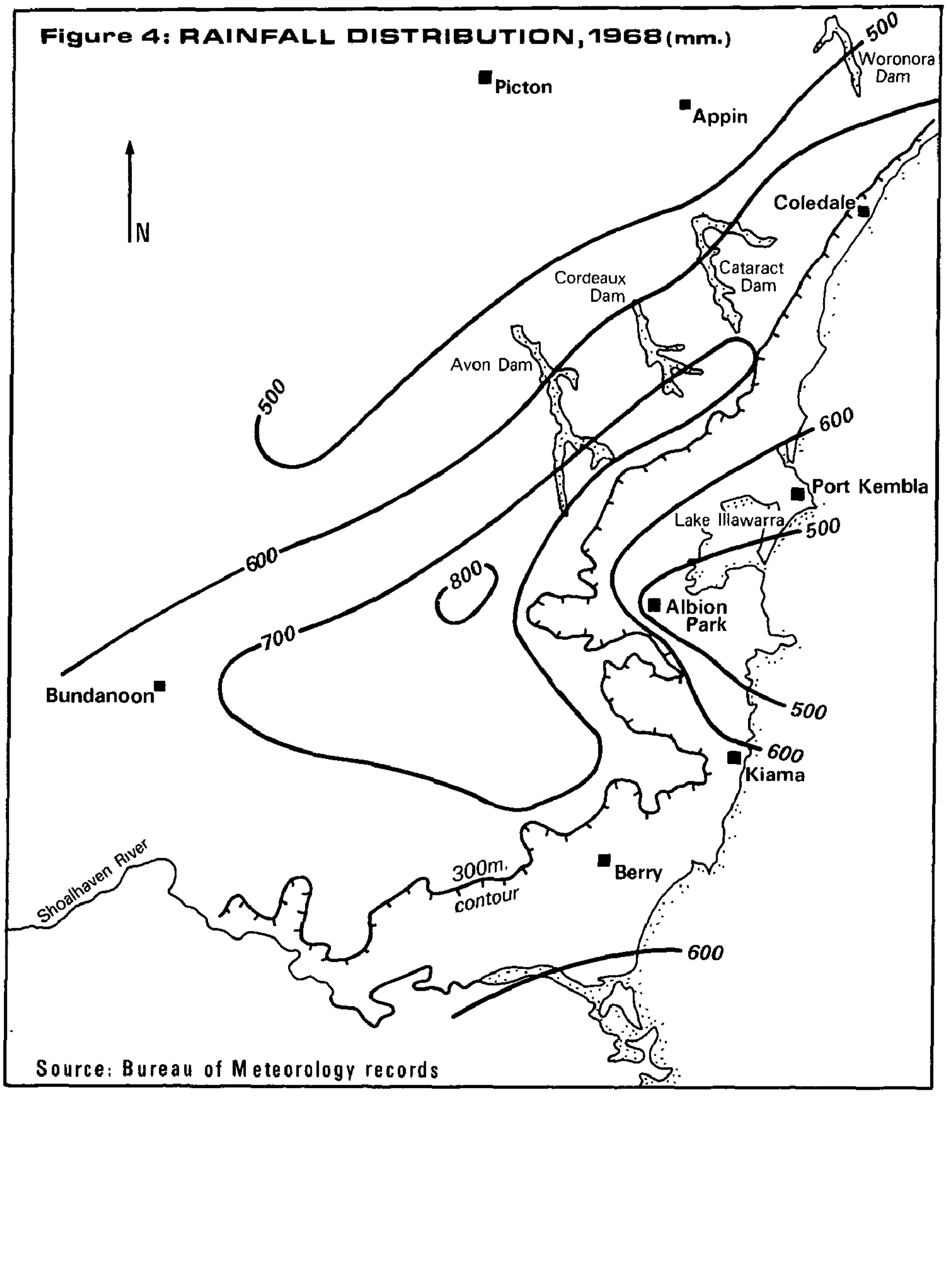
Source: Bu eau of Meteorology records.

be violated in certain years. Likewise the slight tendency toward summer and autumn maxima can be violated when high-intensity falls occur infrequently or fail to occur between January and April.

CYCLIC VARIATIONS

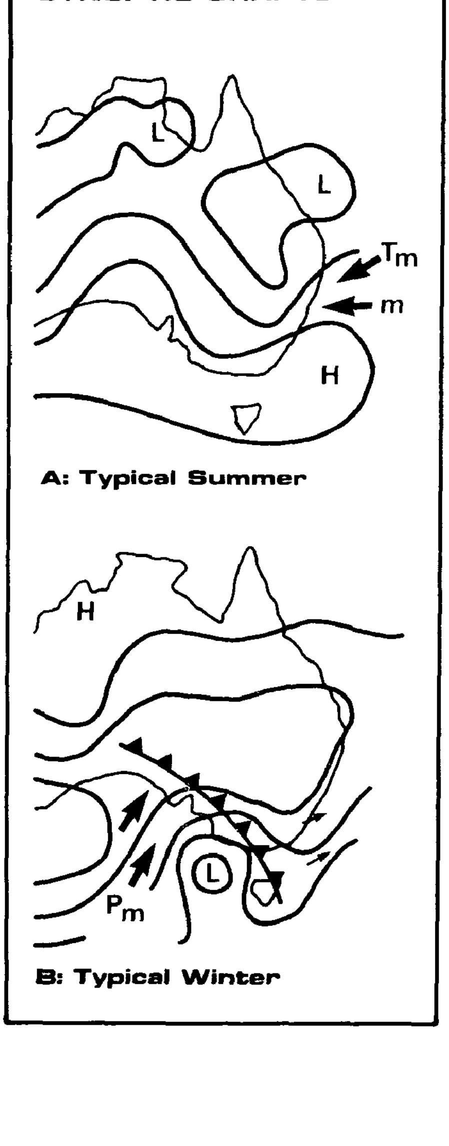
Not all variations in precipitation totals can be explained simply in terms of differences between years and seasons as regards the behaviour of wind and pressure systems. Evidence is accumulating that other factors are operative and may act to produce cycles of wet and dry periods of varying lengths. At Wollongong, rainfall records suggest that these cycles exist. Precipitation totals may diverge considerably from the annual average of 1271 mm (the extreme values over the past 45 years were 2542 in 1950 and 568 mm in 1968); more particularly, wet and dry years appear to occur in 'runs' of some years' duration (Figure 6). The recent drought (1979-82) which has characterized most of New South

Figure 4: RAINFALL DISTRIBUTION, 1968 (mm.)



Source: Bureau of Meteorology records

Figure 5: SYNOPTIC CHARTS



Wales is clearly evident in the Wollongong data.

Variation within a 2-5 year cycle of wet and dry years can be explained by oscillations in global climate (Linacre and Hobbs, 1977, Ch.12). Cycles working themselves out over periods of about a decade (as evidenced by unusually dry periods centred on 1944, 1957 and 1968) may be linked to sunspot cycles (Linacre and Hobbs, 1977, Ch.10). Variations on a 40-50 year cycle may also be present. In south-eastern Australia a series of predominantly wet years occured between 1850 and 1890 and again between 1945 and 1978, with the years between 1890 and 1945 being generally drier (Riley, 1980). Data from Albion Park show that the frequency of wet years has been much higher since 1945 than was the case during the preceding half-century (Young and Johnson, 1977, 47). Explanations for this extended wet-dry cyclical pattern have included sunspot activity, volcanic activity and general changes in the pattern of pressure systems. It is possible, however, that much of the variation may be the result simply of random fluctuations (Dury, 1980). Certainly these variations are as yet far from being clearly understood.

CONCLUSION

Topographic characteristics determine how rainfall is shared over the Illawarra, and the fact that the areal pattern of precipitation varies little between wet and dry years illustrates the strong role of the escarpment as a controller of rainfall distribution within the region. How much moisture is available to fall as precipitation, however, is a function of atmospheric conditions over a much wider area. The distribution of precipitation across seasons and years is quite erratic and presumably derives from variations in the influence of different weather systems at different times. At present, more is known about the mechanisms underlying the distribution of rainfall over space than over time.

REFERENCES

Dury, G. (1980) Step-Functional Changes in Precipitation at Sydney, **Australian Geographical Studies**, 18 (1), 62-78.

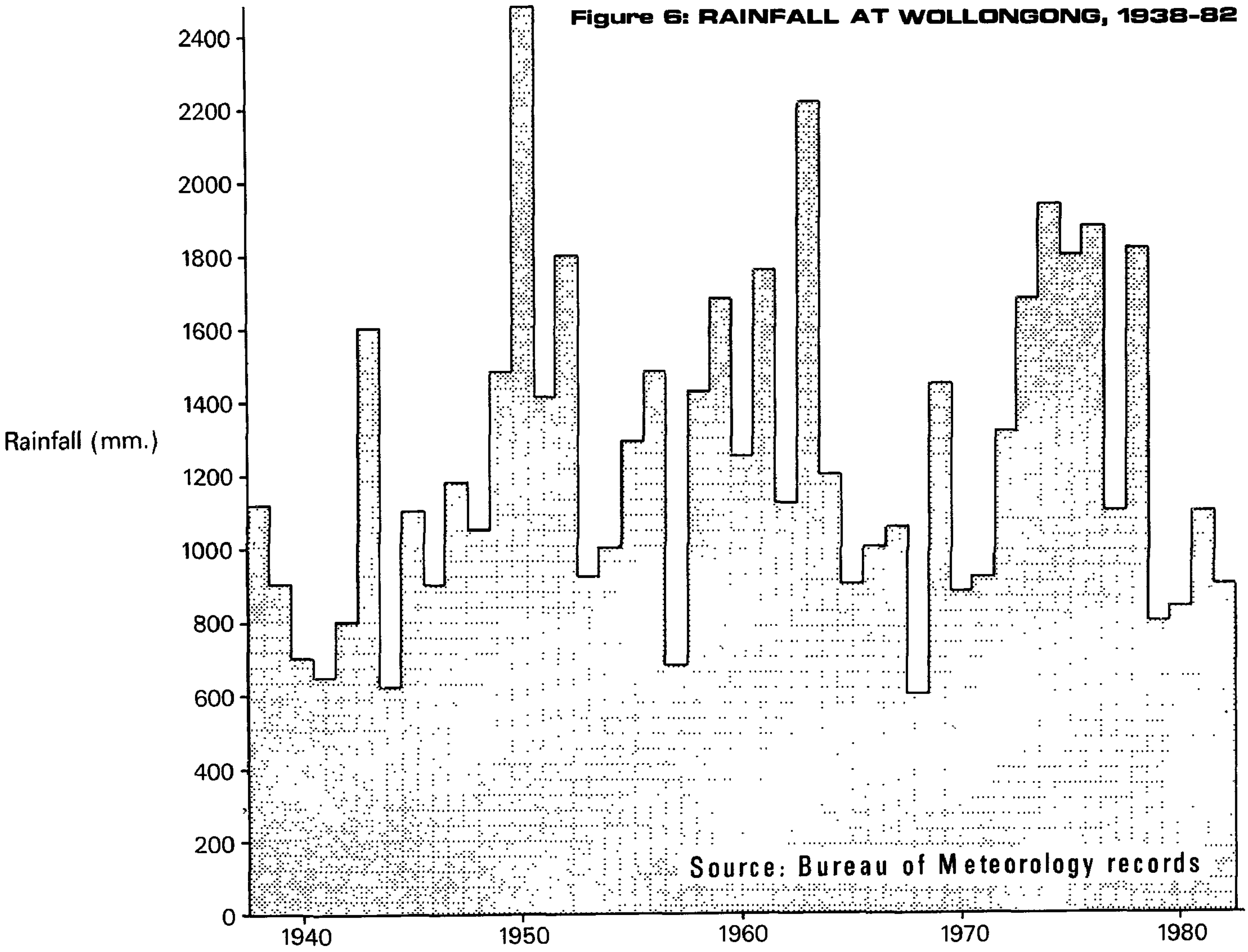
Linacre, E. and Hobbs, J. (1977) **The Australian Climatic Environment**, Brisbane, Jacaranda-Wiley.

Riley, S.J. (1980) Aspects of the Flood Record at Windsor, **Proceedings, Institute of Australian Geographers Conference**, Bathurst, 325-39.

Schermerhorn, V.P. (1967) Relations Between Topography and Annual Precipitation in Western Oregon and Washington, **Water Resources Research**, 3 (3), 707-11.

Young, R.W. and Johnson, A.R.M. (1977) The Physical Setting: Environmental Hazards and Urban Planning in Urban Illawarra, in R. Robinson (ed.) **Urban Illawarra**, Melbourne, Sorrett, 38-57.

Figure 6: RAINFALL AT WOLLONGONG, 1938-82



For further information, on the series, contact
The Department of Geography,
University of Wollongong,
WOLLONGONG. N.S.W. 2500
Telephone: 282939 or 282957

Department of Geography, The University of Wollongong, 1983.